

2012

기계공학과 안내

The Department of Mechanical Engineering

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 - 1) 이태수 Taesoo Lee
 - 2) 이형일 Hyungil Lee
 - 3) 정현용 HyunYong Jeong
 - 4) 신충수 Choongsoo Shin
2. 열, 유체, 및 에너지 분야 Division of Thermal, Fluids and Energy Engineering _ 23
 - 1) 정시영 Siyoung Jeong
 - 2) 허남건 Nahmkeon Hur
 - 3) 손기현 Gihun Son
 - 4) 김대중 Daejoong Kim
 - 5) 강성원 Seongwon Kang
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 - 1) 전도영 Doyoung Jeon
 - 2) 이승엽 Seung-Yop Lee
 - 3) 박정열 Jungyul Park
 - 4) 공경철 Kyoungchul Kong
4. 생산공학 분야 Division of Manufacturing Engineering _ 25
 - 1) 김낙수 Naksoo Kim
 - 2) 최범규 Bumkyoo Choi
 - 3) 김동철 Dongchul Kim
 - 4) 이철수 Cheolsoo Lee
 - 5) 이정철 Jungchul Lee

IV. 연구실 소개 Research Laboratories

1. 바이오공학 연구 그룹 Bioengineering Research
 - 1) 호흡역학 & 장치 연구실 Respiratory Mechanics & Devices Laboratory _ 28
 - 2) 바이오모방 및 정밀기기 연구실 Biomimetics and Precision Device Laboratory _ 33
 - 3) MSM 연구실 Sogang Microsystems & Smart Material Laboratory _ 39
 - 4) 자동차 메카트로닉스 및 바이오 역학 연구실 Automotive Mechatronics & Bio Mechanics Laboratory _ 128

- 5) 나노바이오시스템 및 매니퓰레이션 연구실 Nano Biosystems and Manipulation Laboratory _ 47
- 6) 생체역학 & 의공학 연구실 Sogang Biomechanics and Biomedical Engineering Laboratory _ 52

2. 유체 및 복합체 연구그룹 Research on Fluid and Composite Materials

- 1) 호흡역학 & 장치 연구실 Respiratory Mechanics & Devices Laboratory _ 28
- 2) 정형가공 연구실 Net Shape Manufacturing Laboratory _ 116
- 3) 다중물리 전산유체 연구실 Multi-physics Computational Fluid Dynamics Laboratory _ 58
- 4) 다상 열전달 연구실 Sogang Multiphase Heat Transfer Laboratory _ 64
- 5) 자동차 메카트로닉스 및 바이오 역학 연구실 Automotive Mechatronics & Bio Mechanics Laboratory _ 128
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- 7) 응용유체역학 연구실 Applied Fluid Mechanics Laboratory _ 75

3. 에너지공학 연구그룹 Research on Energy Science

- 1) 열공학 연구실 Thermal Engineering Laboratory _ 82
- 2) 다상 열전달 연구실 Sogang Multiphase Heat Transfer Laboratory _ 64
- 3) 에너지-워터 넥서스 연구실 Sogang Energy-Water Nexus (SEWN) Laboratory _ 87

4. 메카트로닉 시스템 연구그룹 Dynamic Systems, Controls and Mechatronics

- 1) 정밀제어 및 인간 메카트로닉스 연구실 Precision Control & Human Mechatronics Laboratory _ 94
- 2) 바이오모방 및 정밀기기 연구실 Biomimetics and Precision Device Laboratory _ 33
- 3) 자동차 메카트로닉스 및 바이오 역학 연구실 Automotive Mechatronics & Bio Mechanics Laboratory _ 128
- 4) CAD/CAM 연구실 Sogang University CAD/CAM Laboratory _ 121
- 5) 로봇시스템 제어 연구실 Robotic Systems Control Laboratory _ 100

5. 마이크로/나노 시스템 연구그룹 Research on Micro/Nano Systems

- 1) 전산역학 연구실 Computational Mechanics Laboratory _ 106
- 2) MSM 연구실 Sogang Microsystems & Smart Material Laboratory _ 39
- 3) 나노바이오시스템 및 매니퓰레이션 연구실 NanoBiosystems and Manipulation Laboratory _ 47
- 4) 나노 정밀 계측 연구실 Nanoscale Precision Sensing Laboratory _ 111

6. 고급가공기술 연구그룹 Research on Advanced Manufacturing Technologies

- 1) 정형가공 연구실 Net Shape Manufacturing Laboratory _ 116
- 2) 전산역학 연구실 Computational Mechanics Laboratory _ 106
- 3) CAD/CAM 연구실 CAD/CAM Laboratory _ 121

7. 자동차공학 연구그룹 Research on Automotive Engineering

- 1) 정형가공 연구실 Net Shape Manufacturing Laboratory _ 116
- 2) 자동차 메카트로닉스 및 바이오 역학 연구실 Automotive Mechatronics & Bio Mechanics Laboratory _ 128
- 3) 다중물리 & 다중스케일 시스템 연구실 Multiphysics & Multiscale Systems Laboratory _ 70

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- 1. Multi-phenomena CFD ERC _ 136
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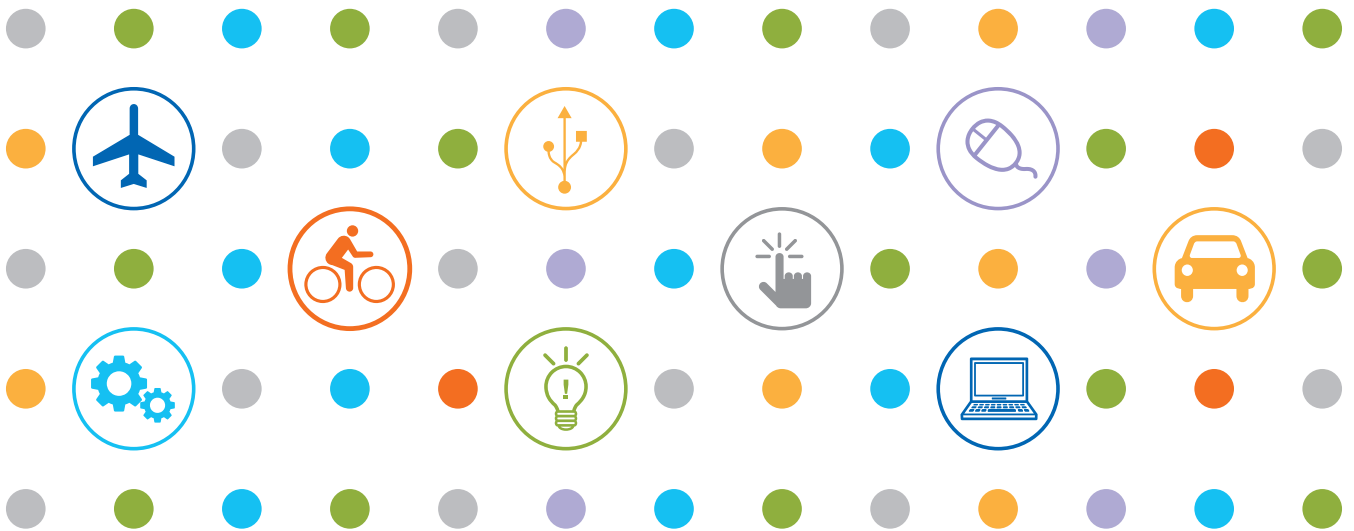
engineering



industry



technology



The Department of Mechanical Engineering

I. 기계공학과 소개

1. 교육목표 및 교육과정
Objectives and Academic Programs
2. 연혁
History
3. 2012 기계공학과 비전과 전략
Vision & Strategy in 2012

기계공학과 소개

1. 교육목표 및 교육과정

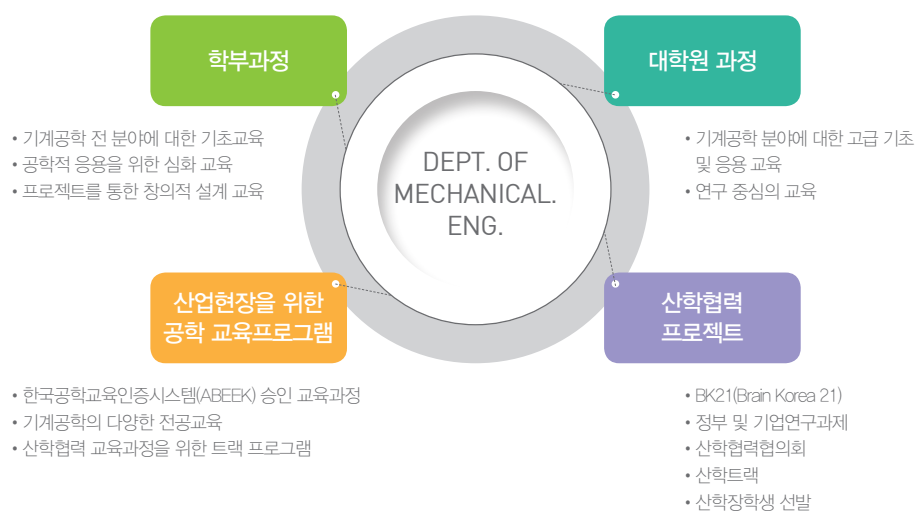
교육목표

기계공학을 기반으로 다양한 분야에서의 종합적인 설계 및 신기술의 창조적 융합에 기여할 수 있는, 독립성과 도전 정신, 봉사 정신을 갖춘 미래형 인재를 양성한다.

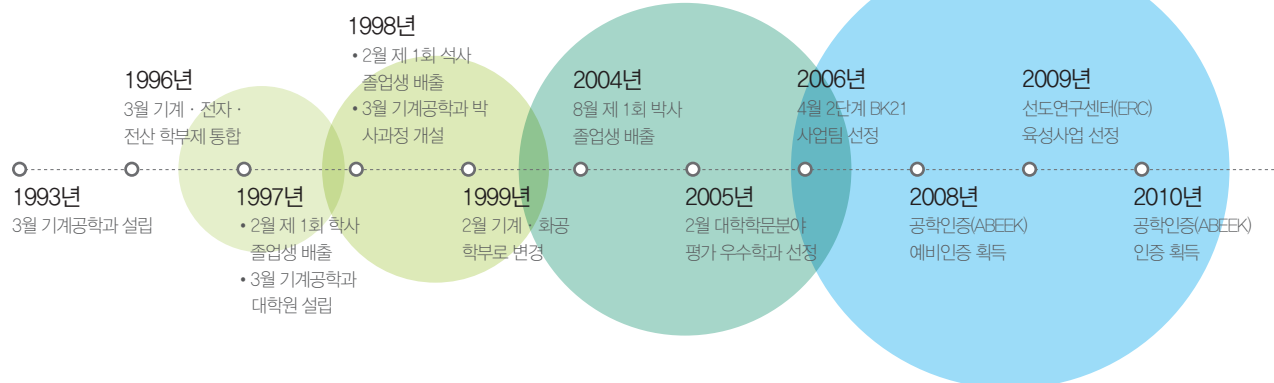
세부교육목표

- 가치 지향적 교육을 통해 남을 위하여 봉사하는 공학인 양성
- 전공 분야에서의 탁월성, 비판적 판단력, 설득력 등을 골고루 갖추어 급변하는 사회에서 창의적으로 대응할 수 있는 미래형 인재 양성
- 기계공학을 기반으로 다양한 분야에서의 종합적인 설계 및 신기술의 창조적 융합을 이룰 수 있는 실력 있는 인재 양성

교육과정



2. 연혁



3. 2012 기계공학과 Vision & Strategy

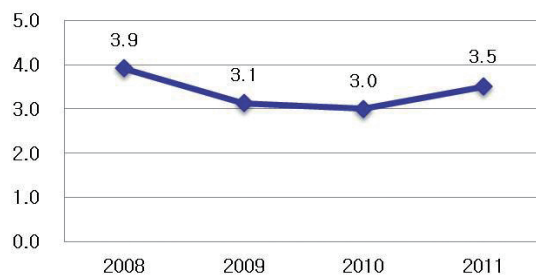
목표 및 추진 전략

목 표	국내 최고수준의 교육경쟁력, 고객만족도, 연구실적, 교육비용			
2012년도	- 학부연구생 의무화 - 발전기금을 통한 장학금 대폭 확충 - 대학원생 확충 : 본교, 타교, 외국인 - 교수진-동문-기업-재학생 연대감 - 효율적 인센티브			
전략&비전	인적자원 확보	자체재정 확보	교육비용 증대	네트워크 인프라 구축
	연구원, 대학원생, 학부, 연구생, 행정 인력	발전기금, 장학금	대형 연구 과제	동문-기업-학부모

인적 자원 및 연구 실적

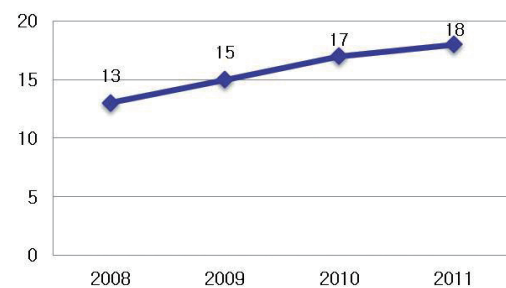
- 우수 교수진 (MIT, U.C. Berkeley, Stanford 등 출신)
- 최근의 공격적인 교수충원으로 대학원생 1인당 교수수 최고 수준
- 전임교수 18명, 연구교수 5명, 행정직원 5명, 대학원생 63명, 학부생 315명
- 발표 논문 : SCI급 57편 (교수1인당 1.07편/ 대학알리미 산정기준)
- 1인당 SCI 급 논문수 최고 상승률 : 연간 74 %
- 연구비 : 64억원(교수 1인당 3.6억원)
- 특허 출원/등록: 34건

대학원생수/전임교원(명)



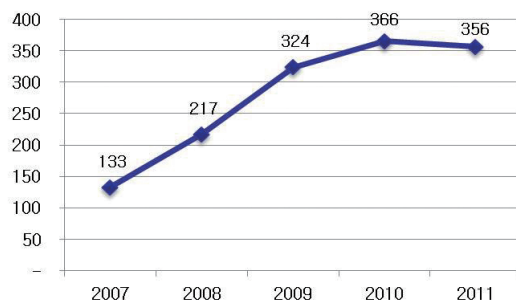
대학원생 1인당 교수수 최고 수준

전임교원수(명)



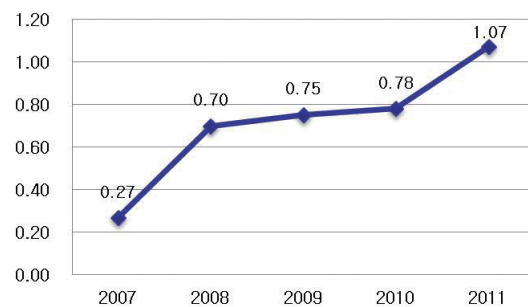
전임교원수 지속적 증가 (향후 계속)

연구비(백만원)/전임교원



전임교수당 연구비 최고 수준 & 지속적 증가

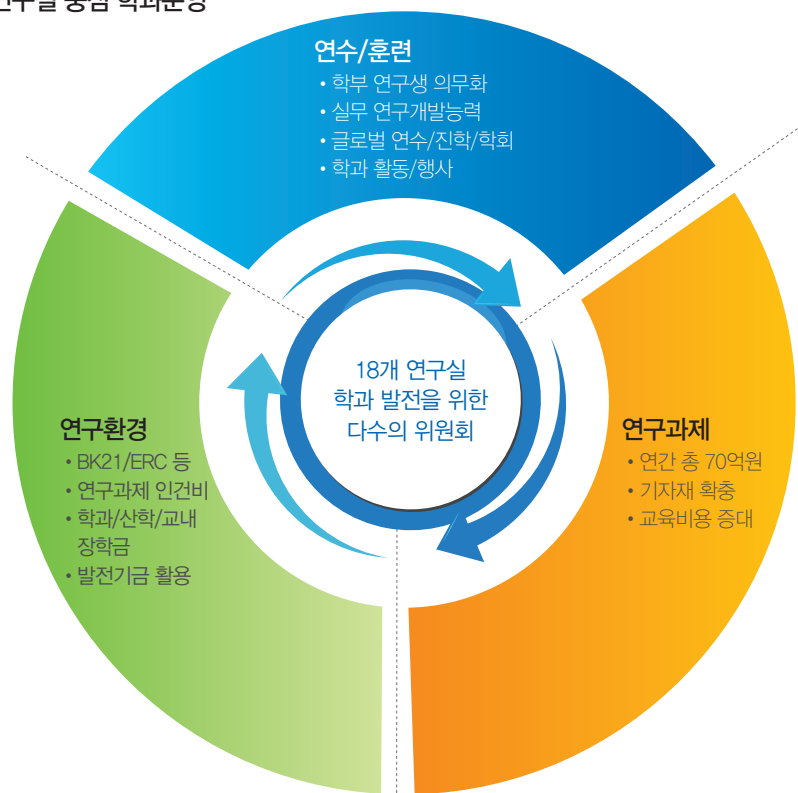
SCI 급 논문실적/ 전임교원



연구결과 다수 발표

기계공학과 발전 추진계획

• 연구실 중심 학과운영



• 산학협력 프로그램

1) 산학협력협의회

대기업과 맞춤형 인력 양성, 인턴, 현장견학, 공동 연구 개발 등을 추진하며, 중소기업과는 가족회사를 구성하여 상호 협력하는 단체

참여 기업 : 기신정기, 진영정기, 삼성전자, 삼성테크윈, 두산인프라코어, 피닉스테크, CSCAM, 산업기술평가원, 국제통상전략연구원, (주)옥서스, 유진테크, Y.T 몰드테크

2) 산학트랙 프로그램

기업체와 기계공학과가 협력하여 교과과정을 선정하고, 학생에게 이수체계를 제시하는 프로그램

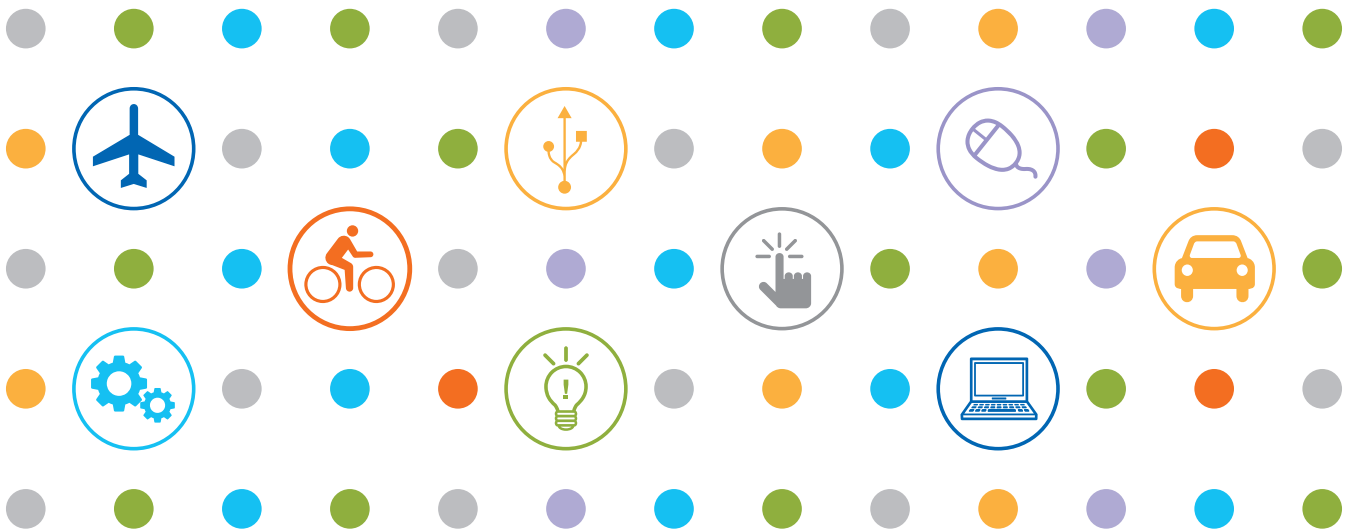
삼성STP(삼성전자), SEC첨단금형기술 전공(삼성전자), 두산인프라코어(추진 중)

3) 산학장학생 선발

삼성전자, 삼성테크윈, 두산인프라코어, 현대기아자동차, 한국타이어, 포스코, LG디스플레이 등, 국내 우수 대기업 등

• 기계공학과 제 위원회

공학인증 운영위원회	• PD 교수: 김낙수, 부PD: 김대중 • 기계공학과 심화과정 (ABEEK) 운영
교과과정위원회	• 위원장: 김낙수 • 공학인증 부PD, 전 부PD • 기타 위원회에 소속되지 않은 교수
연구력강화위원회 겸 공학인증 평가위원회	• 위원장: 이형일 • 대학원 학위과정 절차 진행 • 교수 연구실적 관리 • 대학원/연구원/연구교수 리크루팅 • 국제 협력 업무
대외협력위원회 겸 공학인증 자문위원회	• 위원장: 최범규 • 학과 발전기금/동문, 교수 - 재학생 간담회 주선 • 학과홍보/학부생 리크루팅
홍보위원회	• 위원장: 손기현 • 고교생 대상 홍보 행사 및 자료 제작 • 홈페이지 관리



The Department of Mechanical Engineering

II. 교과과정 Curriculum

1. 교과목 안내

Academic Courses in Mechanical Engineering Department

2. 산학협력 프로그램

Educational and Research Programs in Cooperation with Industry

1. 교과목 안내 Academic courses

▶ 학부 기계공학 심화과정 교과과정

구 분 (Category)	교 과 목 명 (Course name)	선 수 과 목 (Prerequisite)	대표이수학기		비 고 (Note)
			학년 (Year)	학기 (Semester)	
전문교양 (19학점) (General courses 19units)	읽기와 쓰기 Reading and Writing		1	1	필수
	계열별 글쓰기 Academic & Professional Writing		1	2	필수
	영어 I English I		1	1	필수
	영어 II English II		1	2	필수
	철학적 인간학 Philosophical Anthropology		2	1/2	택1
	신학적 인간학 Theological Anthropology		2	1/2	
	그리스도교 윤리 Christian Ethics		2	1/2	
	그리스도교 사상 Christian Thought		2	1/2	
	신의문제 The Problem of God		2	1/2	
	윤리와가치 Ethics and Values		1-4	1/2	택1
	논리와 비판적 사고 Logic and Critical Thinking		1-4	1/2	
	철학 산책 Philosophical Problems		1	1	
	종교와 세계문화 Religion and Culture		1-4	1/2	
	과학사 History of Science		1-2	1/2	택1
	법과 공학 Law and Engineering		1-2	1/2	
	기업과 공학 Business and Engineering		1-2	1/2	
공학기초 (MSC) (35학점)	미적분학Ⅰ Analytic Geometry and Calculus I		1	1	필수
	미적분학Ⅱ Analytic Geometry and Calculus II	미적분학Ⅰ	1	2	필수
	포트란프로그래밍 Fortran Programming		1	1/2	택1
	C언어 C Programming		1	1/2	
	공학수학Ⅰ Engineering Mathematics I		2	1	필수
	공학수학Ⅱ Engineering Mathematics	공학수학Ⅰ	2	2	필수
	일반물리Ⅰ General Physics I		1	1	필수
	일반물리Ⅱ General Physics II	일반물리Ⅰ	1	2	필수
	일반화학Ⅰ General Chemistry I		1	1	필수
	일반물리실험Ⅰ General Physics Laboratory I		1	1/2	필수
	일반물리실험Ⅱ General Physics Laboratory II	일반물리실험Ⅰ	1	2	필수
	일반화학Ⅱ General Chemistry II	일반화학Ⅰ	1	2	택1 수강 시 MSC 학점으로 인정
	일반생물학 General Biology I		1	1	
	일반화학실험Ⅰ General Chemistry Laboratory I		1	1	
	일반화학실험Ⅱ General Chemistry Laboratory II	일반화학실험Ⅰ	1	2	

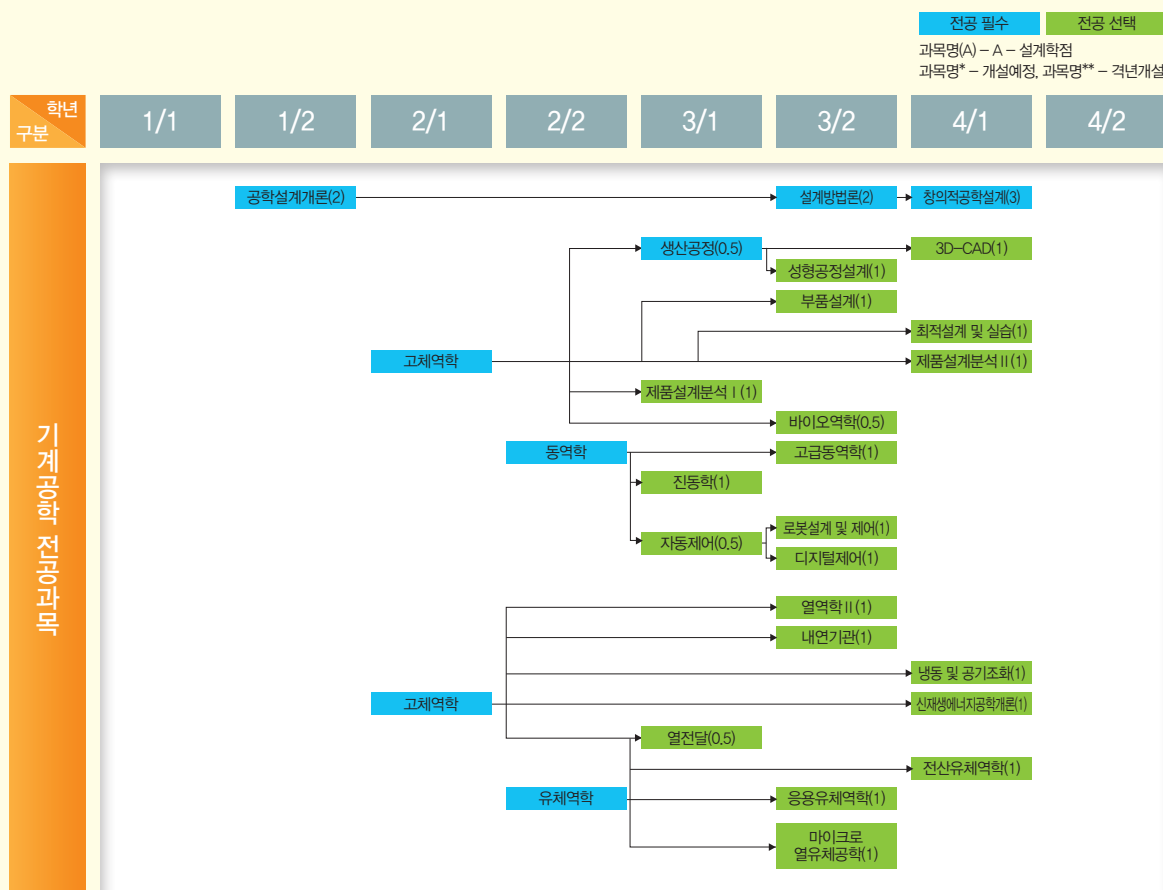
	통계학입문 Introduction to Statistics		2-3	1/2	수강시 MSC 학점으로 인정
	공학수치해석 Numerical Analysis		3	1	필 수
	기계공학해석 Mechanical Engineering Analysis		3	1	필 수
전공필수 (Required major)	공학설계개론 Introduction to Engineering Design		1	2	필 수
	동역학 Dynamics		2	2	필 수
	설계방법론 Design Methodology	공학설계개론	3	2	필 수
	창의적공학설계 Creative Engineering Design	설계방법론	4	1	필 수
	열역학 Thermodynamics I		2	1	필 수
	유체역학 Fluid Mechanics		2	2	필 수
	고체역학 Solid Mechanics		2	1	필 수
	생산공정 Manufacturing Processes	고체역학	3	1	필 수
	모형설계제작 Manufacturing Laboratory		3	1/2	필 수
	기계공학실험 Mechanical Engineering Laboratory I		3	2	필 수
전공선택 (Optional)	2D-CAD		2	1/2	전공 필수 교과목포함 60학점 이상 이수
	기계공학개론 Introduction to Mechanical Engineering		1	1	
	디자인과재료 Materials for Mechanical Design		2	2	
	제품설계분석1-신뢰도 Product Design Analysis I: Reliability	고체역학	3	1	
	진동학 Vibration	동역학	3	1	
	부품설계 Mechanical Component Design	고체역학	3	2	
	내연기관 Thermo Machinery	열역학1	3	2	
	자동제어 Automatic Control	동역학	3	1	
	응용유체역학 Fluid Machinery	유체역학	3	2	
	성형공정설계 Process Analysis and Design	생산공정	3	2	
	냉동및공기조화 Refrigeration	열역학	3-4	1	
	열전달 Heat and Mass Transfer	유체역학, 열역학	3	1	
	MEMS설계제작 MEMS Design and Fabrication		4	1	
	계측및신호처리 Measurement and Signal Processing		4	2	

전공선택 (Optional)	바이오모방공학개론 Introduction to Biomimetics		4	2	전공 필수 교과목포함 60학점 이상 이수
	전산유체역학 Computational Fluid Dynamics	유체역학	4	1	
	디지털제어시스템 Digital Control Systems	자동제어	3	2	
	바이오역학 Biomechanics	고체역학	3	2	
	제품설계분석2-FEA FEA Product Design Analysis II: FEA	고체역학	4	1	
	신재생에너지공학개론 Introduction to Renewable Energy Systems	열역학	4	2	
	로봇설계 및 제어 Robot Design and Control	자동제어	3	2	
	기계공학세미나 Seminar in Mechanical Engineering		3,4	2	
	정역학 Statics		2	1/2	
	기구설계 Mechanism Analyses and Design		2	1/2	
	제품설계기초 Fundamentals of product design	모형설계제작	2	1/2	
	열역학 II Thermodynamics II	열역학	3,4	2	
	3D-CAD 및 실습 3D-CAD	생산공정	3,4	1/2	
	최적설계 및 실습 Optimal Design	고체역학	3,4	1/2	
	고급동역학 Advanced Dynamics	동역학	3,4	1/2	
	자동차공학 Automobile Engineering		3,4	1/2	
	마이크로열유체공학 Micro Thermal Fluid Engineering	유체역학	4	1/2	
	마이크로프로세서 응용 Application of Microprocessor		3,4	1/2	
	기계가공 Mechanical Machining		3,4	1/2	
	연속체역학 Continuum mechanics	고체역학, 유체역학			
	유한요소법개론 Introduction to FEM	공학수치해석			
	기계공학실험II Mechanical Engineering Laboratory II		3,4	2	
	기술혁신과산업화전략 Strategic Management of Technological Innovation		3	1	
	특수연구 Special Topics		4	1/2	

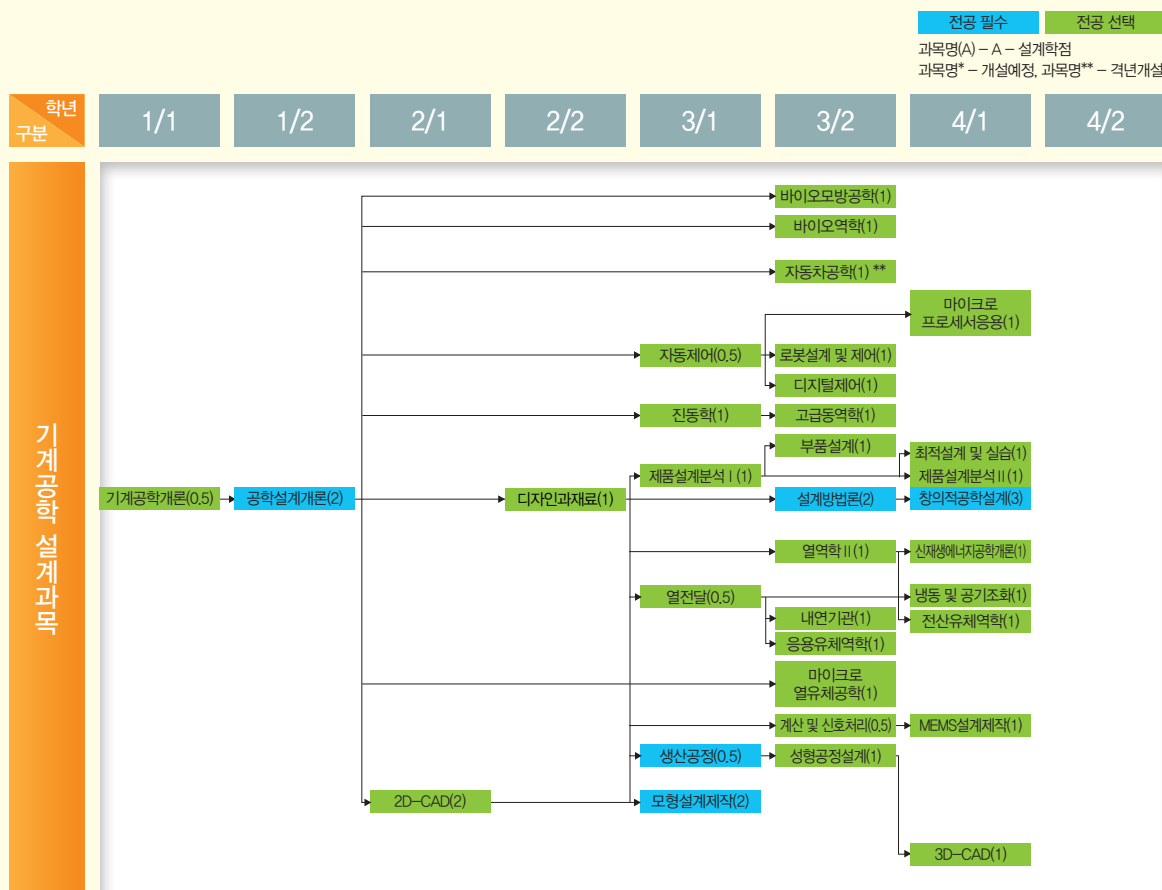
▶ 기계공학 프로그램 교과과정 이수체계도

기계공학 프로그램을 이수하는 학생들은 다음과 같은 순서로 교과목들을 이수할 것을 권장한다.

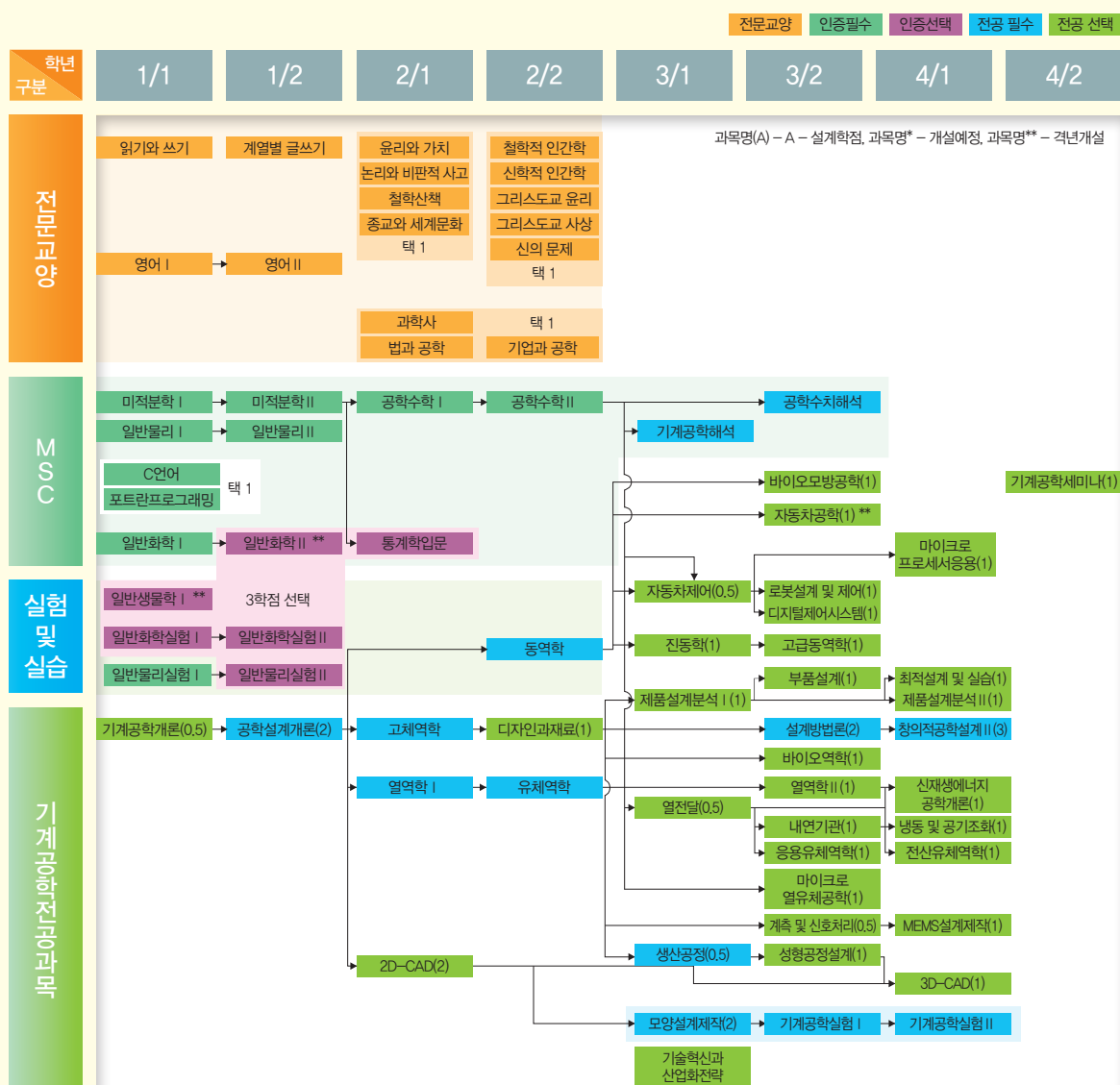
기계공학과 전공과목 선수·후수 체계도



기계공학과 설계 과목 이수 계통도



기계공학과 과목 이수 계통도



2. 산학협력 프로그램 Educational and Research Programs in Cooperation with Industry

공과대학 및 기계공학과 차원의 산학협력 프로그램을 통해 기업 맞춤형 인재를 양성하고 있다. 각 기업체와 학과가 협력해 관련 분야에 필요한 기술과 교과 과정을 선정하고, 트랙 프로그램을 이수한 장학생을 선발하여 장학금 지급 및 취업의 기회를 보장한다. 교육과정의 내실화 기여뿐만 아니라 장학금 재원도 확보함으로써 교육 환경을 지속적으로 개선할 수 있다.

1) 학부과정

트랙명	하이닉스 반도체
목적	반도체 및 설계기술인력양성 'SoHy II 프로그램' 설치운영
기간	2008년 3월 ~ 2014년 2월
대상	전자공학, 물리학, 화공생명공학 (반도체 분야 전공)
규모	연간 20명 이상
선발자격	하이닉스 지정트랙 이수 / TOEIC 650 이상 / 평점 2.87(4.3만점) 이상
혜택	등록금 및 매월 학비보조금 지원 (학사 : 20만원 / 석사 : 30만원)

트랙명	삼성STP 트랙
목적	삼성전자 산학 인력양성
기간	2011년 ~ 2014년 (4년)
대상	공학부 전체 (전자, 컴퓨터, 화공, 기계)
규모	연간 00명
선발자격	6학기 (3학년) 에 이수예정자 지원 / 방학 중 인턴수행 후 삼성전자 합격 필요
혜택	트랙 장학금 지원

트랙명	삼성전자 반도체 트랙 프로그램 (SSEC)
목적	반도체 및 설계 분야 우수인재 육성
기간	2006년 2월 ~ 2013년 2월 (7년)
대상	전자공학과
규모	연간 30명 이상
선발자격	삼성전자 지정트랙 이수 / TOEIC 스피킹5등급 이상 외 / 평점 2.87 (4.3만점) 이상
혜택	장학금 지급 / 인턴십 지원 / 입사보장

트랙명	LG이노텍 트랙 프로그램
목적	전자, 부품, 시스템 및 소재 분야의 고급인력 양성 프로그램 설치운영
기간	2010년 9월 ~ 2014년 9월 (4년)
대상	전자공학과
규모	연간 10명
선발자격	LG이노텍 지정트랙 이수 / TOEIC 스피킹110점 이상 / 평점 2.87 (4.3만점) 이상
혜택	등록금 및 매월 학비보조금 지원 (학사 : 20만원 / 석사 : 40만원, 박사 : 80만원)

2) 대학원 과정

트랙명	SEC 첨단금형기술 전공
목적	금형개발 특성화 인재양성
기간	2012년 3월 ~ 2017년 2월
대상	기계공학과 대학원 입학생
규모	매년 3명(박사 1명, 석사 2명)으로 5년간 15명
선발자격	지정 과목 이수 및 삼성전자 채용 프로세스 통과한 자
혜택	전기간 장학금 지급 및 삼성전자 우선 채용 보장

트랙명	엠텍비전 트랙
목적	반도체 및 소프트웨어 분야 우수인재 발굴 및 양성
기간	2011년 8월 ~ 2015년 7월 (4년)
대상	전자공학과 석사 / 또는 석사 진학예정자
규모	연간 2명
선발자격	지정 과목 이수 / 평점 2.87 (4.3만점) 이상 (학사지원자) / 외국어성적 우수자 우대
혜택	장학금지급



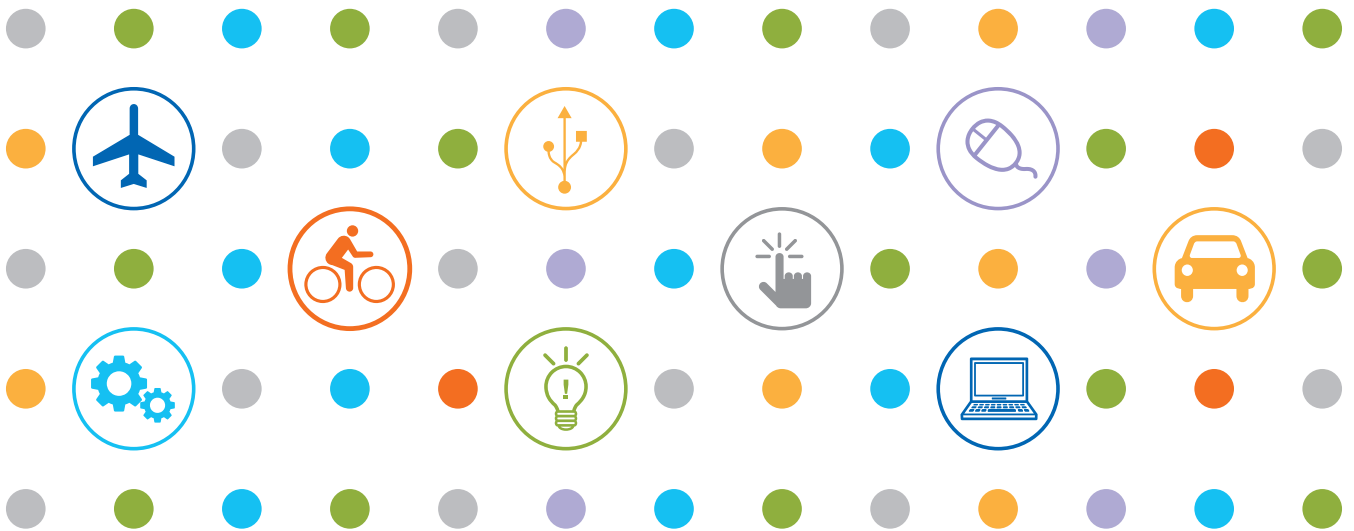
engineering



industry



technology



The Department of Mechanical Engineering

III. 기계공학과 교수진

List of Faculty Members

1. 설계 및 재료역학 분야

Division of Design and Mechanics

- | | |
|-----------------------|----------------------|
| 1) 이태수 Taesoo Lee | 2) 이형일 Hyungil Lee |
| 3) 정현용 HyunYong Jeong | 4) 신종수 Choongsu Shin |

2. 열, 유체, 및 에너지 분야

Division of Thermal, Fluids and Energy Engineering

- | | |
|----------------------|---------------------|
| 1) 정시영 Siyoung Jeong | 2) 허남건 Nahmkeon Hur |
| 3) 손기현 Gihun Son | 4) 김대중 Daejong Kim |
| 5) 강성원 Seongwon Kang | |

3. 제어, 진동, 로봇틱스 분야

Division of Control, Vibration and Robotics

- | | |
|---------------------|------------------------|
| 1) 전도영 Doyoung Jeon | 2) 이승엽 Seung-Yop Lee |
| 3) 박정열 Jungyul Park | 4) 공경철 Kyoungchul Kong |

4. 생산공학 분야

Division of Manufacturing Engineering

- | | |
|---------------------|---------------------|
| 1) 김낙수 Naksoo Kim | 2) 최범규 Bumkyoo Choi |
| 3) 김동철 Dongchul Kim | 4) 이철수 Cheolsoo Lee |
| 5) 이정철 Jungchul Lee | |

1. 설계 및 재료역학분야 Division of Design and Mechanics



이태수 교수 Prof. Taesoo Lee

호흡역학 & 장치연구실 / 28p
Respiratory Mechanics & Devices Laboratory

- 전공분야 : 최적설계
- 학 력 : 서울대학교 기계설계 학사
서울대학교 기계설계 석사
Ohio State University 기계공학 박사
- E-mail : tslee@sogang.ac.kr
- Research area : Optimal design
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Ohio State Univ., USA



이형일 교수 Prof. Hyungyil Lee

전산역학 연구실 / 106p
Computational Mechanics Laboratory

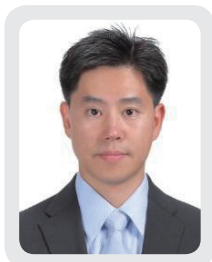
- 전공분야 : 전산설계
- 학 력 : 서울대학교 기계공학 학사
한국과학기술원(KAIST) 기계공학 석사
미국 MIT 기계공학 박사
- E-mail : hylee@sogang.ac.kr
- Research area : Computational design
- Education : B.S. from Seoul Nat'l Univ.
M.S. from KAIST
Ph.D. from MIT, USA



정현용 교수 Prof. Hyun-Yong Jeong

자동차 메카트로닉스 및 바이오역학 연구실 / 128p
Automotive Mechatronics & Bio Mechanics Laboratory

- 전공분야 : 기계공학설계
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계설계학 석사
Michigan University 기계공학 박사
- E-mail : jeonghy@sogang.ac.kr
- Research area : Mechanical design
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Univ. of Michigan, USA



신충수 교수 Prof. Choongsu Shin

생체역학 & 의공학 연구실 / 52p
Sogang Biomechanics and Biomedical Engineering Laboratory

- 전공분야 : 생체역학
- 학 력 : 한양대학교 기계설계학 학사
Stanford University 기계공학 석사
Stanford University 기계공학 박사
- E-mail : cshin@sogang.ac.kr
- Research area : Biomechanics
- Education : B.S. from Hanyang Univ.
M.S. from Stanford Univ., USA
Ph.D. from Stanford Univ., USA

2. 열, 유체 및 에너지 분야 Division of Thermal, Fluids and Energy Engineering



정시영 교수 Prof. Siyoung Jeong

열공학 연구실 / 82p
Thermal Engineering Laboratory

- 전공분야 : 열공학
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
독일 아헨 공대 기계공학 박사
- E-mail : syjeong@sogang.ac.kr

- Research area : Thermal engineering
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from RWTH Aachen, Germany



허남건 교수 Prof. Nahmkeon Hur

다중물리 전산유체 연구실 / 58p
Multi-physics Computational Fluid Dynamics Laboratory

- 전공분야 : 전산유체역학
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
Stevens Inst. Tech. 기계공학 박사
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- Research area : Fluid machinery
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Stevens Inst. Tech., USA



손기현 교수 Prof. Gihun Son

다상 열전달 연구실 / 64p
Sogang Multiphase Heat Transfer Laboratory

- 전공분야 : 열전달
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
미국 UCLA 기계공학 박사
- E-mail : gihun@sogang.ac.kr

- Research area : Heat transfer
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from UCLA, USA



김대중 교수 Prof. Daejoong Kim

에너지-워터 넥서스 연구실 / 87p
Sogang Energy-Water Nexus (SEWN) Laboratory

- 전공분야 : 에너지 및 수처리 기계공학
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
Stanford University 기계공학 박사
- E-mail : daejoong@sogang.ac.kr

- Research area : Energy-water nexus engng.
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Stanford Univ., USA



강성원 교수 Prof. Seongwon Kang

응용유체역학 연구실 / 75p
Applied Fluid Mechanics Laboratory

- 전공분야 : 유체역학
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
Stanford University 기계공학 박사
- E-mail : skang@sogang.ac.kr

- Research area : Fluid mechanics/CFD
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Stanford Univ., USA

3. 제어, 진동, 로봇틱스 분야 Division of Control, Vibration and Robotics



전도영 교수 Prof. Doyoung Jeon

정밀제어 및 인간 메카트로닉스 연구실 / 94p
Precision Control & Human Mechatronics Laboratory

- 전공분야 : 자동제어
- 학 력 : 서울대학교 기계공학 학사
미국 Berkeley 기계공학 석사
미국 Berkeley 기계공학 박사
- E-mail : dyjeon@sogang.ac.kr
- Research area : Automatic control
- Education : B.S. from Seoul Nat'l Univ.
M.S. from UC Berkeley, USA
Ph.D. from UC Berkeley, USA



이승엽 교수 Prof. Seung-Yop Lee

바이오모방 및 정밀기기 연구실 / 33p
Biomimetics and Precision Device Laboratory

- 전공분야 : 기계진동
- 학 력 : 서울대학교 기계공학 학사
미국 Berkeley 기계공학 석사
미국 Berkeley 기계공학 박사
- E-mail : sylee@sogang.ac.kr
- Research area : Mechanical vibration
- Education : B.S. from Seoul Nat'l Univ.
M.S. from UC Berkeley, USA
Ph.D. from UC Berkeley, USA



박정열 교수 Prof. Jungyul Park

나노바이오시스템 및 매니폴레이션 연구실 / 47p
NanoBiosystems and Manipulation Laboratory

- 전공분야 : 바이오 시스템 및 제어
- 학 력 : 서울대학교 기계설계학 학사
서울대학교 기계설계학 석사
서울대학교 기계항공공학부 공학 박사
- E-mail : sortpark@sogang.ac.kr
- Research area : Nanobiosystems and manipulation
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Seoul Nat'l Univ.



공경철 교수 Prof. Kyoungchul Kong

로봇시스템 제어 연구실 / 100p
Robotic Systems Control Laboratory

- 전공분야 : 동적 시스템 및 제어
- 학 력 : 서강대학교 기계공학/물리학 학사
서강대학교 기계공학 석사
미국 Berkeley 기계공학 박사
- E-mail : kckong@sogang.ac.kr
- Research area : Dynamic systems and controls
- Education : B.S. from Sogang Univ.
M.S. from Sogang Univ.
Ph.D. from UC Berkeley, USA

4. 생산공학 분야 Division of Manufacturing Engineering



김낙수 교수 Prof. Naksoo Kim

정형가공 연구실 / 116p
Net Shape Manufacturing Laboratory

- 전공분야 : 생산공학
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
미국 Berkeley 기계공학 박사
- E-mail : nskim@sogang.ac.kr
- Research area : Production engineering
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from UC Berkeley, USA



최범규 교수 Prof. Bumkyoo Choi

MSM 연구실 / 39p
Sogang Microsystems & Smart Material Laboratory

- 전공분야 : 생산공학
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
미국 Wisconsin 기계공학 박사
- E-mail : bkchoi@sogang.ac.kr
- Research area : Manufacturing engineering
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Univ. of Wisconsin, USA



김동철 교수 Prof. Dongchoul Kim

다중물리 & 다중스케일 시스템 연구실 / 70p
Multiphysics & Multiscale Systems Laboratory

- 전공분야 : 전산 나노 공학
- 학 력 : 연세대학교 기계공학 학사
Univ. of Michigan 기계공학 석사
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- E-mail : dckim@sogang.ac.kr
- Research area : Computational nano technology
- Education : B.S. from Yonsei Univ.
M.S. from Univ. of Michigan, USA
Ph.D. from Univ. of Michigan, USA



이철수 교수 Prof. Cheolsoo Lee

CAD/CAM 연구실 / 121p
CAD/CAM Laboratory

- 전공분야 : CAD/CAM
- 학 력 : 한양대학교 산업공학 학사
한국과학기술원(KAIST) 산업공학 석사
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- Research area : CAD/CAM
- Education : B.S. from Hanyang Univ.
M.S. from KAIST
Ph.D. from KAIST



이정철 교수 Prof. Jungchul Lee

나노 정밀 계측 연구실 / 111p
Nanoscale Precision Sensing Laboratory

- 전공분야 : MEMS
- 학 력 : 서울대학교 기계공학 학사
서울대학교 기계공학 석사
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- Research area : MEMS
- Education : B.S. from Seoul Nat'l Univ.
M.S. from Seoul Nat'l Univ.
Ph.D. from Georgia Inst. Tech., USA



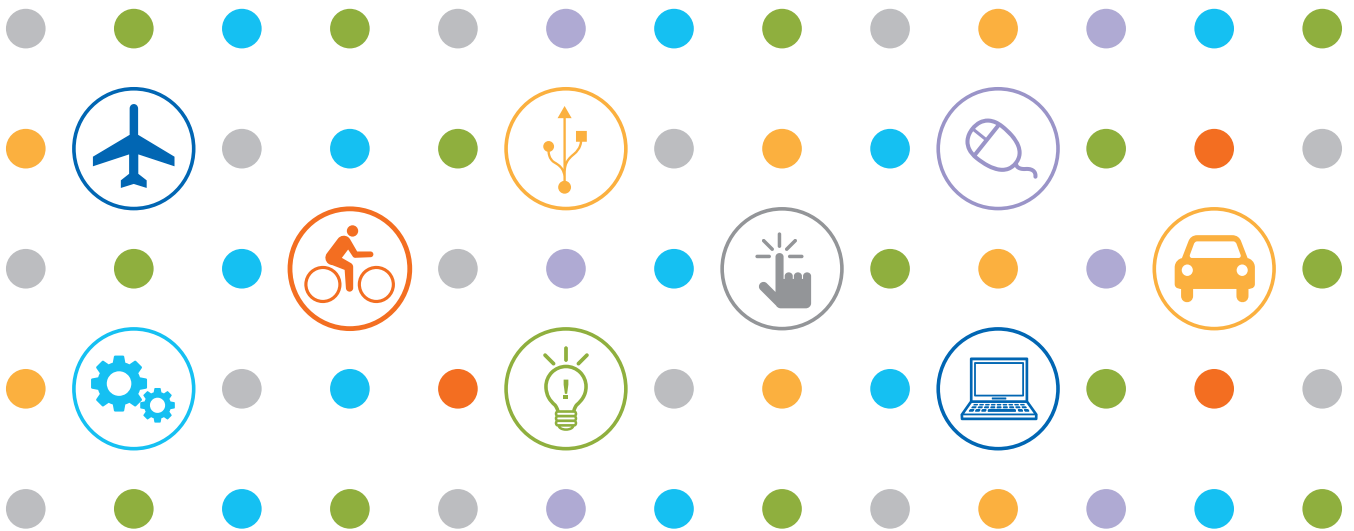
engineering



industry



technology



The Department of Mechanical Engineering

IV. 연구실 소개(1)

Research Laboratories

1. 바이오공학 연구 그룹

Bioengineering Research

- 1) 호흡역학 & 장치 연구실 _ 28
Respiratory Mechanics & Devices Laboratory
- 2) 바이오모방 및 정밀기기 연구실 _ 33
Biomimetics and Precision Device Laboratory
- 3) MSM 연구실 _ 39
Sogang Microsystems & Smart Material Laboratory
- 4) 자동차 메카트로닉스 및 바이오 역학 연구실 _ 128
Automotive Mechatronics & Bio Mechanics Laboratory
- 5) 나노바이오시스템 및 매니퓰레이션 연구실 _ 47
NanoBiosystems and Manipulation Laboratory
- 6) 생체역학 & 의공학 연구실 _ 52
Sogang Biomechanics and Biomedical Engineering Laboratory

Respiratory Mechanics & Devices Laboratory



Professor Taesoo Lee (이태수)
Mechanical Engineering, Sogang University
AS609, <http://design.sogang.ac.kr>



• Design of Air-Compressor

Design of Small-Size Air-Compressor Using Cross-Slider Mechanism

Using cross-slider and scotch-yoke mechanism, small-size air-compressor is designed. Moreover, pressure profile in cylinders, operating torque, and performance curve of the air-compressor are derived.

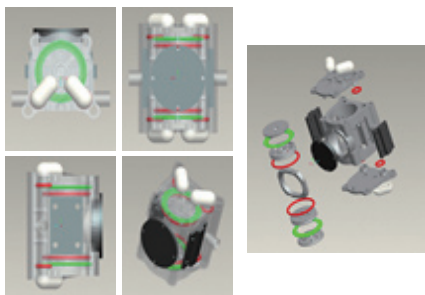


Fig. 1 3D-Modeling of air-compressor using cross-slider mechanism

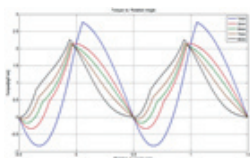


Fig. 2 Torque curve

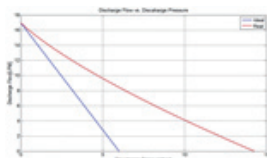


Fig. 3 Performance curve

• CO2 Separation Process I

Design of CO2 separation process using carbon monolith & carbon molecular sieve(CMS)

Using carbon monolith and CMS, CO2 adsorption and desorption process is designed. Low to high concentration CO2 is separated by these processes. In order to desorb CO2, Electric Swing Adsorption(ESA) is applied.

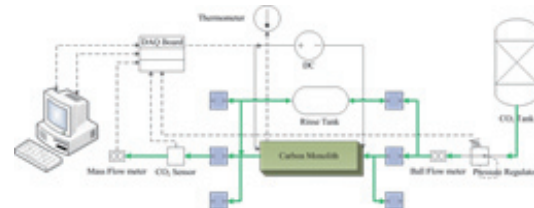


Fig. 4 Schematic of Experiments

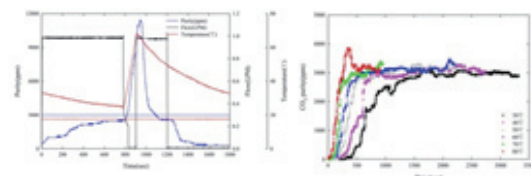


Fig. 5 The profile of ESA Process and Fracture curve

• CO2 Separation Process Design II

CO2 separation from rarefy gas using carbon monolith with ESA cycles

- Electric Swing Adsorption
Electric Swing Adsorption (ESA) is designed to reduce the parasitic energy load using an applied electric field to drive the cycling of CO2 with a basic on/off switch for gas separation.
- Simple: ESA enables gas separation and capture using electric fields to change the thermodynamics of the sorbent material
- Reversible: Switching between ad-/desorption as simple as switching field on and off; removes need to transport or heat sorbent materials
- Efficient: Electrical current used during charging is partially regenerated in discharging → minimal parasitic load for EFSA-based CO2 capture

$$\frac{hA_s(T_s - T_\infty) \cdot W}{hA(T_i - T_\infty) \cdot W} = e^{-\frac{hA_s}{hA} \tau}$$

Eqn. 1 Lumped capacitance model

$$q_{eq} = q_0 \exp\left[-\left(\frac{RT}{E_a} \ln\left(\frac{P_{lim}}{P}\right)\right)\right] \left[\frac{\text{molCO}_2}{\text{kg}_{solid}}\right]$$

$$q_{eq} = q_0 \exp\left[-\left(\frac{T}{T_c}\right)^2\right] \left[\frac{\text{molCO}_2}{\text{kg}_{solid}}\right] \quad \text{let } T_c = \frac{1}{\frac{R}{E_a} \ln\left(\frac{P_{lim}}{P}\right)}$$

Eqn. 2 Dubinin-Asakhov equation

• Synchronized Demand Oxygen Delivery Algorithm

Study of Algorithm employed in COPD Recovery Devices to Save the High Concentration Oxygen

- Chronic Obstructive Pulmonary Disease
One of common causes of mortality worldwide and respiratory diseases. It has increases due to various reasons including air pollution, smoking, and occupational exposure. In patients with COPD, inspired oxygen is not supplied to the blood because of infection or damage to alveoli.
- Oxygen delivery method which supply oxygen flow as a gentle slope by prediction inhalation starting point of next breathing cycle
- To develop breathing prediction algorithm for gradual oxygen delivery breathing
- To buffer shock degree of oxygen supply during breathing
- Discomfort feeling of the patients is reduced by using Synchronized Demand Oxygen Delivery(SDOD).
- Breathing pattern and oxygen discharge are synchronized by prediction and correction algorithm.
- High concentration oxygen can be saved because oxygen delivery is synchronized with the breathing pattern of the patients.
- Application : Respiratory medical device, Hospital Facility, Fish culture, and Other oxygen conserving devices

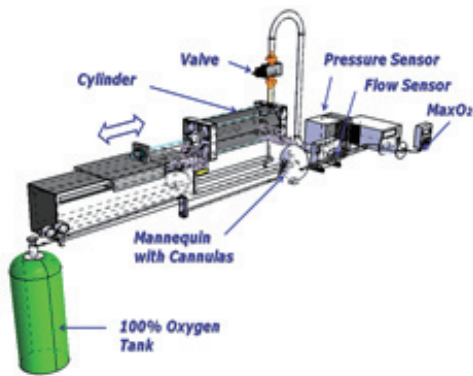


Fig. 6 Breathing Simulator

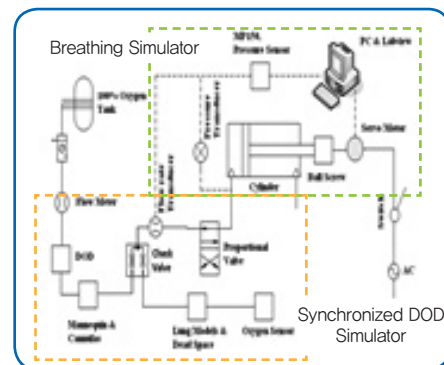


Fig. 7 Experimental Equipment for Measuring FIO2

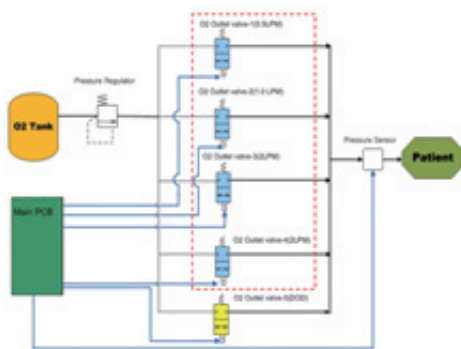


Fig. 8 Synchronized Oxygen Saving Apparatus

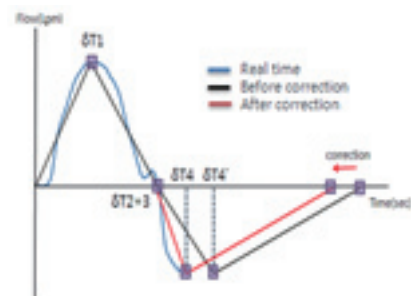


Fig. 9 Prediction & Correction Model

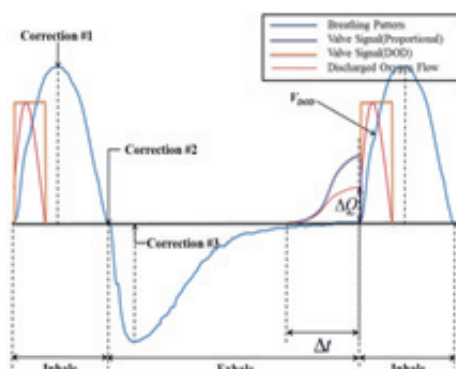


Fig. 10 Oxygen Delivery Curve and Experimental Results : Mode 3

호흡역학 & 장치 연구실 Respiratory Mechanics & Devices Laboratory

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연구실 방장	지석환	전화번호	010-2953-1031	이 메 일	hwanyfunny@sogang.ac.kr

■ 기본연구방향

1. 호흡 메커니즘의 연구 및 호흡기 질환 환자의 치료 장치의 개발
2. 산소 및 이산화 탄소 흡착 공정의 설계 및 연구 개발

■ 최근 수행된 연구과제

1. 호흡장애인의 이동능력 확보를 위한 휴대용 산소공급기 개발, 보건복지부
2. 산소발생기와 센서 네트워크를 융합한 공기청정 살균시스템 개발, 중기청
3. 자장구배를 이용한 산소분자 조작처리용 구동기 개발, 한국학술진흥재단

■ 최근 대표 발표논문 목록

1. Chae SW, Kang HD, Lee MK, Lee TS, Park JY, The Effect of Vertebral Material Description during Vertebroplasty, Proceedings of the Institutions of Mechanical Engineers, Part H, Journal of Engineering in Medicine 2010;224:87-95
2. 최미현, 김지혜, 이수정, 양재웅, 이정환, 전재훈, 김현준, 이태수, 정순철, 고농도 산소 공급량에 따른 20대와 60대의 혈중 산소 포화도의 차이, 감성과학 2010;13:41-46
3. 최미현, 김지혜, 이수정, 양재웅, 최진승, 탁계래, 이태수, 민병찬, 정순철, 고농도 산소 공급량 변화에 따른 심박동율의 성별 차이, 대한인간공학학회지 2010;29:197-202
4. 이문규, 장훈, 이태수, 이형일, Buckling Sensitivity of a Connecting Rod to the Shank Sectional Area Reduction, Materials and Design, 2010;31:2796-2803

■ 연구실 구성원



지석환
(박사과정)
Suk Hwan Chi
(Ph.D program)



이길준
(석사과정)
Gil Jun Lee
(Master program)

◆ 최근 수행 연구과제

연구과제명	호흡장애인의 이동능력 확보를 위한 휴대용 산소공급기 개발		
주무기관	한국보건산업진흥원	연구자역할	책임
연구비	224,785,000원	연구기간	2010.04.01~2011.03.31
주요 참여 대학원생	지석환, 이길준		

연구과제명	산소발생기와 센서 네트워크를 융합한 공기청정 살균시스템 개발		
주무기관	사단법인 한국산학연합회	연구자역할	책임
연구비	139,858,000원	연구기간	2010.06.01~2011.05.31
주요 참여 대학원생	지석환, 이길준		

연구과제명	산소발생기와 센서 네트워크를 융합한 공기청정 살균시스템 개발		
주무기관	사단법인 한국산학연합회	연구자역할	책임
연구비	76,200,000원	연구기간	2011.06.01~2012.05.31
주요 참여 대학원생	지석환, 이길준		

◆ 최근 특허 실적

특허명	고효율 기체 농축 장치 및 그 제어방법				
발명자	이태수				
특허지역	국외	특허유형	출원	출원번호	12/701, 916
발명 참여 대학원생					

특허명	음의 프와송비를 갖는 질점 회전 구조체 튜브 및 그 제조법				
발명자	이태수, 최재봉, 이상혁, 최귀원, 이문규, 허남건				
특허지역	국내	특허유형	등록	등록번호	10-0990023
발명 참여 대학원생					

특허명	호흡동기형 산소 절감 방법 및 장치				
발명자	이태수, 이길준, 최윤순, 오승권				
특허지역	국내	특허유형	출원	출원번호	10-2011-0127062
발명 참여 대학원생	이길준				

특허명	편심축과 크로스 슬라이더 기구를 조합한 하이브리드형 공기 압축기				
발명자	이태수, 최윤순, 유승환, 김용덕, 이길준				
특허지역	국내	특허유형	출원	출원번호	10-2011-0005088
발명 참여 대학원생	이길준				

특허명	편심축과 크로스 슬라이더 기구를 조합한 하이브리드형 공기 압축기				
발명자	이태수, 최윤순, 유승환, 김용덕, 이길준				
특허지역	국외	특허유형	출원	출원번호	13/044,460
발명 참여 대학원생	이길준				

◆ 최근 대표논문

The effect of vertebral material description during vertebroplasty	
채수원, HYUD D KANG AI, 이문규, 이태수, 박정률	공동
PROCEEDINGS OF THE INSTITUTION OF MECHANICAL ENGINEERS, PART H, JOURNAL OF ENGINEERING IN MEDICINE	224, 87-95 (2010)

Vertebroplasty has attracted much attention as a medical treatment for the collapse of the spine by strengthening the vertebral body, correcting deformities, and relieving pain in patients through the injection of bone cement. The finite element method has become popular for analyzing vertebroplasty. The numerical modeling of vertebrae under loading, as in many other cases of representing a composite bone with anatomically scattered properties through a simplified material model, entails difficulties in material assignment for analysis. The aim of this study is to compare and contrast material-assignment methods in the course of modeling through a tetrahedral meshing algorithm. In particular, the study seeks to contrast the element-wise material model with a uniform material assignment for trabecular bone and the bone-poly(methyl methacrylate) (PMMA) composite. The geometries of the vertebral body are constructed from computed tomography image data, which are obtained through scanning at intervals of 1mm. The finite element models are constructed through a tetrahedral meshing algorithm. Various types of material assignment, which encompass the case of normal persons as well as the case of patients following vertebroplastic surgery, are analysed. The results clearly show that the oversimplification of the trabecular bone and the bone-PMMA composite body may lead to significant deviations in the assessment of the effectiveness of vertebroplastic surgery

Buckling sensitivity of a connecting rod to the shank sectional area reduction

이문규, 장훈, 이태수, 이형일

공동

MATERIALS DESIGN

31 (6), 2796–2803 (2010)

Yield, fatigue and buckling characteristics are often used as evaluation indexes for the performance of engine connecting rods in weight reduction design. There are, however, a limited number of studies on the buckling of connecting rods. Even the widely used field equations for the buckling have limitations in the application since they are derived from ideal support conditions. This study first presents an evaluation procedure for the buckling of a connecting rod via finite element analysis (FEA). The FEA approach allows us to treat the first and second modes of buckling collectively. The buckling stresses from the suggested FEA approach are closer to those measured in rig experiments than those from classical formula are. The stress sensitivities to the area reduction of rod shank are then examined in lights of yield, fatigue and buckling. The stress sensitivity in buckling indicates to be relatively higher than of comparable to those of yield and fatigue. Consequently, when weight reduction of connection rod shank is attempted, buckling should be considered as an essential factor along with the other criteria such as yield and fatigue.

The Effectiveness of Oxygen Conserving Device of a Demand Oxygen Delivery System Based on FIO₂ Equivalency

Suk Hwan Chi, Seung Chan Kim, Choongsoo S. Shin and Tae Soo Lee

공동

INTERNATIONAL JOURNAL OF PRECISION ENGINEERING AND MANUFACTURING

Vol. 12, No. 4 687–694 (2011)

Recently demand oxygen delivery (DOD) system has been preferred to continuous flow oxygen (CFO) method for long term oxygen therapy in patients with chronic obstructive pulmonary disease, since DOD system supplies oxygen during only inhalation and saves oxygen consumption. However, the oxygen saving ratio have not properly compared without considering fraction of inspired oxygen (FIO₂), though FIO₂ determines the efficacy of treatment. The purpose of this study was 1) to investigate the equivalence between the CFO method and a DOD system in terms of FIO₂ with considering dead space under various breathing parameters, 2) to propose and calculate the new effective oxygen saving ratio of the DOD method, 3) to compare FIO₂ obtained from calculation with that from experiment. The mathematical and experimental models of human respiratory system were developed. FIO₂ was calculated depending upon various breathing parameters and the new effective oxygen saving ratio was calculated to accurately compare oxygen saving consumption between the DOD and CFO method. Results of this study have shown that as supplied volume of oxygen increased, FIO₂ linearly increased. As beat per minute or tidal volume increased, FIO₂ decreased. The obtained FIO₂ between mathematical model and experiment showed errors less than 5% in CFO method and less than 11% in DOD method. Effective conserving oxygen ratios of the DOD system changed between 3.4 and 3.8, but had higher values when the volume of supplied oxygen was larger. In conclusion, CFO method had different equivalent values of FIO₂ depending on breathing parameters. Therefore it is appropriate to take into account of FIO₂ when considering performance of oxygen saving devices. The effective oxygen saving ratio proposed in this study may provide the new valuable index of oxygen saving of the DOD method while maintaining the same treatment effect compared with CFO method. In addition, the mathematical model developed in this study seems to predict FIO₂ similarly as obtained using experiment.

Biomimetics and Precision Device Laboratory



Professor Seung-Yop Lee
Mechanical Engineering, Sogang University
R615, [Http://ispdl.sogang.ac.kr](http://ispdl.sogang.ac.kr)



• Bio Optical Sensor

The Biologically inspired Humidity Sensor

This research presents a biomimetic humidity sensor inspired by the humidity-dependent color change observed in the cuticle of the Hercules beetle. (with prof. Jungyul Park) Paper Published Research highlight in Nature, 23th Sept, 2010

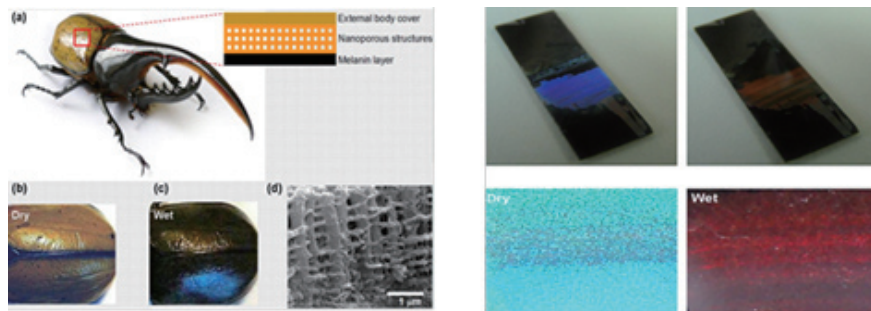


Figure 1. The exoskeleton of the Hercules beetle and biomimetic humidity sensor

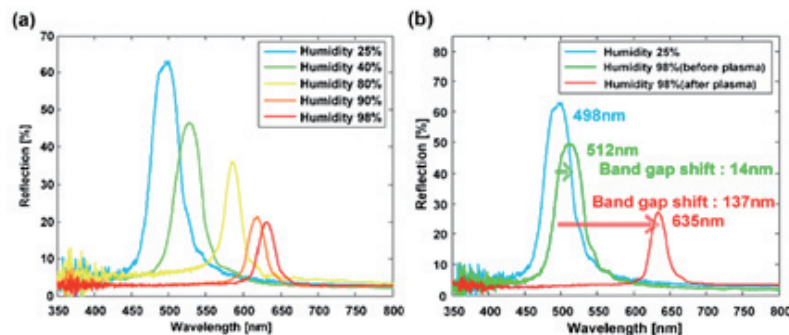


Figure 2. Corresponding reflectance spectra of the humidity sensor under various humidity condition

Bio Scanning and Patterning Device

We developed the scanning device that precisely was measuring the surface by blue-ray. And this system was patterning the cell to fluorescence matter.

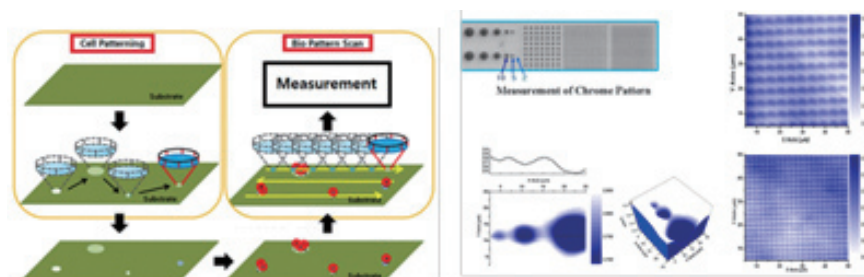


Figure 3. Schematic diagram of scanner and scanning result

Optical Interferometer for Surface Scanning

An interferometer system enables a precise surface measurement with the accuracy of sub-nanometer and the relatively wide detecting range.

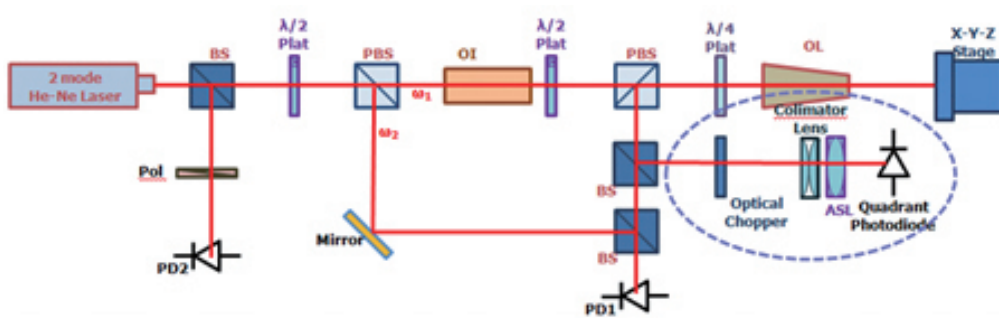


Figure 4. Schematic diagram of interferometer

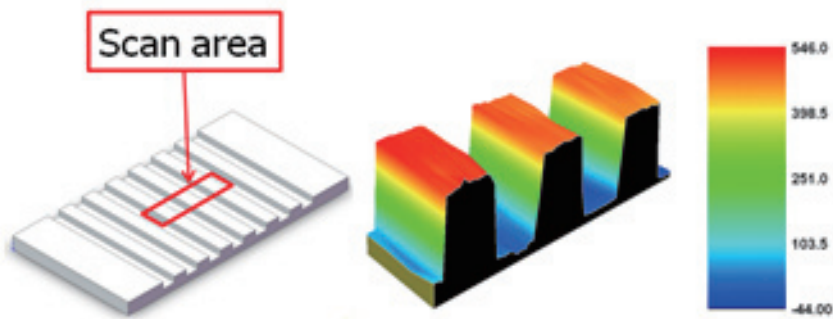


Figure 5. Measurement result

• Biomimetic Micro Robot

Biomimetic Modular Micro Robot

This system employs segmented solenoids to mimic crawling mechanism of soft-bodied creature. This robot has not only a simple structure composed of cores, coils and wires, but it also enables bidirectional actuation and high speed locomotion regardless of friction condition

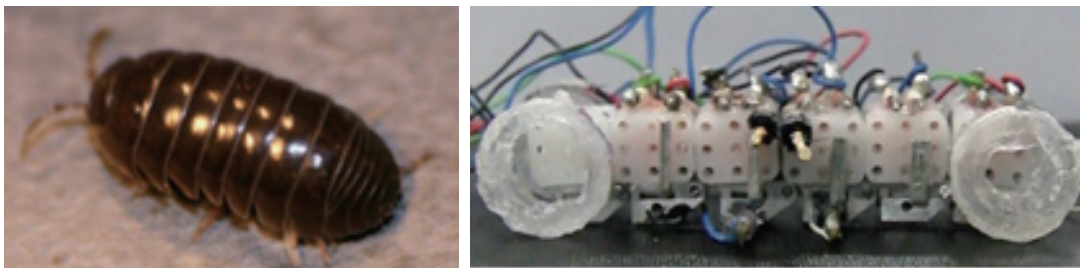


Figure 6. Armadillium vulgare and robot prototype

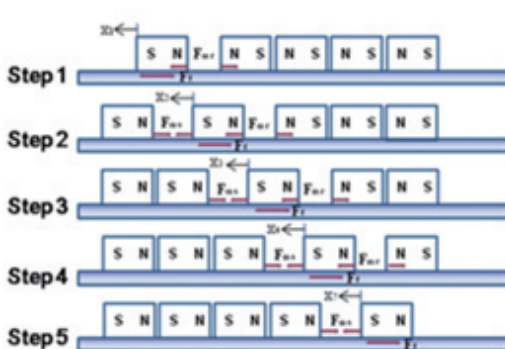


Figure 7. Working mechanism of the robot

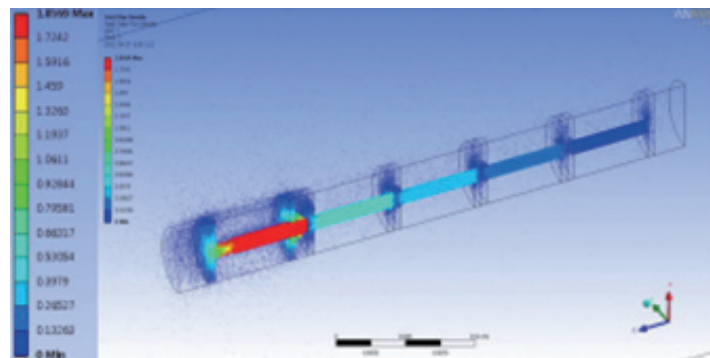


Figure 8. Flux density by FEM

• 바이오모방 및 정밀기기 연구실 Biomimetics and Precision Device Laboratory

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연구실 방장	송창우	전화번호	010-5037-0143	이메일	geniuschw@sogang.ac.kr

■ 기본연구방향

1. 지능형 재료(Piezo, PMN, EAP/IPMC)를 이용한 초소형 정보저장기기, 카메라폰용 AF 및 Zoom 액츄에이터 개발
2. DNA칩 광스캐너 및 지능형 폴리머를 이용한 정밀 세포 패턴 기술 연구
3. 바이오모방형 초소형 모듈 로봇 및 바이오 센서 연구

■ 최근 수행된 연구과제

1. 생체이식이 가능한 EAP기반의 생체모방형 안구 구동 시스템 개발, 한국연구재단.
2. 생체 모방을 통한 환경 적응형 초소형 이동 로봇의 개발, 중견핵심과제, 한국연구재단
3. 나노기술을 이용한 바이오 융합산업 혁신 클러스터, 클러스터사업, 서울시

■ 최근 대표 발표논문 목록

1. Bu Hyun Shin, Seung-Wook Choi, Young-Bong Bang and Seung-Yop Lee, August 2011, "An earthworm-like actuator using segmented solenoids", Smart Material Structure, Vol. 20, pp. 105020
2. Youngkyu Park, Kyoung-Eop Kim, Seong-Jin Kim, June-Gyu Park, Young-Hun Joo, Bu Hyun Shin, Seung-Yop Lee, and Kyuman Cho, August 2011, "Wide measurement range scanning heterodyne interferometer utilizing astigmatic position sensing scheme", Optics Letters, Vol. 36, pp. 3112-3114
3. Bu Hyun Shin, Kyung-Ho Kim, Seung-Yop Lee, January 2011, "Active magnetic inertia latch for hard disk drives", Microsystem Technology, Vol. 17, pp. 127-132
4. Kim JH, Moon JH, Lee S-Y, Park J, Biologically Inspired Humidity Sensor based on Three Dimensional Photonic Crystals, Applied Physics Letters 2010; 97: 103701

■ 연구실 구성원



김경엽
(박사과정)
Kyungeop Kim
(Ph.D program)



추용주
(박사과정)
Yongju Chu
(Ph.D program)



송창우
(석박통합과정)
Changwoo Song
(united course of M.S
and Ph.D)



서한복
(석사과정)
Hanbok Seo
(Master program)



이상효
(석사과정)
Sanghyo Lee
(Master program)



김건우
(석사과정)
Kyeonwoo Kim
(Master program)



이병남
(학부연구생)
Byungnam Lee
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	의공학 응용 바이오 센서 및 액츄에이터 인력양성		
주무기관	재단법인 한국연구재단	연구자역할	책임
연구비	200,000,000원	연구기간	2010.03.01~2011.02.28
주요 참여 대학원생	김경업, 송창우, 최승욱, 서한복, 이상호		

연구과제명	생체 모방을 통한 환경 적응형 초소형 이동 로봇의 개발		
주무기관	재단법인 한국연구재단	연구자역할	책임
연구비	97,000,000원	연구기간	2010.05.01~2011.04.30
주요 참여 대학원생	김경업, 추용주, 최승욱, 송창우, 서한복, 이상호		

◆ 최근 특허 실적

특허명	광학식 표면 측정 장치 및 방법				
발명자	이승엽, 김경업, 김재현, 조규만, 박영규				
특허지역	국외	특허유형	등록	출원번호	영국 특허 2468177
발명 참여 대학원생	김경업				

특허명	이온성 고분자 복합체 및 그 제조방법				
발명자	이승엽, 양우성, 최현광, 최수호				
특허지역	국외	특허유형	출원	등록번호	PCT/KR2010/009050
발명 참여 대학원생	최수호				

특허명	다공성 습도센서 및 그 제조방법				
발명자	이승엽, 박정열, 김재현, 문준혁				
특허지역	국외	특허유형	출원	출원번호	PCT/KR2010/007632
발명 참여 대학원생	김재현				

특허명	PSD를 이용한 간섭계 위상 신호 보정 방법				
발명자	이승엽, 김경업, 김성진, 조규만, 박영규				
특허지역	국내	특허유형	등록	출원번호	10-1085014
발명 참여 대학원생	김경업				

특허명	듀얼 레이어 광디스크의 광 픽업 장치 및 이를 이용한 회전식 엔코더				
발명자	이승엽, 김경업				
특허지역	국내	특허유형	등록	출원번호	10-1044286
발명 참여 대학원생	김경업				

특허명	방향성 결합 돌기를 갖는 벨크로				
발명자	이승엽, 김성근, 나병훈, 이일, 김경업, 송창우				
특허지역	국내	특허유형	출원	출원번호	10-2011-0130038
발명 참여 대학원생	김경업, 송창우				

특허명	반자동 삽				
발명자	이승엽, 이현지, 강호, 김수일, 김경업				
특허지역	국내	특허유형	출원	출원번호	10-2011-0119440
발명 참여 대학원생	김경업				

◆ 최근 대표논문

An earthworm-like actuator using segmented solenoids

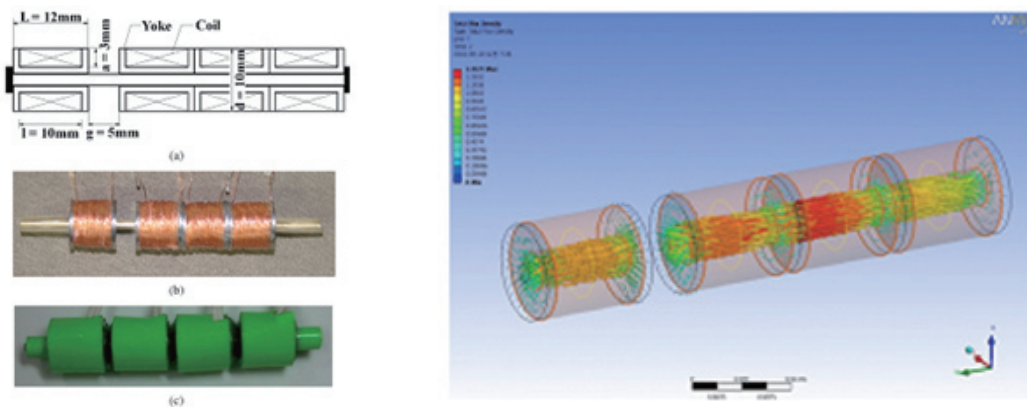
Bu Hyun Shin, Seung-Wook Choi, Young-Bong Bang and Seung-Yop Lee

책임

SMART MATERIALS and STRUCTURES

20, 105020 (2011)

A biomimetic actuator is developed using four segmented solenoids mimicking earthworm locomotion. The proposed actuator not only has a simple structure composed of cores and coils, but also enables bi-directional actuation and high speed locomotion regardless of friction conditions. We have implemented theoretical analysis to design the optimal profiles of input current signal for maximum speed and predict the output force and stroke. Experiments using a prototype show that the earthworm-like actuator travels with a speed above 60 mm s⁻¹ regardless of friction conditions.



Wide measurement range scanning heterodyne interferometer utilizing astigmatic position sensing scheme

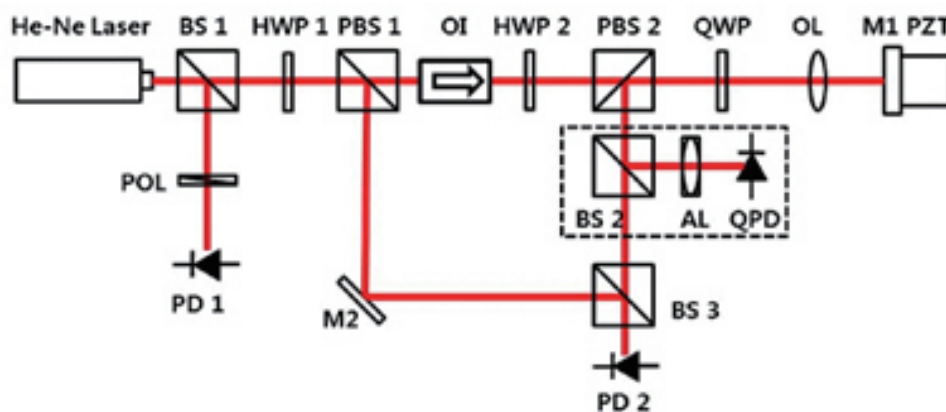
Youngkyu Park, Kyoung-Eop Kim, Seong-Jin Kim, June-Gyu Park, Young-Hun Joo, Bu Hyun Shin, Seung-Yop Lee, and Kyuman Cho

책임

Optics Letters

36, 3112-3114 (2011)

A scanning heterodyne I/Q-interferometer scheme is proposed to overcome phase ambiguity caused by the periodic nature of its phase-dependent signal. A position sensing scheme using an astigmatic method in the confocal arrangement has been interfaced to the interferometer to retrieve the real phase value during a scanning process. The experimental results show that the vertical measurement range can be expanded up to 16 μm . The potential of this interferometer on the scanning microscopy of a rough surface is discussed.



Active Magnetic Inertia Latch for Hard Disk Drives

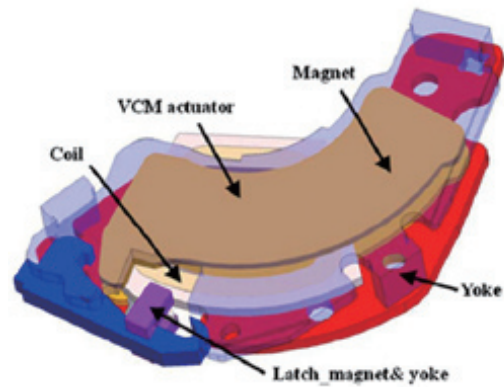
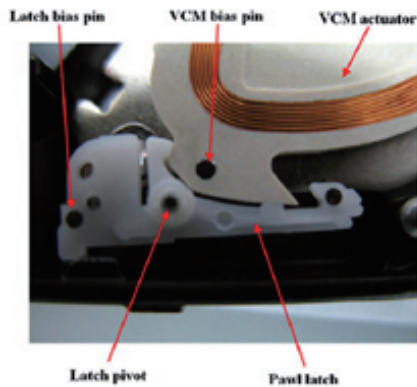
Bu Hyun Shin, Kyung-Ho Kim, Seung-Yop Lee

책임

Microsystem Technologies

17, 127-132 (2011)

Abstract In this paper, a new hybrid inertia latch is proposed to improve the shock resistance and the loading time for hard disk drives. The new latch mechanism combines the inertia effect and the magnetic force by additional yoke and magnets, reducing the time required for loading the head to media that is the mechanical limitation of the widely used pawl inertia latch. The operating mechanism of the proposed latch is optimally designed using an electromagnetic simulation, and it is verified by experiments using a prototype. The new latch system reduces the time required for loading the head to media up to 8 ms.



Laboratory of Microsystems & Smart Material



Professor Bumkyoo Choi
Mechanical Engineering, Sogang University
R617, <http://memslab.sogang.ac.kr>



► Introduction

• Laboratory of Microsystems & Smart Material

Research Interests

- MEMS technology for industrial and biomedical applications
- Sensor and Actuator design for implantable and biocompatible systems
- Smart material developments for eco-friendly and intelligent device applications

• Research director

Bumkyoo Choi
(Professor, Ph.D., Univ. of Wisconsin-Madison)

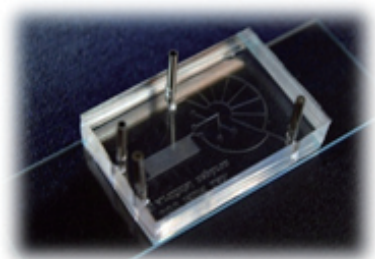
- Samsung Electronics Co. Ltd.,
Principal Researcher (1994. 06 ~ 1997. 08)
- Forest Product Lab. in USDA,
Consultative Professor (2001. 07 ~ 2003. 06)
- Sogang University, Professor (1997. 09 ~ Present)

• Status of R&D Ongoing Governmental Research

Project Name	R&D division
Development of status monitoring and therapeutic system for urologic diseases	Ministry of Health & Welfare
Development of minimally invasive ambulatory-batteryless/wireless bladder pressure monitoring system	Ministry of Educational Science and Technology
Development of intelligent tire system	Ministry of Knowledge Economy

► Artificial nephron

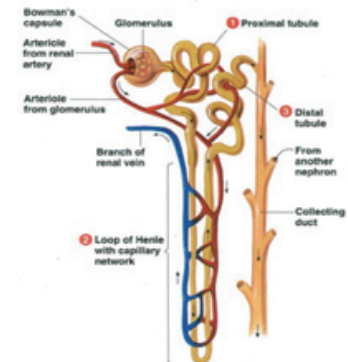
• Research and Development of Artificial Nephron



PDMS Artificial Nephron



Schematic of the Artificial Nephron



Human Nephron

Blood component	Molecular weight	Molecular radius (Å)	Diffusion coefficient (m ² /s)
Urea	60	1.6	1.4×10^{-9}
Glucose	180	3.6	6.2×10^{-10}
Serum albumin	69,000	35.5	6.3×10^{-11}

Components of the human blood

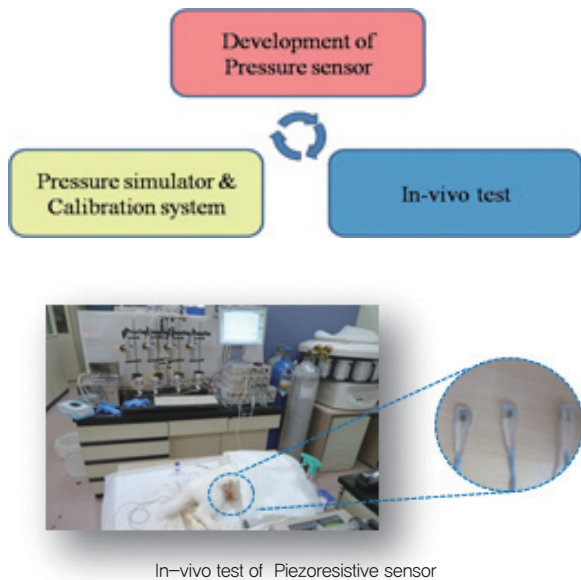


Sequential Nano-particle Separation Technology

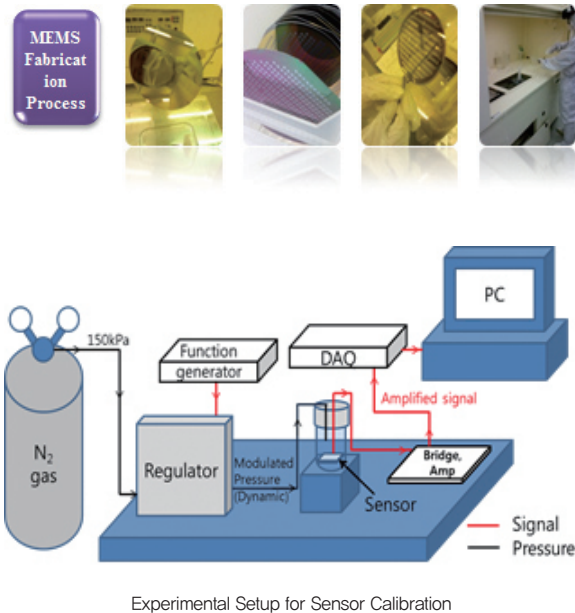
► Bladder pressure monitoring system

• Development of bladder pressure monitoring system using MEMS technology

- Implantable sensor using MEMS technology
- Wireless system using SAW communication technology
- Biocompatible and minimal invasive system



• Fabrication Process

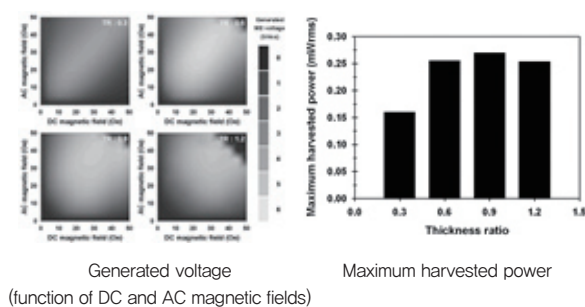
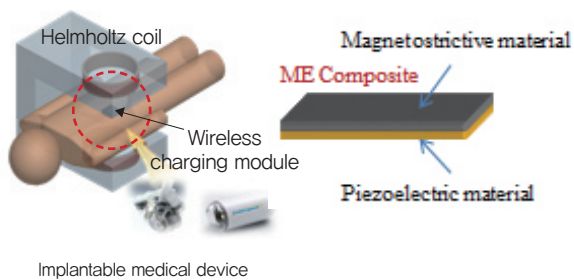


► Energy harvesting for biomedical and mobile devices

• Research and Development of Magnetic and Acoustic Energy Harvesting Devices

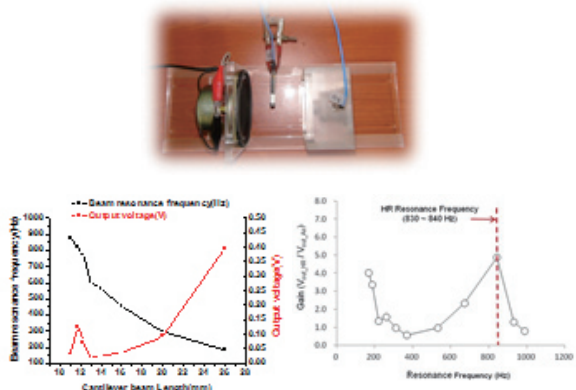
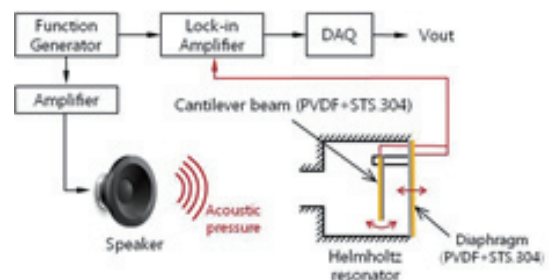
Magnetic source energy harvesting using ME composite

- Concept $\Rightarrow$ **Wireless charging module**



Acoustic Energy Harvesting using Acoustic Resonator

- Concept $\Rightarrow$ **Recycling wasted energy**



• MSM 연구실 Sogang Microsystems & Smart Material Laboratory

지도교수	최범규				
연구실 위치	R617	전화번호	705-8639 / 703-5639	홈페이지	http://home.sogang.ac.kr/sites/memslab
연구실 방장	김종찬	전화번호	010-8884-5350	이메일	havegood@sogang.ac.kr

■ 기본연구방향

- 과거 마이크로 터빈, 펌프, 믹서 등의 MEMS components and devices 설계 및 제작 등의 연구 진행
- 현재 Biomedical 시스템 적용을 위한 무전원/무선 센서, MEMS Actuator, Artificial devices 등의 연구 진행

■ 최근 수행된 연구과제

1. 비뇨기 질환 모니터링 및 치료기기 시스템 개발, 보건복지부
2. 무전원/무선 압력센서를 이용한 상시 모니터링 장치의 개발, 보건복지부
3. 이동형 최소침습적 방광내압 무전원/무선 모니터링 장치 개발, 교육과학기술부
4. 대면적 점착 제어 공정 및 모듈화 기술 개발, 지식경제부
5. 무전원 구동방식 인텔리전트 타이어 센서기술 개발, 지식경제부
6. 고내구성 바이오 compatible 무선충전 슈퍼전지 개발, 교육과학기술부
7. 무선충전기능 포함한 초소형 압력센서 개발, 삼성전자 (주)
8. 인공 신단위 장치 개발, 교육과학기술부

■ 최근 대표 발표논문 목록

1. Lee M, Jun S, Kim S, Kim S, Choi B. Evaluation of sensitivity and linearity for touch-mode capacitive pressure sensor measuring the inner bladder pressure. International Journal of Precision Engineering and Manufacturing 2011;12:907-912
2. Lee M, Lee S, Hur N, Kim S, Kim S, Choi B. Correlation between an intravesical pressure and a prostatic obstruction size using computational fluid dynamics in benign prostatic hyperplasia. Proceedings of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine 2011;225: 920-928
3. Kim J, Choi B. Design and fabrication of implantable pressure sensing resistor sensor for human bladder monitoring system. Microsystem Technologies-Micro- and Nanosystems Information Storage and Processing Systems 2011;17:1453-1458
4. Kim J, Lee M, Choi B. A Study on the Fluid Mechanical Urinary Bladder Simulator and Reproduction of Human Urodynamics. International Journal of Precision Engineering and Manufacturing 2011;12:679-685
5. Kim M, Park J, Choi B. Measurement and analysis of micro-scale adhesion for efficient transfer printing. Journal of Applied Physics 2011;110: 024911
6. Kang H, Choi B. Development of the MHD micropump with mixing function. Sensors & Actuators: A, Physical 2011;165: 439-445

■ 연구실 구성원



이제윤
(박사과정)
Jaeyun Lee
(Ph.D program)



김종찬
(석박통합과정)
Jongchan Kim
(Combined MS & PhD)



노승준
(석사과정)
Seung Jun Noh
(Master program)



차순도
(석사과정)
Soondo Cha
(Master program)



엄정호
(석사과정)
Jeongho Eom
(Master program)



김석범
(학부연구생)
Seok Beom Kim
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	비뇨기 질환 모니터링 및 치료기기 시스템 개발		
주무기관	보건복지부 한국보건산업진흥원	연구자역할	책임
연구비	465,000,000원	연구기간	2011.05.01~2012.03.31
주요 참여 대학원생	권용상, 김종찬, 김석범, 노승준, 엄정호, 전수민, 차순도		

연구과제명	이동형 최소침습적 방광내압 무전원/무선 모니터링 장치 개발		
주무기관	교육과학기술부 재단법인 한국연구재단	연구자역할	책임
연구비	96,800,000원	연구기간	2011.03.01~2012.02.29
주요 참여 대학원생	권용상, 김종찬, 엄정호, 이제윤, 전수민, 차순도		

연구과제명	무전원 구동방식 인텔리전트 타이어 센서기술 개발		
주무기관	지식경제부	연구자역할	공동
연구비	40,000,000원	연구기간	2011.06.01~2012.05.31
주요 참여 대학원생	김종찬, 노승준, 엄정호, 차순도		

연구과제명	고내구성 바이오 compatible 무선충전 슈퍼전지 개발		
주무기관	교육과학기술부 신기술융합형 성장동력사업	연구자역할	공동
연구비	677,000,000원	연구기간	2010.07.01~2011.06.30
주요 참여 대학원생	권용상, 김종찬, 노승준, 엄정호, 전수민, 홍민아		

연구과제명	무전원/무선 압력센서를 이용한 최소침습적 방광내압 상시 모니터링 장치의 개발		
주무기관	보건복지부 한국보건산업진흥원	연구자역할	책임
연구비	197,000,000원	연구기간	2010.04.01~2011.03.31
주요 참여 대학원생	권용상, 김종찬, 노승준, 엄정호, 전수민, 차순도, 홍민아		

연구과제명	대면적 접촉 제어 공정 및 모듈화 기술 개발		
주무기관	지식경제부 한국생산기술연구원	연구자역할	책임
연구비	40,000,000원	연구기간	2010.06.01~2011.05.31
주요 참여 대학원생	권용상, 노승준		

◆ 최근 특허 실적

특허명	방광 용적 센서 및 방광 용적 산출 방법				
발명자	최범규, 이승준				
특허지역	국내	특허유형	등록	등록번호	10-1064180
발명 참여 대학원생	이승준				

특허명	압력측정장치 및 그 제조방법				
발명자	최범규, 김종현, 이문규				
특허지역	국외	특허유형	출원	출원번호	PCT/KR2011/001463
발명 참여 대학원생	김종현				

특허명	무선충전 압력센서 및 그 제조 방법				
발명자	최범규, 김종현				
특허지역	국내	특허유형	출원	출원번호	10-2011-0016080
발명 참여 대학원생	김종현				

◆ 최근 대표논문

Evaluation of sensitivity and linearity for touch-mode capacitive pressure sensor measuring the inner bladder pressure

Moon Kyu Lee, Su Min Jun, Sewoong Kim, Sujin Kim, Bumkyoo Choi

책임

International Journal of Precision Engineering and Manufacturing

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Evaluation of Sensitivity and Linearity for Touch-mode Capacitive Pressure Sensor Measuring the Inner Bladder Pressure

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KEYWORDS: Bladder pressure, Touch-mode capacitive pressure sensor, Sensitivity, MEMS, Finite element method

Recent studies have shown that pressure sensors for monitoring bladder pressure in real time are under way to develop treatments for urinary bladder dysfunction. Therefore, this study is designed to assess the sensitivity and linearity of touch-mode capacitive pressure sensor (TMCPS), which is appropriate for measuring urinary bladder pressure. In addition, this study analyzes TMCPS's ability responding to geometric design parameters. Finite element model consists of diaphragm and insulator plane. The modeling is based on three geometric design variables: size of square diaphragm, thickness of diaphragm and gap distance between diaphragm and insulator. The result from finite element analysis (FEA) based on those design variables can be used to produce capacitance-pressure (C-P) graph and the first order regression curve enables this study to analyze the sensitivity and linearity within 20–100 cmH₂O which is the measurable range of urinary bladder pressure. Regarding the effect on the thickness of diaphragm under the gap distance of 4 μm corresponding to the square size of 2.6 mm, this research shows that remarkable decline in sensitivity from 0.0031 pF/cmH₂O to 0.0022 pF/cmH₂O occurs as thickness increases from 11 μm to 15 μm. Even in the case of 5 μm gap distance, sensitivity is shown to decrease from 0.0032 pF/cmH₂O to 0.0015 pF/cmH₂O as thickness increases from 11 μm to 15 μm. From a linearity point of view, however, it always marks higher value than 0.9 regardless of its thickness and describes relatively small deviation under 3.0 mm. The study shows that as the size of diaphragm gets larger, sensitivity increases but linearity decreases. In addition, the thicker the diaphragm is, the less sensitivity the sensors are. However, the change in linearity turns out to be invalid. This research could be helpful in designing a touch-mode capacitive pressure sensor for urinary bladder pressure measurement.

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Design and fabrication of implantable pressure sensing resistor sensor for human bladder monitoring system

Jonghyun Kim and Bumkyoo Choi

책임

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TECHNICAL PAPER

Design and fabrication of implantable pressure sensing resistor sensor for human bladder monitoring system

Jonghyun Kim · Bumkyoo Choi

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Abstract Many aging people and patients have difficulties in bladder control. Recent methods have been studied for non-invasive measuring for bladder information. It must be improved to a more convenient and real time measurable system for accurately analyzing and controlling individual bladder information. This paper presents the pressure sensor for the invasive bladder monitoring system. The system has the pressure sensing resistor sensor (PSRS) which is set-up inside the bladder. The PSRS consists of a flexible and contactable diaphragm which deforms towards an underlying substrate while a range of pressure is applied. The flexible diaphragm has a thin metal film which acts as a switch and the underlying substrate has interdigitated electrodes which serve as a variable resistor. The PSRS initially exhibits infinite electrical resistance with no external pressure applied since the metal switch is not contact with the interdigitated electrodes. As the applied pressure increases above a threshold, the contact area increases thus the resistance of the PSRS decreases. Based on the finite element analysis, proper ranges for the diaphragm size and gap distance are determined. The sensor, the diaphragm size of which is $2.6 \times 2.6 \text{ mm}^2$, has been fabricated through MEMS technology. The change of the electrical resistance is 0.5Ω for the range of human bladder pressure (0–10 kPa). This PSRS will be effectively used for reliability and stability of the research for the improvement of bladder management. It can also be utilized for the future application.

1 Introduction

Many aging people and patients have difficulties in bladder control. Its symptoms are largely urinary frequency and urinary incontinence, which can cause life-threatening illnesses. A therapeutic research for bladder nerves and surgical treatment has been studied. However, such treatments are likely to cause complications and need more reliability and safety. An urodynamic study, which is designed to monitor the relationship between flow, pressure, and volume by inserting a condom catheter into the urethra, is most commonly used for the measurement of bladder operation. Unfortunately, this method may cause inconvenience and side effects. Thus, recent methods have been studied for non-invasive measuring. In addition, it must be improved to a more convenient and real time measurable system for accurately analyzing and controlling individual bladder information (KCS 2005; Kim et al. 2008b).

With that in mind, we propose the invasive bladder monitoring system. The system has the pressure sensor which is set-up inside the bladder. It can avoid the inconvenience and directly check the dynamic variation of the relation between bladder pressure and volume. Bladder pressure monitoring, therefore, is one of the important areas in the development of medical devices. However, there has been little progress in the implantable sensor for the human/animal bladder. Micro sensors for the measurement of blood pressure and for intraocular pressure have been developed (Fonseca et al. 2006; Axisa et al. 2009). The pressure sensor for bladder has been studied by F. Axia group (Axisa et al. 2009). However, it had much difficulty in real time monitoring continuously for a long time because it was an implantable type of catheter with a large battery. To this end, a pressure sensing resistor sensor

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Development of MHD Micropump with mixing function

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책임

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Development of the MHD micropump with mixing function

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ABSTRACT

As μ -TAS (micro total analysis system) is developed with enhancement of MEMS technology, the growth of medical and biological research areas increases rapidly. The study on LOC (lab on a chip), which is one of the μ -TAS and has the functions of mixing and analyzing with a tiny amount of sample and reagent on one chip, is actively progressed. LOC is composed of the microfluidic components such as micromixers and micropumps. Because the flow on the microfluidic system is generally laminar, it is very difficult to mix and feed fluidic reagents efficiently. This paper presents the design and the fabrication of the MHD micropump with mixing function, in which the fluids are simultaneously mixed and pumped by coupling between Lorentz force and the moving force of an electric charge in the electric field. The advanced model was determined through the commercial CFD program after several models were modified. The numerical results have been compared with the experimental results. This study shows the proposed micropump can be made through simple fabrication procedure and has the low energy consumption.

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Real-time bladder volume monitoring by the application of a new implantable bladder volume sensor for a small animal model

Dong Sub Lee, Su Jin Kim, Dong Wan Sohn, Bum Kyoo Choi, Moon Kyu Lee, Seung Joon Lee, Sae Woong Kim

공동

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ORIGINAL ARTICLE

Real-time bladder volume monitoring by the application of a new implantable bladder volume sensor for a small animal model

Dong Sup Lee ^a, Su Jin Kim ^a, Dong Wan Sohn ^a, Bumkyoo Choi ^b, Moon Kyu Lee ^b, Seung Joon Lee ^b, Sae Woong Kim ^{a,*}

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KEYWORDS

Device;
MEMS;
Urinary bladder;
Urodynamics

Abstract Although real-time monitoring of bladder volume together with intravesical pressure can provide more information for understanding the functional changes of the urinary bladder, it still entails difficulties in the accurate prediction of real-time bladder volume in urodynamic studies with small animal models. We studied a new implantable bladder volume monitoring device with eight rats. During cystometry, microelectrodes prepared by the microelectromechanical systems process were placed symmetrically on both lateral walls of the bladder, and the expanded bladder volume was calculated. Immunohistological study was done after 1 week and after 4 weeks to evaluate the biocompatibility of the microelectrode. From the point that infused saline volume into the bladder was higher than 0.6 mL, estimated bladder volume was statistically correlated with the volume of saline injected ($p < 0.01$). Additionally, the microelectromechanical system microelectrodes used in this study showed reliable biocompatibility. Therefore, the device can be used to evaluate changes in bladder volume in studies with small animals, and it may help to provide more information about functional changes in the bladder in laboratory studies. Furthermore, owing to its biocompatibility, the device could be chronically implanted in conscious ambulating animals, thus allowing a novel longitudinal study to be performed for a specific purpose.
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Laboratory for NanoBiosystems and Manipulation



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• Bacteria Based Biomedical Microrobot

지능형 진단치료용 박테리아 기반의 의료용 마이크로 로봇 융합원천기술



이동성, 암 지향성, 형광발현성 등의 특징들을 가진 지능형 박테리아의 유전자 조작기술(BT)과 고효율 약물전달 기능을 가진 마이크로시스템기술(NT)의 접목을 통해 보다 효과적이고 능동적인 질병 진단 및 치료 기술의 개발

This research is to develop a bacteria based microrobot (bacteriobot) using various characteristics of gene modified bacteria, such as locomotion, targeting to cancer, and fluorescence.

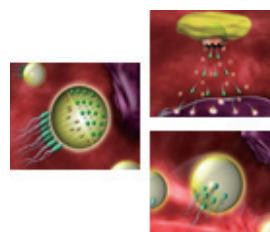
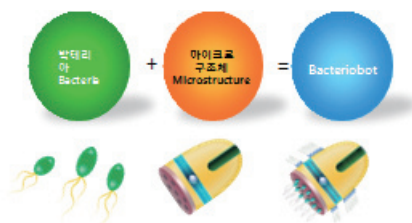


Fig. 1 Concept of intelligent bacteriobot as a new drug delivery system

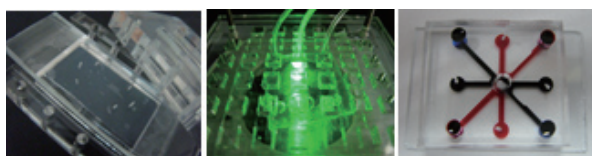


Fig. 2 Microfluidic chip for bacteria chemotaxis study

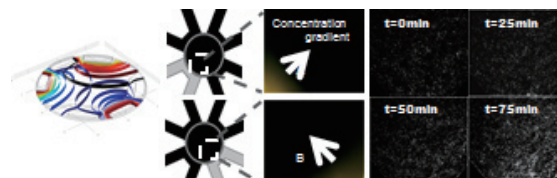


Fig. 3 Generation of multiple concentration gradients

• Visual Colorimetric Nanosensors

구조색 기반의 생체모방형 습도센서 및 바이오 센서 개발

남아메리카에 서식하는 헤라클레스 장수 풍뎡이의 겹질 속의 나노구조물을 모방하여 박테리아 같은 외부의 전원의 도움 없이 주위의 습도에 따라 색깔이 변하는 습도센서를 개발하고, 색깔의 변화로 각종 항체 및 외부 오염원 등을 누구나 손쉽게 검출할 수 있는 바이오 센서 개발

Inspired to humidity-dependent color changing observed in the cuticle of the Hercules beetle, we developed the humidity sensor based on 3D photonic crystals. Moreover this photonic crystals based sensors can be applied to the next generation display, optoelectrical devices, biosensors, solar cells, LED, energy transfer, ink, coating, food, environment sensor, and military area.

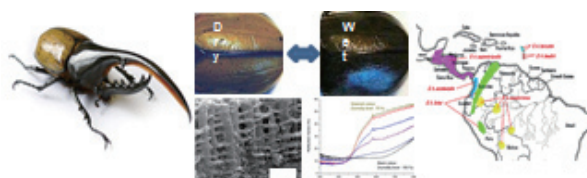


Fig. 8 Dynastes Hercules appear khaki-green in a dry atmosphere and turn black passively under high humidity levels

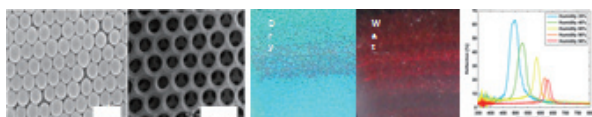


Fig. 9 Development of colorimetric humidity sensors based on photonic crystals

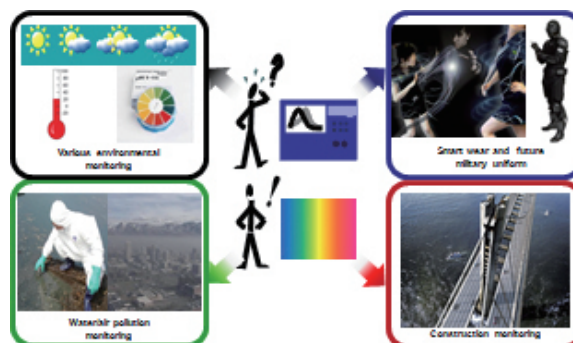


Fig. 10 Development of various colorimetric nanosensors

• Micropower Generation Using Cardiac Cells

심장세포를 이용한 에너지 하비스트 소자 개발

NRF 한국연구재단

외부의 전기적 에너지 없이 움직일 수 있는 심장세포의 기계적 에너지를 활용하여 배터리 없이 작동할 수 있는 소형 마이크로 디바이스 및 전기 에너지 발생 장치 개발

This research is about a novel hybrid MEMS-based micro-device and power generation system that uses the contractile forces generated by self-organized cardiomyocytes without any external power source

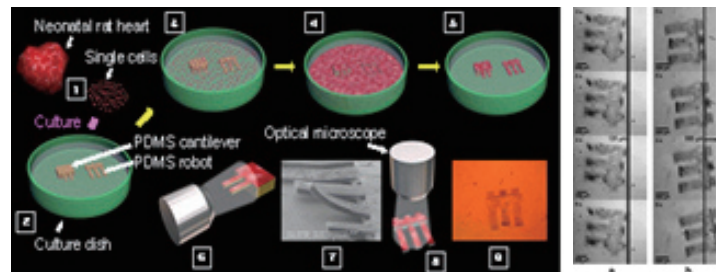


Fig. 6 Microrobot (size < 750 μ m) driven by cardiac cell power

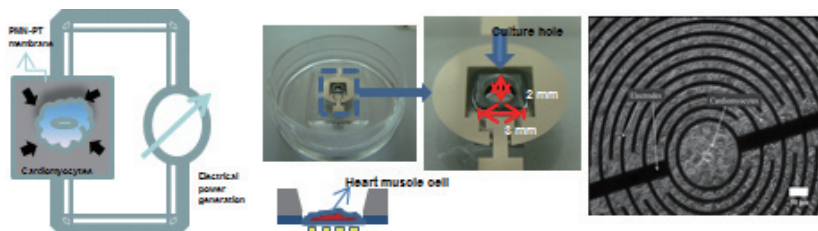


Fig. 7 MEMS-based power generation system using contractile force generated by self-organized cardiomyocytes

• Cell Chips and Cell Manipulation

유전영동을 이용한 세포의 물리적 특성분석 및 미소분리시스템 개발

NRF 한국연구재단

기존의 항원-항체 반응에 기반한 세포 분리 방법과는 달리, 마치 인체의 지문과 같은 세포 자체의 물리적 특성을 이용하여, 고속으로 암세포를 정상 세포들로부터 분리하는 유전영동 현상을 활용한 새로운 미소유체시스템 개발

This research is about a novel microfluidic device that separate cancer cells from the normal cells by using the dielectrophoresis without any immuno-labeling.

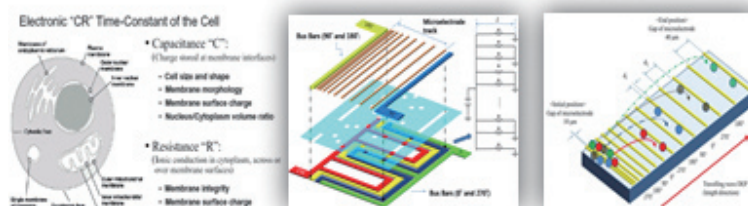


Fig. 4 High-throughput cell separation system

세포의 미세 물리적 변화 측정을 통한 암 변이 정도 및 암 진단

NRF 한국연구재단

미소 유체칩을 활용하여 세포의 물리적/기계적인 특성 변화를 정량적으로 측정하고 이를 활용하여 암의 변이 정도 및 암 진단에 적용

This research is to measure the mechanical and electrical properties of single cells by using the microfluidic chip. It can be used to analyze the biomechanical characteristics of cancer cells

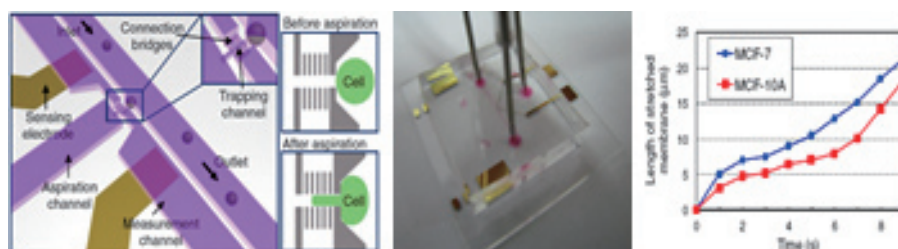


Fig. 4 High-throughput cell separation system

• 나노바이오시스템 및 메니플레이션 연구실 NanoBiosystems and Manipulation Laboratory

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■ 기본연구방향 Research Area

본 연구실은 MEMS/microfluidic 기술을 기반으로 지능형 박테리아를 이용한 암치료용 박테리오톱 개발, 3차원 계층적 나노구조물 제작을 통한 구조색 변화 기반의 colorimetric nanosensor 개발, 암 치료 및 심장 질환 모니터링을 위한 셀칩(cell chip)의 개발, 세포의 물리적 특성 연구 및 조직 공학 응용, 생체시스템을 이용한 유기-무기 물질의 하이브리드 액츄레이터 및 센서의 개발 등을 연구하고 있습니다.

- Bacteria based biomedical microrobot
- Visual colorimetric nanosensors
- Cell chips and cell manipulation
- Micropower generation using cardiac cells

■ 최근 수행된 연구과제 Recent Research Project

1. 박테리오톱 제작을 위한 박테리아 고정화 및 체외 주화성 테스트 플랫폼 개발
(Encapsulation of bacteria for bacteriobot and development of microplatform for studying in vitro bacterial chemotaxis)
2. 암세포의 물리적 변이 측정을 위한 미소유체 기반의 나노 기계컬 시스템 개발 및 통합적 해석
(Design of microfluidic based nanomechanical assay to detect the physical variation of malignant human breast cancer and integration analysis for its origin)

■ 최근 대표 발표논문 목록 Recent Published Paper (2011)

1. Eunpyo Choi, Indong Jun, Hyung-kwan Chang, Kyung Min Park, Heungsoo Shin, Ki Dong Park and Jungyul Park, "Quantitatively controlled in situ formation of hydrogel membranes in microchannels for generation of stable chemical gradients", Lab on a Chip, 2011 (in press)
2. Min Sock Kim, Jungyul Park, and Bumkyoo Choi, "Measurement and analysis of micro-scale adhesion for efficient transfer printing," Journal of Applied Physics, vol.110, 024911, 2011.
3. Siyoung Jeong, Jungyul Park, Jimmy M. Kim, and Seungwoo Park, "Microfluidic mixing using periodically induced secondary potential in electroosmotic flow," Journal of Electrostatics, vol.69, no.5, pp. 429-434, 2011.
4. Junghun Lee, Youngho Kim, Younggeun Kim, Jungyul Park, and Byungkyu Kim, Polymer microcantilever arrays for high-throughput separation using a combination of dielectrophoresis and sedimentations," Biochip Journal, vol. 5, no. 1, pp.8-13, 2011.

■ 연구실 구성원 Lab. Members



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(Ph.D. Program)



장형관
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Hyung-kwan Chang
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이탁건
(석사과정)
Tahk Guhn Lee
(Master Program)



최유리
(석사과정)
Yuri Choi
(Master Program)



임채영
(석사과정)
Chaeyoung Lim
(Master Program)

◆ 최근 수행 연구과제

연구과제명	박테리오톱 제작을 위한 박테리아 고정화 및 체외 주화성 테스트 플랫폼 개발		
주무기관	교육과학기술부 한국연구재단	연구자역할	책임
연구비	50,000,000원	연구기간	2011.03.01~2012.02.29
주요 참여 대학원생	최은표, 장형관, 이탁건, 최유리		

◆ 최근 특허 실적

특허명	다공성 검출센서 및 그 제조방법			
발명자	박정열, 이승엽, 문준혁			
특허지역	국내/해외	특허유형	PCT	출원번호
발명 참여 대학원생	PCT/KR2010/007632			

특허명	미세채널의 폴리머 멤브레인 형성방법 및 그 방법에 의해 제작된 미세 채널 장치				
발명자	박정열, 최은표				
특허지역	국내	특허유형	국내	출원번호	10-2010-0136675
발명 참여 대학원생	최은표				

특허명	풍력발전장치 및 듀얼 풍력발전시스템				
발명자	박정열, 김대중, 장형관				
특허지역	국내/해외	특허유형	PCT	출원번호	PCT/KR2010/007075
발명 참여 대학원생	장형관				

◆ 최근 대표논문

Quantitatively controlled in situ formation of hydrogel membranes in microchannels for generation of stable chemical gradients

Eunpyo Choi, Indong Jun, Hyung-kwan Chang, Kyung Min Park, Heungsoo Shin, Ki Dong Park and Jungyul Park

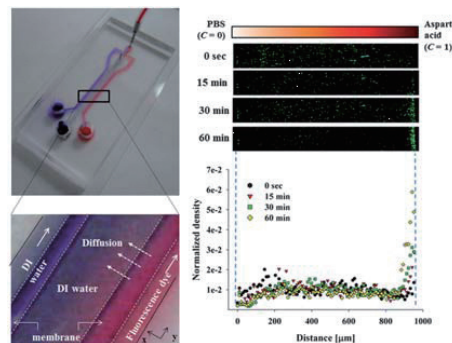
책임

Lab on a chip

In print

Abstract

The in situ formation of membranes in microfluidic channels has been given attention because of their great potential in the separation of components, cell culture support for tissue engineering, and molecular transport for generation of chemical gradients. Among these, the porous membranes in microchannels are vigorously applied to generate stable chemical gradients for chemotaxis-dependent cell migration assays. Previous work on the in situ fabrication of membranes for generating the chemical gradient, however, has had several disadvantages, such as fluid leaking, uncontrollable membrane thickness, need of extra equipment, and difficulty in realizing stable interfacial layers. In this paper, we report a novel technique for the in situ formation of membranes within microchannels using enzymatically crosslinkable hydrogels and microfluidic techniques. The thickness of the membrane can be controlled quantitatively by adjusting the crosslinking reaction time and velocity of the microfluidics. By using these techniques, parallel dual hydrogel membranes were prepared within microchannels and these were used for the generation of stable concentration gradients. Moreover, the migration of *Salmonella typhimurium* was monitored to validate the efficacy of the chemical gradients. These results suggest that our in situ membrane system can be used as a simple platform to understand many cellular activities, including cell adhesion and migration directed by chemotaxis or complex diffusions from biological fluids in three-dimensional microstructures.



Measurement and analysis of micro-scale adhesion for efficient transfer printing

Min Sock Kim, Jungyul Park, and Bumkyoo Choi

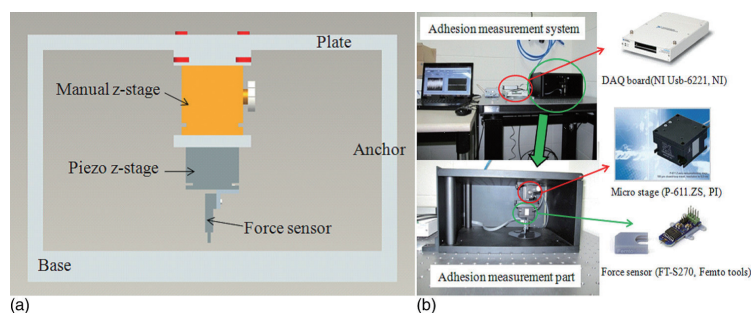
책임

Journal of Applied Physics

vol.110, 024911, 2011

Abstract

The adhesion-based transfer printing process allows the devices to be fabricated through low temperature process, which is important for realizing flexible electronics with high mobility. Therefore, comprehensive understanding about adhesion between the solid object and the surface of elastomeric stamp (generally, polydimethylsiloxane is used) and the optimal strategy to control adhesion can support the effective and high yield transfer. In this paper, a novel adhesive force measurement system is developed to measure dynamic adhesive forces from the surface on the flexible stamp. The thermodynamic work of adhesion at the moment of debonding of a tip of sensor from the flexible stamp is modeled and used for developing the adhesion control strategy. The measurement results show that the work of adhesion is strongly dependent on the peel-off velocity of tip, while the indentation force has only minor effects on it. The effect of Young's modulus of elastomeric stamp is also investigated using the model of work of adhesion based on the relation between the adhesive force and peel-off velocity. The elastomeric stamp with low Young's modulus is preferred for efficient transfer printing



Microfluidic mixing using periodically induced secondary potential in electroosmotic flow

Siyoung Jeong, Jungyul Park, Jimmy M. Kim, and Seungwoo Park

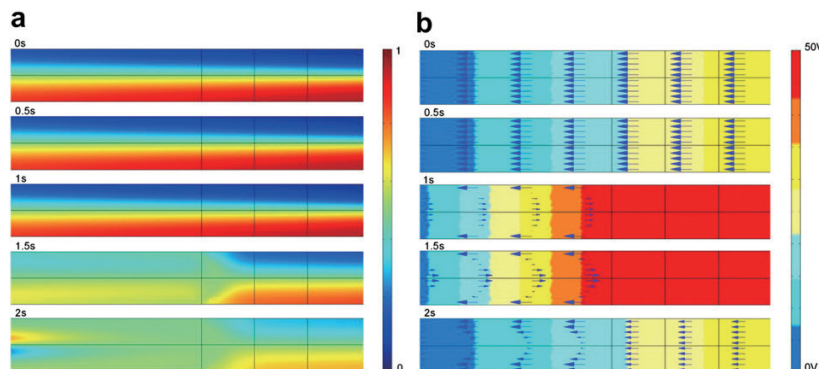
책임

Journal of Electrostatics

vol.69, no.5, pp. 429–434, 2011

Abstract

This research develops a novel microfluidic mixing in a simple manner: An electrode was installed between two primary electrodes that generate DC fields and induce electroosmotic flow (EOF). While EOF was introduced by DC fields from the two primary electrodes, the active mixing could be achieved if potential was supplied to the secondary anode. Normal EOF was recovered as soon as the supply of potential to the secondary anode was terminated. By periodically repeating the on/off phase of the driving potential to the secondary anode, oscillating and vortex swirling flow patterns occurred and vigorous and efficient mixing was obtained.



Polymer microcantilever arrays for high-throughput separation using a combination of dielectrophoresis and sedimentations

Junghun Lee, Youngho Kim, Younggeun Kim, Jungyul Park, and Byungkyu Kim

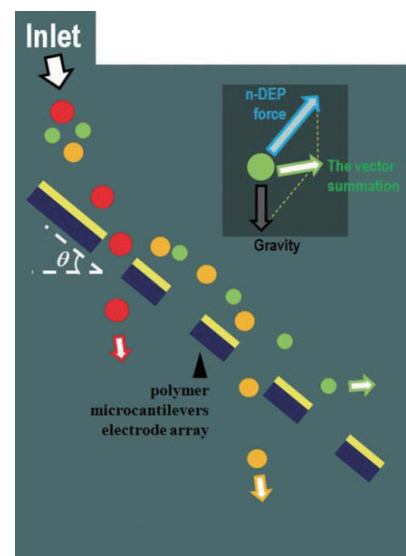
공동

Biochip Journal

vol. 5, no. 1, pp.8–13, 2011

Abstract

This paper presents a polymer microcantilever platform for handling massive microparticles or cells using combined forces induced by dielectrophoresis and gravity. Although cell separation based on dielectrophoresis is a very useful and versatile method, its low throughput is a key problem that must be resolved before it can be used clinically. In this study, high throughput separation could be achieved without any external pumping or complex microtubing by combining dielectrophoresis and sedimentation. The absence of any external pumping or injection system makes it possible to realize a simple configuration of devices with low cost and easy separation procedures, which is carried out by just dropping the target microparticles without any pretreatment. The transport of microparticles is driven by gravitation in the medium, and during the sedimentation the particles are either deflected from or pass through the gap between the microcantilevers depending on their physical properties. The position of passing through is defined by the equilibrium point between the dielectrophoretic force and gravity. We compared the degree of complexity of the fabrication process and its successful throughput between both the glass-based and polymerbased microcantilevers. The feasibility of our suggestion was demonstrated by performing microparticle separation experimentally, which showed that our device can be applied in various biological areas.



Sogang Biomechanics Laboratory



Professor Choongsoo Shin (신충수)
Mechanical Engineering, Sogang University
AS610, <http://biome.sogang.ac.kr>



• Sports Science and Rehabilitation

전방십자인대 부상기전 모델 개발



Development, validation, and application of a 3D dynamic knee model to investigate injury mechanisms: 3D image reconstruction, experiment, clinical application using in vivo motion data

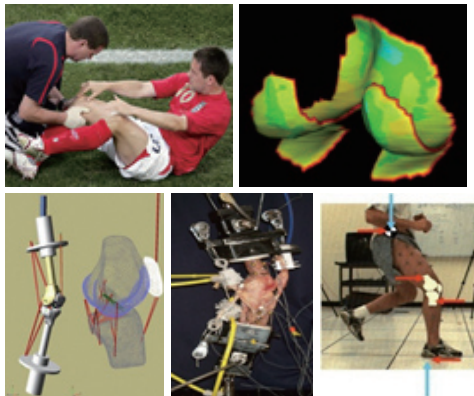


Fig 1 Reconstruction cartilage from MR image

Fig 2 ACL(anterior cruciate ligament) injury

Fig 3 Experimental apparatus, simulated landing apparatus and knee model

Fig 4 Human in vivo experiment

인체모션 분석 및 재활기법 평가 모델 개발

Evaluating the influence of patellar ligament insertion angle on quadriceps usage during walking. Developing patient-specific musculoskeletal knee model to investigate musculoskeletal adaptation. Understanding and developing rehabilitation strategy using motion analysis and biomedical imaging.

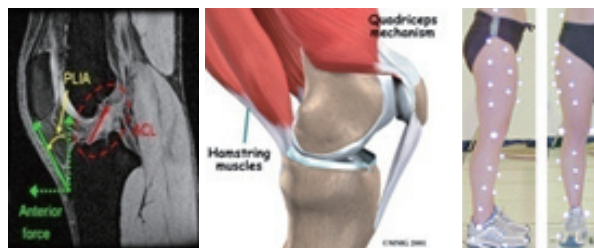


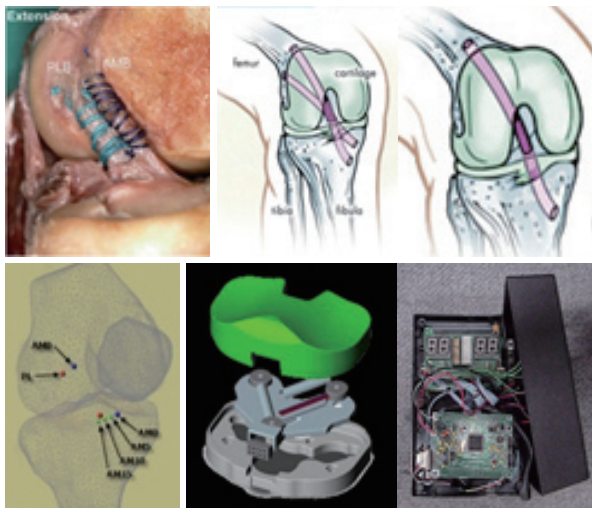
Fig 5 Patella ligament insertion angle

Fig 6 Quadriceps mechanism

Fig 7 Marker based motion capture of subject

• Orthopedic Bioengineering

수술계획법 및 평가 모델 개발



Evaluating scientific outcome of new surgical techniques and parametric design improvement.

Fig 8 Double bundle of the ACL

Fig 9 Single and double bundle ACL reconstruction technique

Fig 10 Simulated ACL reconstruction

Fig 11 New medical device for total knee replacement surgery

• Biomedical Imaging

의료영상 해석 및 평가 모델 개발



Development of 3D in vivo kinematics measurement of joints using biomedical imaging and its application to clinical diagnosis and evaluation of treatment

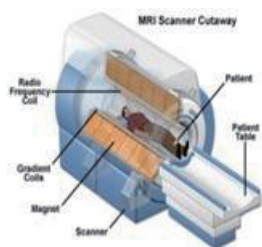


Fig 12 Patient scanning in MRI device

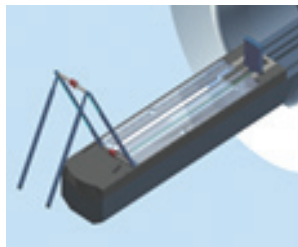


Fig 13 Custom-designed experimental device for medical imaging

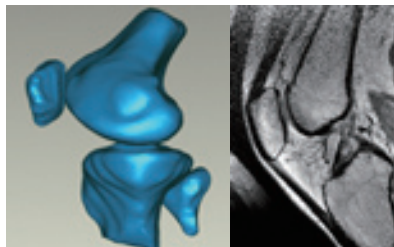


Fig 14 Patient MRI of the knee joint and its 3D reconstruction



Fig 15 Kinematics study of the patellofemoral joint

• Computational Biomechanics

운동 형상학: 조인트의 6자유도 운동 해석



Development of in vivo kinematics measurement of the knee joint for motion capture system. It involves a complex set of coupled translations and rotations → 6 degrees of freedom motion.

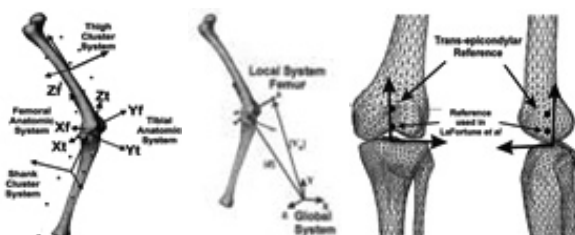


Fig. 16 Local and global coordinate system of the tibiofemoral joint

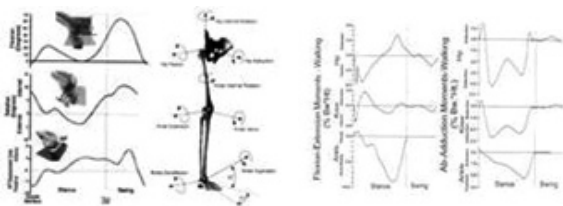


Fig 17 Rotation and translation of the knee joint

Fig 18 Force and moment during walking

스포츠 부상 방지 실험 & 모델 개발

Development of a measurement method to investigate injury mechanisms and prevention techniques in sports. Mechanical shock is attenuated by several structure in the body including bone, synovial fluids, cartilage, meniscus, and ligaments.

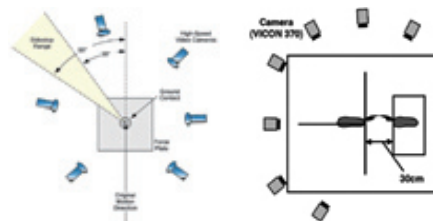


Fig 19 Experimental Setup for motion analysis



Fig 20 Human lower-extremity model using marker based motion capture system

• 생체역학 & 의공학 연구실 Sogang Biomechanics and Biomedical Engineering Laboratory

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연구실 방장	이승훈	전화번호	010-9069-9717	이 메 일	takiply@naver.com

■ 기본연구방향

기계공학의 이론과 방법을 이용하여 생체역학 및 의공학 문제들을 연구한다. 컴퓨터 시뮬레이션과 3D 모션 캡처 시스템을 이용한 인체실험을 병행함으로써 각 방법의 한계를 보완하여 완성도 높은 연구성과를 도출한다. 주요 연구주제는 인체 근골격계 모델 및 생체역학 해석, 재활 및 수술 개선을 위한 모델 개발, 스포츠 부상 및 성능 향상을 위한 연구 등이다.

■ 최근 수행된 연구과제

1. 전방십자인대 부상 메커니즘 및 퇴행성 슬관절염에 대한 연구, 서강대학교
2. 호흡장애인의 이동능력 확보를 위한 휴대용 산소공급기 개발, 보건복지부

■ 최근 대표 발표논문 목록

1. Shin, C. S., Chaudhari, A. M., Andriacchi, T. P., Valgus plus internal rotation moments increase ACL strain more than either alone, *Medicine & Science in Sports & Exercise*, 43(8), 1484-1491, 2011. Impact Factor: 4.106, Top 5% Journal in Sport Science Category
2. Shin, C. S., Souza, R. B., Kumar, D., Link, T. M., Wyman, B. T., Majumdar, S., In vivo tibiofemoral cartilage-to-cartilage contact area of females with medial osteoarthritis under acute loading using MR images, *Journal of Magnetic Resonance Imaging*, 34(6), 1405-13, 2011. Impact Factor: 2.749
3. Chi, S. H., Kim, S. C., Shin, C. S., Lee, T. S., The effectiveness of oxygen conserving device of a demand oxygen delivery system based on FIO2 equivalency, *International Journal of Precision Engineering and Manufacturing*, 12(4), 687-694, 2011. Impact Factor: 1.060
4. Kim, M. S., Shin, Y. M., Lee, J., Kim, S. I., Nam, Y. S., Shin, C. S., Shin, H., Release kinetics and in vitro bioactivity of basic fibroblast growth factor: effect of the thickness of fibrous matrices, *Macromolecular Bioscience*, 11(1), 122-130, 2011. Impact Factor: 3.458
5. Shin CS, Carpenter RD, Majumdar S, Ma B. Three-Dimensional in Vivo Patellofemoral Kinematics and Contact Area of Anterior Cruciate Ligament-Deficient and -Reconstructed Subjects using Magnetic Resonance Imaging, *Arthroscopy* 2009;25:1214-1223, Impact Factor: 3.458, Top 5% Journal in Orthopedics Category
6. Shin CS, Chaudhari AM, Andriacchi TP. The Effect of Isolated Valgus Moments on ACL Strain during Single-Leg Landing: A Simulation Study, *Journal of Biomechanics* 2009;42:280-285, Impact Factor: 2.897
7. Shin CS, Chaudhari AM, Dyrby CO, Andriacchi TP. The Influence of Patellar Ligament Insertion Angle on Quadriceps Usage during Walking in Anterior Cruciate Ligament Reconstructed Subjects, *Journal of Orthopaedic Research* 2009;27:730-735, Impact Factor: 2.963, Top 10% Journal in Orthopedics Category

■ 연구실 구성원



노재현
(석사과정)
Jaehun Ro
(Master program)



이승훈
(석사과정)
Seunghoon Lee
(Master program)



김여정
(학부연구생)
Yeojeong Kim
(Undergraduate program)



이희정
(학부연구생)
Heejung Lee
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	특정인체정보기반 슬관절모델 개발과 인체실험을 이용한 전방십자인대 부상기전 연구		
주무기관	교육과학기술부 한국연구재단	연구자역할	책임
연구비	93,000,000원	연구기간	2010.05.01~2011.04.30
참여연구원			

연구과제명	호흡장애인의 이동능력 확보를 위한 휴대용 산소공급기 개발		
주무기관	보건복지부 한국보건산업진흥원	연구자역할	공동
연구비	75,000,000원	연구기간	2010.04.01~2011.03.31
참여연구원			

연구과제명	인공관절의 국제규격 및 가이드라인 연구		
주무기관	식품의약품안전평가원	연구자역할	책임
연구비	60,000,000원	연구기간	2011.01.16~2011.11.30
참여연구원			

◆ 최근 대표논문

Valgus Plus Internal Rotation Moments Increase Anterior Cruciate Ligament Strain More Than Either Alone	
CHOONGSOO S. SHIN, AJIT M. CHAUDHARI, and THOMAS P. ANDRIACCHI	책임
Medicine & Science in Sports & Exercise	

Abstract

Purpose: To test the influence of combined knee valgus and internal tibial rotation moment on anterior cruciate ligament (ACL) strain during single-leg landing. We tested the following hypotheses: the combination of the valgus and internal rotation moments observed during single-leg landing produces a higher ACL strain than either moment applied individually, the combined rotational moments at the physiological levels observed could theoretically increase strain in the ACL high enough to rupture the ACL, and the location of the peak contact force was at the posterior-lateral side for combined loading. **Methods:** The study was conducted by applying in vivo human loading data to a validated simulation model of the three-dimensional dynamic knee joint to predict ACL strains. **Results:** The peak ACL strain increased nonlinearly when either applied valgus moment or internal rotation moment was increased in the model. When the two rotational moments were applied individually, neither caused ACL strain 90.077. However, when applied in combination, the two rotational moments had a much larger effect, and the predicted peak ACL strain increased up to 0.105. During landing, the peak contact force occurred at the posterior-lateral side of the tibial cartilage in the model when the combined maximum valgus moment and tibial internal rotation moments were applied. **Conclusions:** Combined knee valgus and internal rotation moments increases ACL strain more than either alone. The combination of a valgus and internal rotational moment at magnitudes that occurs in vivo during landing can cause ACL strains that may be high enough to cause ACL rupture. This predicted high ACL strain and the contact force location suggest that combined valgus and internal tibial rotational moments during single-leg landing are relevant to ACL injuries.

In Vivo Tibiofemoral Cartilage-to-Cartilage Contact Area of Females With Medial Osteoarthritis Under Acute Loading Using MRI	
Choongsoo S. Shin, PhD, Richard B. Souza, PhD, Deepak Kumar, PhD, Thomas M. Link, MD, Bradley T. Wyman, PhD, and Sharmila Majumdar, PhD	책임
Journal of Magnetic Resonance Imaging	

Abstract

Purpose: To investigate the effect of acute loading on in vivo tibiofemoral contact area changes in both compartments, and to determine whether in vivo tibiofemoral contact area differs between subjects with medial knee osteoarthritis (OA) and healthy controls. **Materials and Methods:** Ten subjects with medial knee OA (KL3) and 11 control subjects (KL0) were tested. Coronal three-dimensional spoiled gradient-recalled (3D-SPGR) and T2-weighted fast spin-echo FSE magnetic resonance imaging (MRI) of the knee were acquired under both unloaded and loaded conditions. Tibiofemoral cartilage contact areas were measured using image-based 3D models. **Results:** Tibiofemoral contact areas in both compartments significantly increased under loading ($P < 0.001$) and the increased contact area in the medial compartment was significantly larger than in the lateral compartment ($P < 0.05$). Medial compartment contact area was significantly larger in KL3 subjects than KL0 subjects, both at unloaded and loaded conditions ($P < 0.05$). Contact areas measured from 3D-SPGR and T2-weighted FSE images were strongly correlated ($r = 0.904$). **Conclusion:** Females with medial OA increased tibiofemoral contact area in the medial compartment compared to healthy subjects under both unloaded and loaded conditions. The contact area data presented in this study may provide a quantitative reference for further cartilage contact biomechanics such as contact stress analysis and cartilage biomechanical function difference between osteoarthritic and healthy knees.

Three-Dimensional In Vivo Patellofemoral Kinematics and Contact Area of Anterior Cruciate Ligament-Deficient and -Reconstructed Subjects Using Magnetic Resonance Imaging

Choongsoo S. Shin, Ph.D., R. Dana Carpenter, Ph.D., Sharmila Majumdar, Ph.D., and C. Benjamin Ma, M.D.

책임

Arthroscopy

Abstract

Purpose: The purpose of this study was to test whether (1) the 3-dimensional in vivo patellofemoral kinematics and patellofemoral contact area of anterior cruciate ligament (ACL)-deficient knees are different from those of normal, contralateral knees and (2) ACL reconstruction restores in vivo patellofemoral kinematics and contact area. **Methods:** Ten ACL-deficient knees and twelve ACL-reconstructed knees, as well as the contralateral uninjured knees, were tested. Magnetic resonance imaging was performed at full extension and 40° of flexion under simulated partial weight-bearing conditions. Six- degrees of freedom patellofemoral kinematics, patellofemoral contact area, and contact location were analyzed by use of magnetic resonance image- based 3-dimensional patellofemoral knee models. **Results:** The patella in the ACLdeficient knees underwent significantly more lateral tilt during flexion ($P < .05$) and tended to translate more laterally ($P = .083$) than the patella in contralateral knees. After ACL reconstruction, no kinematic parameters were significantly different from those in contralateral knees. The patellofemoral contact areas of ACL-deficient knees at both the extended and flexed positions ($37 \pm 22 \text{ mm}^2$ and $357 \pm 53 \text{ mm}^2$, respectively) were significantly smaller than those of contralateral knees ($78 \pm 45 \text{ mm}^2$ and $437 \pm 119 \text{ mm}^2$, respectively) ($P < .05$). After reconstruction, the patellofemoral contact area of ACL-reconstructed knees in the extended position ($86 \pm 41 \text{ mm}^2$) was significantly larger ($P < .05$) than that of contralateral knees ($50 \pm 34 \text{ mm}^2$), but no difference was detected in the flexed position. Reproducibility of all patellofemoral kinematic parameters, contact centroid translation, and contact area showed coefficients of variation of less than 6.8%. **Conclusions:** ACL injuries alter patellofemoral kinematics including patellar tilt and patellar lateral translation, but ACL reconstruction with hamstring or allograft restores altered patellar tilt. ACL injuries reduce the patellofemoral contact area at both the extended and flexed positions, but ACL reconstruction enlarges the patellofemoral contact area at extension and restores the normal contact area at low angles of flexion. **Level of Evidence:** Level III, case-control study

Influence of Patellar Ligament Insertion Angle on Quadriceps Usage during Walking in Anterior Cruciate Ligament Reconstructed Subjects

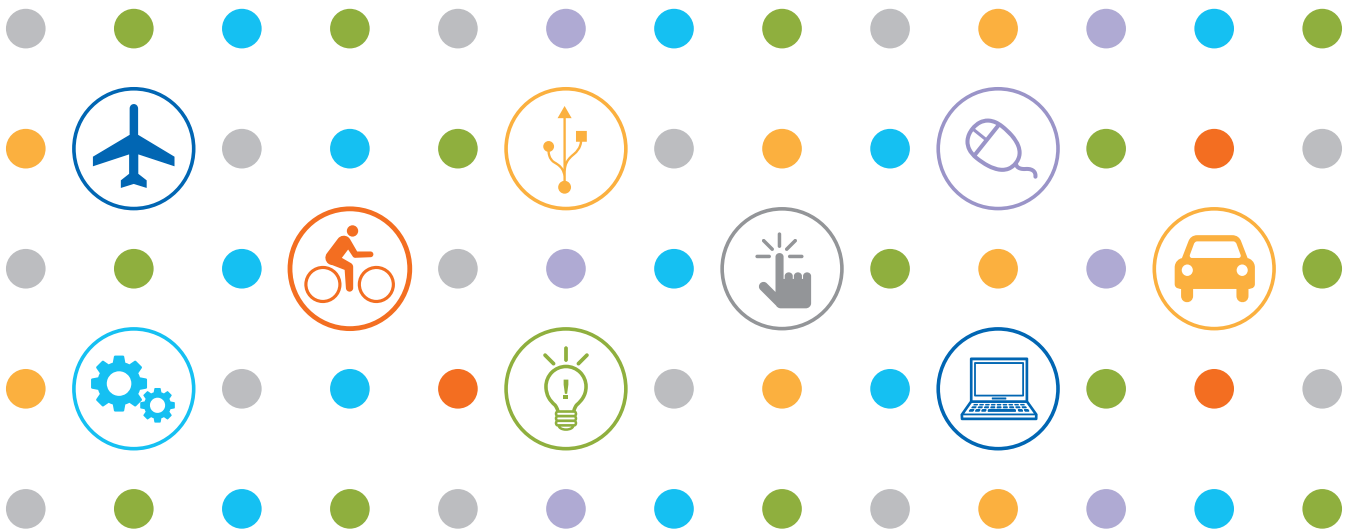
Choongsoo S. Shin, Ajit M. Chaudhari, Chris O. Dyrby, Thomas P. Andriacchi

책임

Journal of Orthopaedic Research

Abstract

Purpose: Reduced quadriceps contraction has been suggested as an adaptation to prevent anterior tibial translation in anterior cruciate ligament (ACL)-deficient knees. This theory has been supported by a recent study that peak knee flexion moment (thought to be created by a decrease of quadriceps contraction) during walking was negatively correlated with patellar ligament insertion angle (PLIA) in ACL-deficient knees, but not in contralateral, uninjured knees. In addition, the PLIA was significantly smaller in ACL-deficient knees than in contralateral, uninjured knees. However, it is unknown whether ACL reconstruction restores the PLIA or whether the relationship between the PLIA and knee flexion moments previously observed in ACL-deficient knees disappears. This study tested the following hypotheses: (1) The PLIA of ACL-reconstructed knees is significantly smaller than the PLIA of uninjured contralateral knees; (2) Peak knee flexion moment (balanced by net quadriceps moment) during walking is negatively correlated with the PLIA in ACL-reconstructed knees. The PLIA of 24 ACLreconstructed and contralateral knees were measured using MRI, and peak knee flexion moments during walking were measured. Results showed that the PLIA of ACL-reconstructed (22.9 ± 4.48) knees was not significantly smaller ($p = 0.09$, power = 0.99) than the PLIA of contralateral (24.1 ± 4.88) knees. Peak knee flexion moment was not correlated with the PLIA following ACL reconstruction ($R^2 = 0.016$, power = 0.99). However, the magnitude of the knee flexion moment remained significantly lower in ACL-reconstructed knees. In summary, this study has shown that the PLIA of ACL-reconstructed knees returned to normal and that patients no longer adapt their gait in response to the PLIA, though quadriceps function did not return to normal levels. Orthopaedic Research Society. Published by Wiley Periodicals, Inc.



The Department of Mechanical Engineering

IV. 연구실 소개(2)

Research Laboratories

2. 유체 및 복합체 연구그룹

Research on Fluid and Composite Materials

- 1) 호흡역학 & 장치 연구실 _ 28
Respiratory Mechanics & Devices Laboratory
- 2) 정형가공 연구실 _ 116
Net Shape Manufacturing Laboratory
- 3) 다중물리 전산유체 연구실 _ 58
Multi-physics Computational Fluid Dynamics Laboratory
- 4) 다상 열전달 연구실 _ 64
Sogang Multiphase Heat Transfer Laboratory
- 5) 자동차 메카트로닉스 및 바이오 역학 연구실 _ 128
Automotive Mechatronics & Bio Mechanics Lab
- 6) 다중물리 & 다중스케일 시스템 연구실 _ 70
Multiphysics & Multiscale Systems Laboratory
- 7) 응용유체역학 연구실 _ 75
Applied Fluid Mechanics Laboratory

Multi-Physics Computational Fluid Dynamics Lab.



Professor Nahmkeon Hur
Mechanical Engineering, Sogang University
AS615, <http://cfdlab.sogang.ac.kr>



• CFD Code Development

CFD Code Development – NUFLEX



Program development for CFD analysis based on the polyhedral grids for prediction of characteristics of the multi-phenomena fluid system, (EHD/MHD, interfacial flow, spray system etc.)

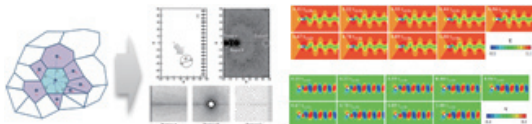


Fig. 1 CFD program (NUFLEX) based on polyhedral grids.



Fig. 2 Various applications using NUFLEX.

• Appliances

Spray Painting Simulation



Numerical analysis on the spray painting process of electronic product case.

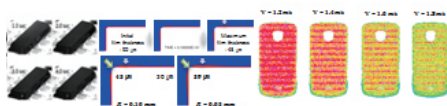


Fig. 3 Spray painting simulation on the electronic product.

Ventilation Flow Simulation



Numerical analysis for development of interpretation tools hood airflow.

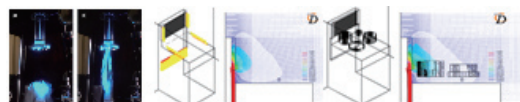


Fig. 4 Hood system using a vortex flow generated by a swirl fan.

Cross Flow Fan of Air-Conditioner



Numerical analysis for optimal design simulator development of cross fan of air-conditioner.

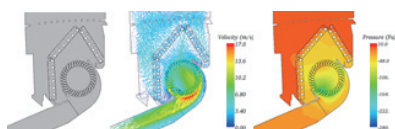


Fig. 5 Flow noise of the cross-flow fan.

• Environmental and Bio Fluid Dynamics

Environment



Numerical simulation on the natural ventilation and fire propagation with the complex surrounding terrain.



Fig. 6 Air ventilation simulation of Haein temple and fire simulation result.

Bio-Fluids



Numerical analysis on the blood flow inside the deformable blood vessel for the prediction of cerebral arterial disease.

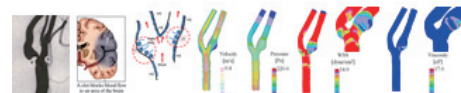


Fig. 7 Infarction of brain artery and blood flow characteristics.

• Automotive

Windshield Wiper Lift



Numerical study on aerodynamic characteristics of windshield wiper for improving the wiping performance of high-speed passenger vehicles.



Fig. 8 Aerodynamic simulation for lift and drag force on windshield wiper.

Ventilation Flow Simulation



Numerical analysis for development of interpretation tools hood airflow.



Fig. 9 Thermal characteristics of drying performance.

Rotation-Dipping Painting



Numerical study on rotating-dipping painting process on car for prevent deformation on front hood and other parts caused by paint water



Fig. 10 Geometric characteristics and pressure levels on front hood

• Turbomachinery

Torque Converter



Numerical analysis for improvement on automotive torque converter with complex geometry.

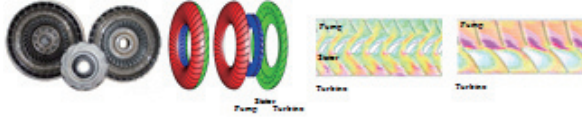


Fig. 11 Complex geometry and analysis results of torque converter.

Industrial Mixer



Numerical analysis on industrial mixer and development pre- and post process program.

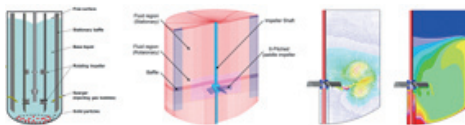


Fig. 12 Flow analysis of mixer with complex physics environment.

Cooling Fan



Numerical study on automotive cooling fan for cooling performance improvement.

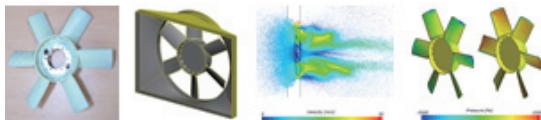


Fig. 13 Radiator cooling fan analysis for performance improvement.

• Manufacturing Process

EGL Coating



Numerical study on EGL coating process for improving coating performance.

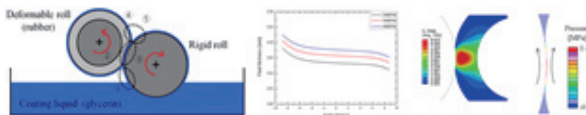


Fig. 14 Simulation of the underhood thermal management of a vehicle.

High Pressure Deburring



Numerical analysis on high pressure water-jet deburring with various process condition.

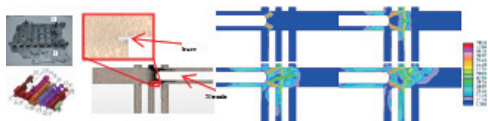


Fig. 12 Flow analysis of mixer with complex physics environment.

Wet Blasting Process



Numerical simulation by Lagrangian multi-phase method for analysis impulse caused by wet blasting particles.

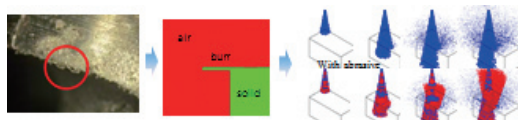


Fig. 16 Computational domain and simulation results with and without abrasive

• Energy

Heat Exchanger



Numerical analysis on flow and thermal characteristics of various types of heat exchanger with complex geometries.

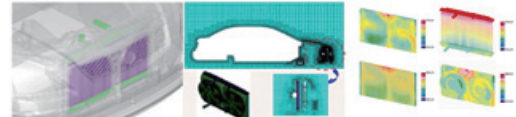


Fig. 17 Simulation of the underhood thermal management of a vehicle.

Tidal Power Generation



Numerical simulation on flow of sea water around tidal power generators.

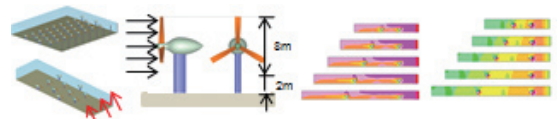


Fig. 18 Computational conditions and analysis results on power generators.

Wind Power Generation



Numerical simulation on wind power generators for improving generation efficiency.

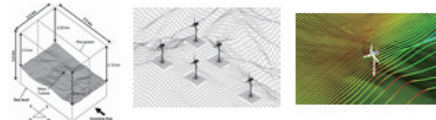


Fig. 19 Computational domains and analysis on wind power generators.

• Tunnel/Ventilation

Ventilation in Tunnels



Numerical analysis for predict ventilation in subway station and tunnels.



Fig. 20 Simulation domain and analysis results in train station

Wind Pressure at PSD



Numerical simulation on subway station with PSD for predict wind pressure caused by subway.

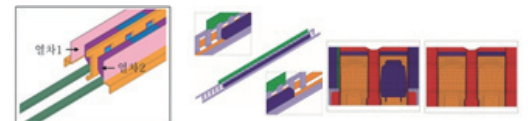


Fig. 21 Simulation domain and pressure levels on PSD.

H2 Ventilation in Parking lot



Numerical analysis for predict H2 ventilation in underground parking lot with various H2 leaking condition.

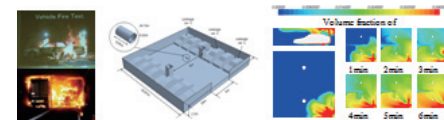


Fig. 22 Simulation for H2 leaking and volume fraction by time

• 다중물리 전산유체 연구실 Multi-physics Computational Fluid Dynamics Laboratory

지도 교수	허남건				
연구실 위치	AS615	전화번호	705-8637	홈페이지	http://cfdlab.sogang.ac.kr
연구실 방장	최종락	전화번호	010-7301-8816	이 메 일	jrchoi17@sogang.ac.kr

■ 기본연구방향

서강대학교 Multi-Physics CFD 연구실에서는 유체를 포함하는 다중 현상의 열/유동 현상에 대해 컴퓨터를 이용하여 다중 현상을 예측하고 이를 산업분야에 적용하는 연구를 수행하고 있습니다. 다중물리 열/유동 현상 해석을 위한 범용 열/유체 유동해석 프로그램(NUFLEX, NUmberical FLOW EXpert)을 개발하고 있으며, 핸드폰 케이스 도장, 가정용 후드 시스템 개발, 에어컨 유동 및 소음 해석, 실린더 헤드 버 제거, 차량 도장 공정 분석, 판재 코팅을 위한 코팅액 거동, 산업용 교반기 내부유동, 혈관 내 혈액유동 등과 같은 다양한 CFD 응용분야에 연구를 활발하게 진행하고 있습니다.

■ 최근 수행된 연구과제

1. 다중현상 CFD 연구센터, 한국연구재단
2. 전자기기 외장 케이스의 스프레이 도장 성능 향상을 위한 수치해석 연구, (주)삼성전자
3. 후드 기류 해석 Tool 개발, (주)삼성전자
4. CFD를 이용한 실내기 인자 최적 설계 Simulator 개발, (주)LG전자
5. 도장 후 변형 해석 기술개발, (주)현대기아자동차
6. 알루미늄 Wet Blast 디버링 공법 개발, (주)현대기아자동차
7. 중상도 공정 내 중간 건조로의 수성 도료 건조 인자 분석, (주)현대기아자동차
8. 엔진/변속기 가공품 고압 디버링 공정의 청정도 증대 방안 연구, (주)현대기아자동차
9. EGL 코팅용 액체 자유표면 유동 수치 해석 기술, (주)포스코
10. 산업용 교반기 유동해석 기술 개발, (주)하도
11. 산업용 소형/고효율 PMSM 기술개발(고효율화), 지식경제부 전자부품연구원

■ 최근 대표 발표논문 목록

1. S.-H. Lee, S.-H. Lee, K. Jang, J. Lee and N. Hur, "A Numerical Study for the Optimal Arrangement of Ocean Current Turbine Generators in the Ocean Current Power Parks," Current Applied Physics, Vol.10, pp.S137-S141, 2010.
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3. J.J. Cannon, D. Tang, N. Hur and D. Kim, "Competitive Entry of Sodium and Potassium into Nanoscale Pores," Journal of Physical Chemistry, Vol.114, pp.12252-12256, 2010.
4. S.-H. Lee and N. Hur, "Dust Collection Simulation Inside a Wire-pipe Type Electrostatic Precipitator System," Progress in Computational Fluid Dynamics, Vol.11, Nos.3/4, pp.206-214, 2011.
5. J.-H. Jung, S. Kang and N. Hur, "A Numerical Study of a Torque Converter with Various Methods for the Accuracy Improvement of Performance Prediction," Progress in Computational Fluid Dynamics, Vol.11, pp.261-268, 2011.
6. J.-T. Kim, S.-H. Lee, N. Hur and S.-K. Jeong, "Blood Flow Velocities of Cerebral Arteries in Lacunar Infarction and Other Ischemic Strokes," Journal of the Neurological Sciences, Vol.308, pp.57-61, 2011.
7. M.-K. Lee, S.-H. Lee, N. Hur, S. Kim, S. Kim and B. Choi, "Correlation Between Intravesical Pressure and Prostatic Obstruction Grade Using Computational Fluid Dynamics in Benign Prostatic Hyperplasia," Proceeding of the Institution of Mechanical Engineers, Part H: Journal of Engineering in Medicine, Vol.225, No.9, pp.920-928, 2011.
8. S.-H. Lee, N. Hur and S. Kang, "A Numerical Analysis of a Drop Impact on the Liquid Film by Using a Level Set Method," Journal of Mechanical Science and Technology, Vol.25, No.10, pp.2567-2572, 2011.
9. J.-H. Kim, J.-M. Seo, J.-H. Jung and N. Hur, "An Investigation on Development of Bus Electrical Cooling Fan System," International Journal of Automotive Technology, Vol.12, No.3, pp.417-423, 2011.
10. W. Kim, W.-H. Jeon, N. Hur, J.-J. Hyun, C.-K. Lim and S.-H. Lee, "Development of a Low Noise Cooling Fan for an Alternator by Using Numerical Method and DOE Method," International Journal of Automotive Technology, Vol.12, No.2, pp.307-314, 2011.

■ 연구실 구성원



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(연구교수)
Junghee Lee
(Research Prof.)



이상혁
(박사 후 과정)
Sanghyuk Lee
(Post Doctor)



최종락
(석사과정)
Jongrak Choi
(Master program)



박성훈
(석사과정)
Sunghoon Park
(Master program)



이건강
(학부연구생)
Geonkang Lee
(Master program)



최영욱
(석사과정)
Younguk Choi
(Master program)



민윤홍
(석사과정)
Yunhong Min
(Master program)



윤종혁
(석사과정)
Jonghyuk Yoon
(Master program)

◆ 최근 수행 연구과제

연구과제명	산업용 소형/고효율 PMSM 기술개발(고효율화)		
주무기관	지식경제부 전자부품연구원	연구자역할	책임
연구비	40,000,000원	연구기간	2010.05.01~2011.04.30
주요 참여 대학원생	이명성, 이상혁		

연구과제명	상용차용 5kW급 고효율 쿨링팬 시스템 기술개발		
주무기관	경기개발연구원	연구자역할	책임
연구비	23,750,000원	연구기간	2010.06.01~2011.05.31
주요 참여 대학원생	이상혁, 최종락		

연구과제명	(초)장대터널 화재 안전설계 기술 개발		
주무기관	건설교통부 한국건설교통기술평가원	연구자역할	공동
연구비	33,000,000원	연구기간	2010.06.01~2011.05.31
주요 참여 대학원생	이명성, 정재혁, 이승재		

연구과제명	엔진/변속기 가공품 고압 디버링 공정의 청정도 증대 방안 연구		
주무기관	(주)현대기아자동차, (주)엔지비	연구자역할	책임
연구비	34,000,000원	연구기간	2010.08.15~2011.05.14
주요 참여 대학원생	이상혁, 최종락		

연구과제명	산업용 교반기의 유동해석 기술개발		
주무기관	(주)하도	연구자역할	책임
연구비	25,000,000원	연구기간	2010.09.01~2011.08.31
주요 참여 대학원생	이명성, 이상혁, 최종락		

연구과제명	CFD를 이용한 실내기 인자 최적 설계 Simulator 개발		
주무기관	(주)엘지전자	연구자역할	책임
연구비	30,000,000원	연구기간	2010.11.01~2011.04.30
주요 참여 대학원생	이명성		

연구과제명	FSI 해석 기술		
주무기관	재단법인 한국연구재단	연구자역할	책임
연구비	800,038,471원	연구기간	2011.03.01~2012.02.29
주요 참여 대학원생	이명성, 이상혁, 최종락, 박성훈, 이건강		

연구과제명	도장 공장 수성 도로 중상도 공정내 중간건조로의 건조인자 최적화		
주무기관	(주)현대기아자동차, (주)엔지비	연구자역할	책임
연구비	43,350,000원	연구기간	2011.04.01~2011.11.31
주요 참여 대학원생	최종락		

연구과제명	신도립과 양동시장역에 PSD를 설치할 때 지역적 기본풍속 및 열차풍이 구조물에 미치는 영향 해석		
주무기관	(주)태창	연구자역할	책임
연구비	6,000,000원	연구기간	2011.05.17-2011.06.10
주요 참여 대학원생	이명성		

연구과제명	전자기기 외장 케이스의 스프레이 도장 기술 개발		
주무기관	(주)삼성전자	연구자역할	책임
연구비	70,000,000원	연구기간	2011.05.01-2011.10.30
주요 참여 대학원생	이명성, 이상혁, 최종락, 이건강		

연구과제명	Hood 기류 해석 Tool 개발		
주무기관	(주)삼성전자	연구자역할	책임
연구비	70,000,000원	연구기간	2011.05.01-2011.10.31
주요 참여 대학원생	이명성, 이상혁, 최종락		

연구과제명	알루미늄 실린더 블록/헤드 WET BLAST 공법 개발		
주무기관	(주)현대기아자동차, (주)엔지비	연구자역할	책임
연구비	40,750,000원	연구기간	2011.05.02-2011.12.31
주요 참여 대학원생	이상혁, 최종락		

연구과제명	도장 후 변형 해석 기술 개발		
주무기관	(주)현대기아자동차, (주)엔지비	연구자역할	책임
연구비	30,000,000원	연구기간	2011.07.01-2012.06.30
주요 참여 대학원생	이상혁, 최종락		

연구과제명	고정확도 수치해석 기법을 이용한 에어컨 실내기 난류유동 소음 예측 기술		
주무기관	(주)현대기아자동차, (주)엔지비	연구자역할	책임
연구비	30,000,000원	연구기간	2011.07.01-2012.06.30
주요 참여 대학원생	이명성, 최종락		

◆ 최근 대표논문

A numerical study of a torque converter with various methods for the accuracy improvement of performance prediction

Jae Hyuk Jung, Nahmkeon Hur,

책임

Progress in Computational Fluid Dynamics,

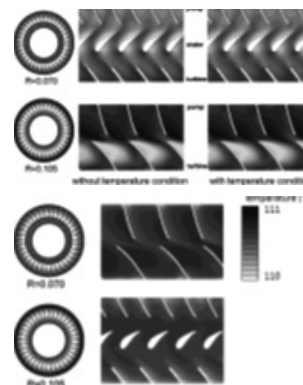
11, 261-268 (2011)

A numerical study of a torque converter with various methods for the accuracy improvement of performance prediction.

Jae Hyuk Jung, Seongwon Kang and Nahmkeon Hur,

Abstract

A comparative study was carried out on numerical methods for simulating a flow inside a torque converter. To investigate the effect of different methods for handling the relative motion of the parts, three methods were considered – the frozen rotor, sliding mesh and mixing plane methods. To improve the accuracy of performance prediction, the influence of viscosity variation with the temperature was studied by a thermo-fluid analysis. From parametric studies on the numerical scheme and the mesh resolution, it is observed that the results with the frozen rotor and sliding mesh methods agree well with the experimental data, whereas the mixing plane method induces a larger difference. The effect of viscosity variation on the accuracy of simulation is also investigated.



Dust collection simulation inside a wire-pipe type electrostatic precipitator system

Sang Hyuk Lee, Nahmkeon Hur,

책임

Progress in Computational Fluid Dynamics,

11, 206–214 (2011)

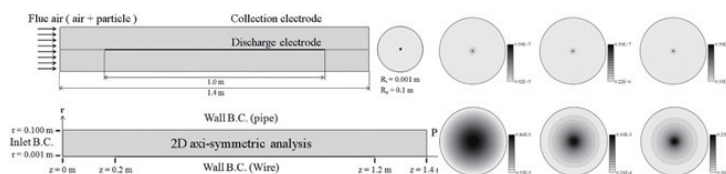
Dust collection simulation inside a wire-pipe type electrostatic precipitator system.

Sang Hyuk Lee and Nahmkeon Hur,

Abstract

The collection mechanism inside the Electrostatic Precipitator System (EPS) is determined by the electric field, the fluid flow and the particle motion. In this study, the collection phenomena inside a wire-pipe type EPS were simulated by coupling the Electrohydrodynamics (EHD) simulation with the particle dynamics.

The presented numerical method was verified by comparing to the analytical solution for an electric field and to the available numerical results for a dust collection of wire-plate type EPS. From the present EHD simulation, the collection mechanism of the wire-pipe type EPS was investigated for various operating conditions.



A numerical analysis of drop impact on the liquid film by using a level set method.

Sang Hyuk Lee, Nahmkeon Hur, Seongwon Kang,

책임

Journal of Mechanical Science and Technology,

25, 1–6 (2011)

A numerical analysis of drop impact on the liquid film by using a level set method.

Sang Hyuk Lee, Nahmkeon Hur and Seongwon Kang,

Abstract

Splashing and spreading of a liquid by a drop impact on the liquid film depend on the impact velocity, the drop size, the drop properties and the liquid film thickness. These parameters can be summarized by three main dimensionless parameters; Weber number, Ohnesorge number and non-dimensional film thickness.

Upon the impact of a drop on the liquid film, these parameters influence the shape of the splashing and the formation and propagation of the crown. In the present study, the splashing and spreading resulting from a drop impact on the liquid film has been numerically investigated by using a Level Set method for the interface tracking of the two-phase flow simulation. For various dimensionless parameters, characteristics of the crown formation and spreading were predicted, and the results were compared with the available experimental data showing good agreements in the earlier stage of the crown formation and some discrepancies in the later stage of crown spreading due to the present 2D axis-symmetric computation which cannot predict the secondary drops.



Blood flow velocities of cerebral arteries in lacunar infarction and other ischemic strokes.

Joon-Tae Kim, Sang Hyuk Lee, Nahmkeon Hur, Seul-Ki Jeong,

책임

Journal of the Neurological Sciences,

308, 57–61 (2011)

Blood flow velocities of cerebral arteries in lacunar infarction and other ischemic strokes.

Joon-Tae Kim, Sang Hyuk Lee, Nahmkeon Hur, Seul-Ki Jeong,

Abstract

Blood flow velocity is an important determinant of vascular hemodynamics. The aim of the present study was to determine the mean flow velocities (MFVs) of cerebral arteries in patients with ischemic stroke, comparing lacunar and nonlacunar infarctions. 388 consecutive patients were examined for lacunar infarction, other subtypes of ischemic stroke, and the presence of underlying internal carotid artery steno-occlusion (ICS).

MFVs were measured using transcranial Doppler along the full segments of each cerebral artery including both right and left middle cerebral arteries, basilar artery, and both of the vertebral arteries. The patients were categorized into two major groups: lacunar infarction, and nonlacunar infarction with or without underlying ICS. The characteristics of patients with lacunar infarction (n=83, 21.4%) were significantly different from those with nonlacunar infarctions: younger age, lower prevalence of type 2 diabetes, and lower concentration of plasma total homocysteine. The patients with lacunar infarction had lower MFVs in cerebral arteries than the patients with nonlacunar infarctions, especially in the posterior circulation vessels such as the basilar artery and both vertebral arteries. Different hemodynamics might be pathophysiologically associated with the lacunar infarction, compared with the other subtypes of ischemic stroke.

Multiphase Heat Transfer Laboratory



Professor GihunSon (손기현)
Mechanical Engineering, Sogang University R621,
<http://htlab.sogang.ac.kr>



• Research Area

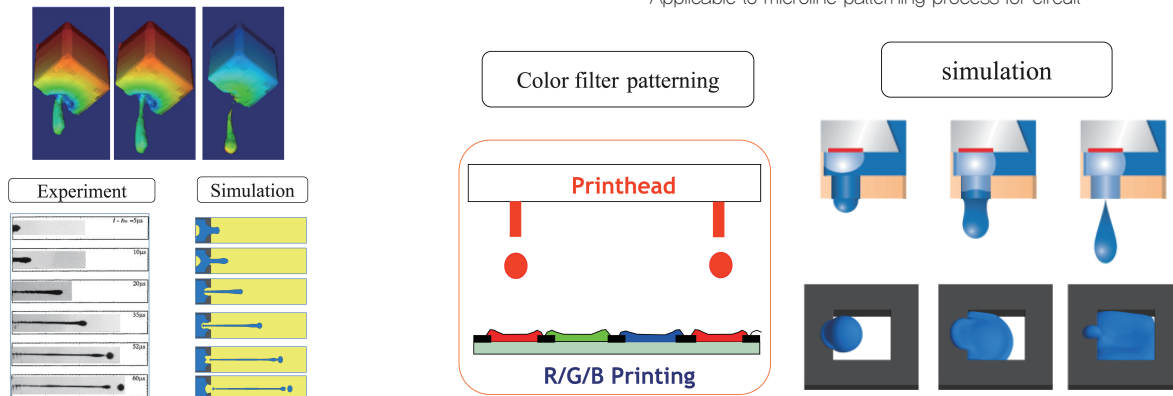
- Development of Analysis Technique for Multiphase (liquid/vapor/solid) CFD
 - Design of microstructure manufacturing process using Inkjet patterning
 - Design and analysis of inkjet heat
 - Design of microflow driving mechanism
 - Analysis of liquid generation/transport inside the fuel cell
- Development of energy system simulator based on GUI
- Development of boiling heat transfer enhancing technique
 - Development of analysis for boiling in Nuclear Power Plant
 - Development of nucleate boiling heat transfer enhancing method using microstructures
- Development of analysis and manufacturing technique for heat transfer process
 - A study on cooling method of hot-rolled steel using impinging Jet
 - Analysis of LNG transport tank



• Design of inkjet ejection and patterning process

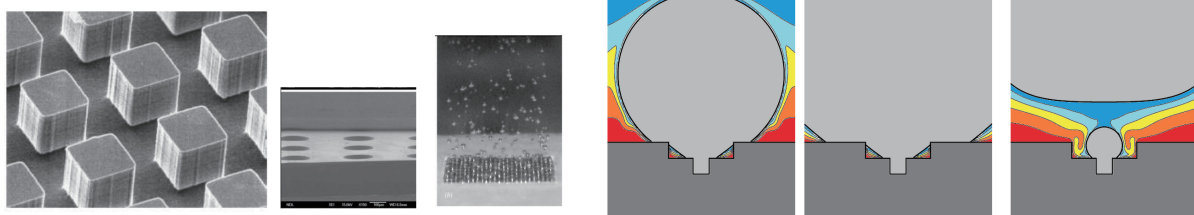
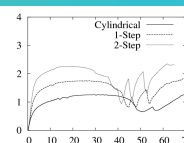
– Analysis and Design of inkjet print head

– Design LCD color filter patterning process using inkjet printing
– Applicable to microline patterning process for circuit



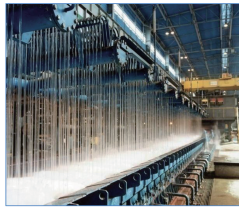
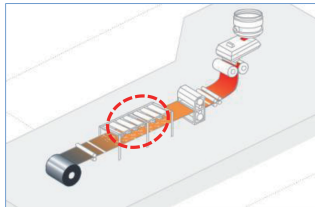
• Analysis of boiling heat transfer and development of enhancing technique

- Analysis bubble motion on microstructured surface
- Find optimal geometry of fin or groove to enhance boiling heat transfer
- Effect of step-type structure on bubble motion and boiling enhancement

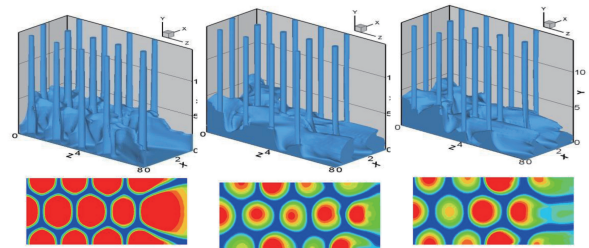


• Analysis of enhancing cool efficiency of high temperature steel

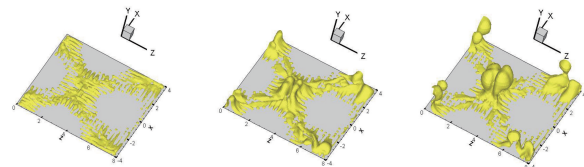
- Analysis flow field include water-air interface in impinging jet array
- Analysis heat transfer characteristics with boiling phenomena in impinging jet array
- Find optimal condition of impinging jet array enhance boiling heat transfer



- Analysis of liquid-vapor interface motion on Impinging jet array

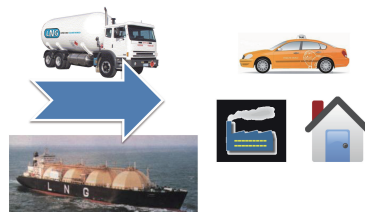


- Simulation of bubble grow in impinging jet array-

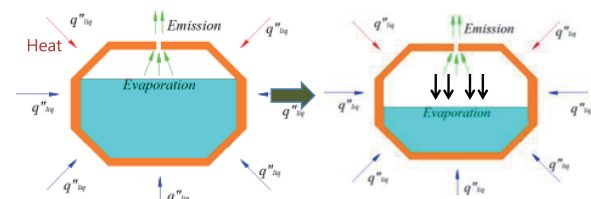


• Analysis of LNG reduction in tank

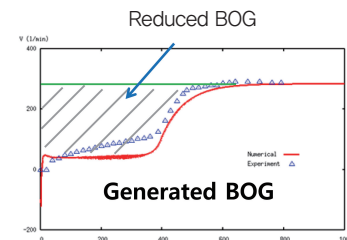
- Prediction for generation of BOG (boil off gas) by solving natural convection of the LNG storage tank
- Reduction of the BOG generation rate by increasing the tank operating pressure.



evaporation LNG production, transport, and storage



External heat flows during transport $\Rightarrow$ steel internal temperature increase and LNG evaporation



-The amount of BOG after increasing inner pressure

• 다상 열전달 연구실 Sogang Multiphase Heat Transfer Laboratory

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■ 기본연구방향

1. 다상유동 및 열전달 해석을 위한 수치기법 개발
2. 마이크로 다상 열유동 시스템의 해석 및 설계
3. 에너지시스템 시뮬레이터 개발

■ 최근 수행된 연구과제

1. 마이크로 열교환기 설계, ERC, 한국연구재단
2. 다중유체 계면 해석기술, ERC, 한국연구재단
3. 수치모사를 통한 마이크로구조표면에서의 비등특성 예측 및 향상에 대한 연구, 한국연구재단
4. 미세 액적의 자기정렬 기법을 포함한 패터닝 공법에 대한 해석적인 연구, 한국연구재단
5. 압력 및 수위변화를 고려한 화물창 내 BOG 예측 모델 개발, 삼성중공업
6. 비등현상을 포함한 고온강판의 폭방향 온도분포에 대한 수치해석, 포스코
7. 수분류의 충돌특성을 고려한 고온강판의 비등열전달 수치해석, 포스코
8. 수냉각중인 강판 위 비등현상에 대한 수치해석 모델 개발, 포스코
9. 핵비등현상의 직접수치모사기법 연구, 한국원자력연구원
10. 고효율 무교정 후판 가속냉각 제어기술, 지식경제부

■ 최근 대표 발표논문 목록

1. Lee W, Son G., Han YY, Numerical Study of Bubble Growth and Boiling Heat Transfer on a Microfinned Surface, International Communications in Heat and Mass Transfer; Accepted(2011)
2. Lee W, Son G, Numerical Study of Droplet Impact and Filling in a Microgroove, Progress in Computational Fluid Dynamics 2011; 11, 175-183
3. Lee W, Son G, Numerical Study of Droplet Impact and Coalescence in a Microline Patterning Process, Computers & Fluids 2011; 42:26-36
4. Lee W, Son G, Jeong JJ, Numerical Analysis of Bubble Growth and Departure from a Microcavity, Numerical Heat Transfer, Part B 2010; 58:323-342
5. Son G, A Level-Set Method for Analysis of Microdroplet Evaporation on a Heated Surface, Journal of Mechanical Science and Technology 2010; 24:991-997
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8. Suh Y, Son G, A Sharp-Interface Level-Set Method for Simulation of Piezoelectric Inkjet Process, Numerical Heat Transfer, Part B 2009; 55:295-312
9. Choi IK, Kim JA, Jeong CK, Woo JH, Choi, JY, Son G, Development of a Digital Turbine Control System in a Nuclear Power Plant, International Journal of Control, Automation, and Systems 2009; 7:67-73

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◆ 최근 수행 연구과제

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주무기관	한국연구재단 ERC	연구자역할	책임
연구비	57,600,000원	연구기간	2011.03.01~2012.02.28
주요 참여 대학원생	이우림, 노상은, 김경민, 이재원		

연구과제명	핵비등현상의 직접수치모사기법 연구		
주무기관	한국원자력연구원	연구자역할	책임
연구비	30,000,000원	연구기간	2011.03.01~2012.02.28
주요 참여 대학원생	이우림		

연구과제명	비등현상을 포함한 고온강판의 폭방향 온도분포에 대한 수치해석		
주무기관	포스코	연구자역할	책임
연구비	50,000,000원	연구기간	2011.02.01~2011.12.31
주요 참여 대학원생	김경민		

연구과제명	고효율 무교정 후판 가속냉각 제어기술		
주무기관	지식경제부	연구자역할	책임
연구비	67,000,000원	연구기간	2011.09.01~2012.08.31
주요 참여 대학원생	이우림, 김경민		

◆ 최근 대표논문

Numerical Study of Droplet Impact and Coalescence in a Microline Patterning Process	
W. Lee, G. Son	책임
Computers & Fluids	42, 26–36 (2011)

ARTICLE INFO

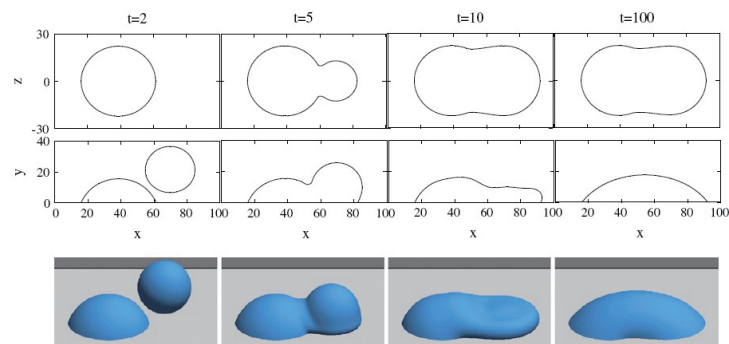
Article history:
Received 2 July 2010
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Keywords:
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Droplet coalescence
Level-set method
Microline

ABSTRACT

The droplet impact and coalescence on a substrate, which is applicable to the manufacture of microlines, is studied numerically by solving the equations governing the conservation of mass and momentum. The liquid–gas interface or droplet shape is tracked by a sharp-interface level-set method which is modified to account for the change between advancing and receding contact angles at the liquid–gas–solid interline. The numerical results show that the droplet impact and merging pattern depends significantly on the advancing and receding contact angles. Also, the effect of droplet spacing on the droplet motion is investigated to find the optimal conditions in manufacturing microlines.

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Numerical Simulation of Boiling Enhancement on a Microstructured Surface

W. Lee, G. Son, J. Jeong

책임

International Communications in Heat and Mass Transfer

38, 168–173 (2011)

ARTICLE INFO

Available online 4 December 2010

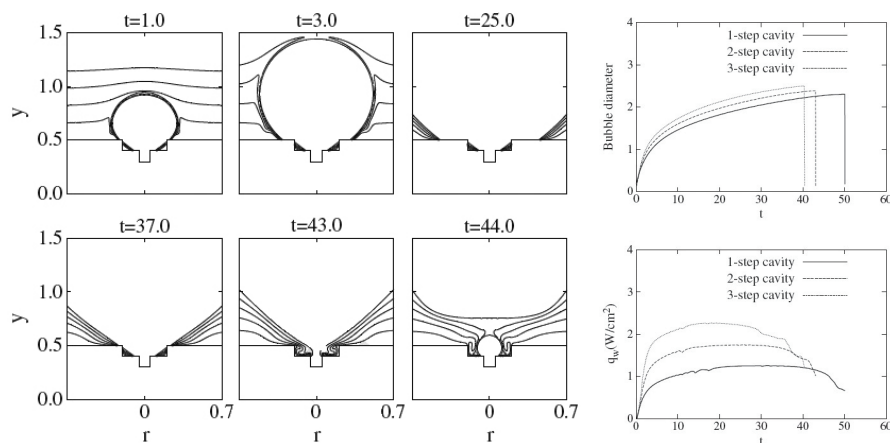
Keywords:

Boiling enhancement
Level-set method
Microstructured surface
Numerical simulation

ABSTRACT

Significant efforts have been made to augment nucleate boiling by surface modification with micro-machined structures, but a general predictive approach for heat transfer enhancement has not yet been developed. In this work, complete numerical simulations are performed for boiling enhancement on a microstructured surface by employing the sharp-interface level-set method, which is modified to handle the contact angle and the evaporative heat flux from the liquid microlayer on an immersed solid surface. The effects of cavity diameter and surface modification such as concentric grooves and multi-step cavities on bubble growth and boiling heat transfer are investigated.

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Numerical Study of Bubble Growth and Boiling Heat Transfer on a Microfinned Surface

W. Lee, G. Son, H. Yoon

책임

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Accepted (2011)

ARTICLE INFO

Available online xxxx

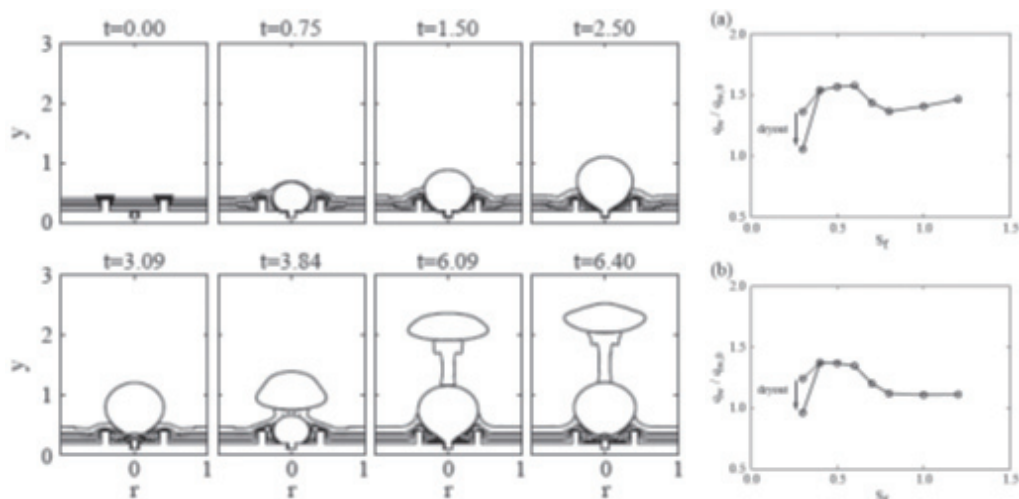
Keywords:

Boiling enhancement
Level-set method
Microfinned surface
Numerical simulation

ABSTRACT

The bubble growth and boiling heat transfer on a microfinned surface are studied numerically by solving the conservation equations of mass, momentum and energy. The bubble shape is tracked by a sharp-interface level-set method, which is modified to include the effect of phase change and to treat the contact angle and microlayer heat flux on an immersed solid surface. The present computation demonstrates that the microfinned surface enhances boiling heat transfer significantly compared to a plain surface. The effects of fin spacing and height on the bubble growth and heat transfer are investigated to find the optimal conditions for boiling enhancement.

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Numerical Study of Droplet Impact and Filling in a Microgroove

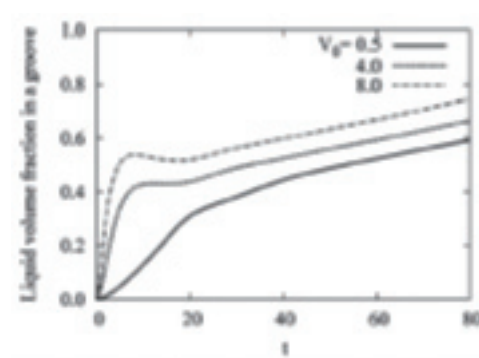
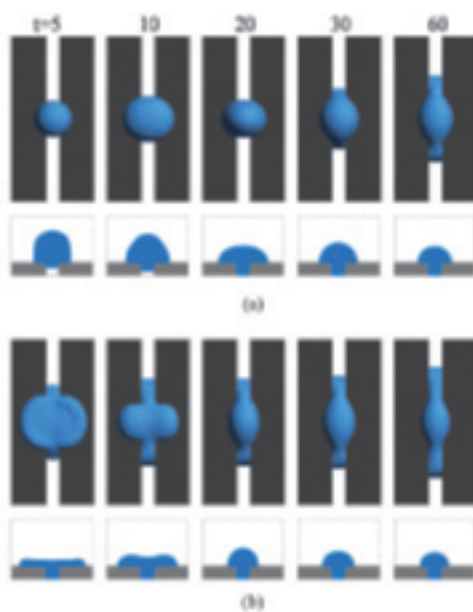
W. Lee, G. Son

책임

International Communications in Heat and Mass Transfer

11, 175–183 (2011)

Abstract: The droplet impact and filling behaviour in a microgroove, which can be used to produce a very narrow microline, is studied numerically by solving the conservation equations of mass and momentum. The droplet interface is tracked by a Level-Set (LS) method, which is extended to treat the no-slip and contact angle conditions at the immersed solid surface of a microgroove. The numerical results show that the droplet filling time can be significantly reduced through the combination of hydrophilic and hydrophobic microstructures. Further, the effects of impact velocity and groove geometry on the droplet motion in a microgroove are investigated.



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• Multiphysics Modeling & Simulation

미소 구조물의 자기조립 현상 해석

A study for the self-assembly process of micro- and nanostructures



나노 구조물의 자기조립(self-assembly)현상의 다중 물리적 메커니즘들을 모두 고려하여 이론적으로 확립하고 이론적 모델개발을 통해 자기조립 현상을 가시화하여 새로운 나노공정기술 개발에 필요한 효과적인 도구를 개발



Fig. 1 Patterning thin film by surface chemistry and elastic field

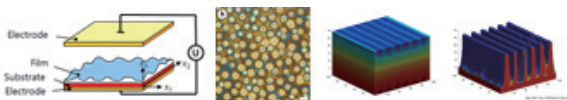


Fig. 2 Evolving thin polymer film driven by electrostatic field



Fig. 3 Evolution of flip-chip solder joints under electromigration and elastic field

Laser 용접공정 해석을 통한 핵연료 지지격자체 개발

Development of integrated system of process analysis and design for nuclear fuel space r grid



핵연료 지지격자체의 용접 잔류응력 및 변형을 예측하고, 레이저 용접 변수를 최적화시켜 지지격자의 생산성과 품질을 향상하고, 이를 통해 지지격자 공정해석 및 설계 융합 시스템을 개발



Fig. 4 Pulsed welding experiment with Nd:YAG laser

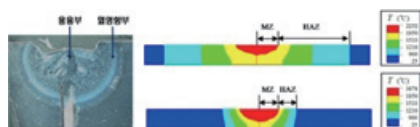


Fig. 5 Molten zone and heat affected zone profile of Zircaloy-4



Fig. 6 z-direction displacement after laser welding process

• Computational Mechanics

차체 용접부 내구수명 예측기법 표준화 개발



Development of techniques for fatigue life estimation of spot welds

차체 점용접부의 내구수명을 비파괴 측정방법으로 예측 하기 위하여 차체의 표면에 부착하는 strain-gage kit을 개발하고 이를 통해 실차 상태의 복합하중을 받는 점용접부에 대한 내구수명 예측 모델을 개발



Fig. 7 Spot weld in automobile body frame and fatigue fracture

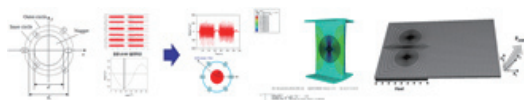


Fig. 8 Developed strain-gage kit and spot welding model applied multi-axial load



Fig. 9 Specimen test and on-vehicle test for verification

차량 충돌해석을 위한 무요소/유한요소 기법의 접목기술 개발



Development of a coupled meshfree/finite element method for automotive crashworthiness simulations

차량 충돌해석 시 기존 FE method의 격자계의 한계로 해석결과의 신뢰성 저하를 보완하기 위한 방법으로 meshfree method에 대한 구체적인 분석 및 차량 충돌해석에 사용할 무요소/유한요소 접목기술 연구



Fig. 10 Meshfree/FE method application in vehicle

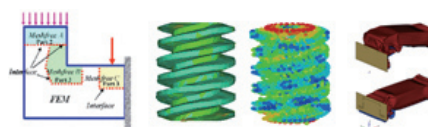


Fig. 11 Meshfree method component analysis

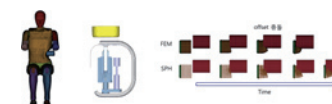


Fig. 12 Dummy impact analysis

Multiscale Modeling & Simulation

지능재료 시스템의 멀티스케일 설계 기술 개발 
Multiscale design technology for intelligent materials systems

각 스케일에 해당하는 제일원리-분자동역학-상장모델-다결정 유한요소 기법을 유기적으로 결합하는 멀티스케일 해석 기술을 개발한다. 이를 위해, 형상기억합금에 대한 각 해석 기법의 장점과 한계를 분명히 규명하고, 스케일 별 장점을 유지한 조건에서 한계를 극복할 수 있는 방법으로 기법들을 유기적으로 브릿징

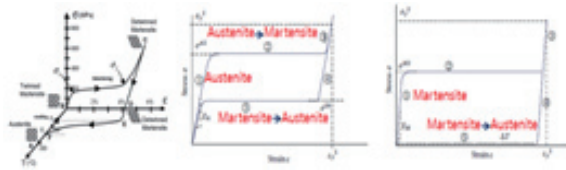


Fig. 13 Phase transformation curve and shape memory effect, pseudoelastic effect of Shape Memory Alloy

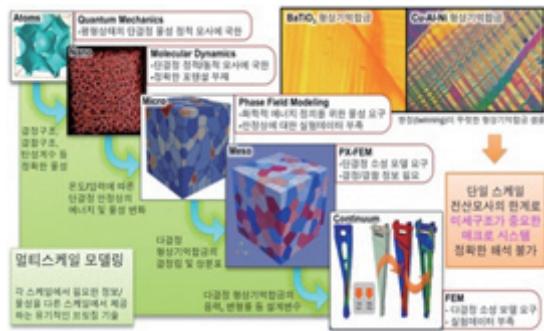


Fig. 14 Multiscale design technology for intelligent materials systems

다중스케일 해석 모델 개발 Development of multiscale model

다양한 현상에서 정확하고 신뢰성 있는 자료를 얻기 위해서는 다중현상에 대한 복합적인 해석이 필요하며 20세기 매크로 스케일-21세기 초반 마이크로/나노 스케일 연구의 연계를 위해 나노-마이크로-매크로 스케일을 통합할 수 있는 멀티 스케일 해석기법을 개발

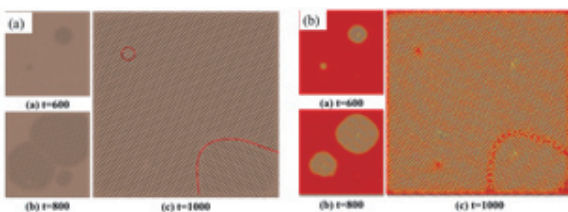


Fig. 15 Figure (a) represents the nature of the grain boundary from three different crystallites. Three different crystallites show the different grain boundary, respectively. There are different boundary energies at the grain boundary (b).

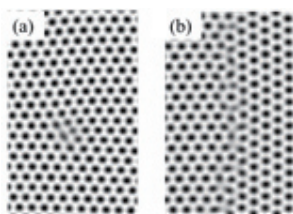


Fig. 16 The grain boundary energy between grains that differ in orientation was determined numerically by angle θ . The higher grain boundary energy is estimated in large angle grain boundary (b) than the small angle grain boundary (a).

Computational Bioengineering

3차원 동적 다중스케일 모델 개발을 통한 암세포 증식 및 치료과정 예측 기술 개발 
A study on cancer cell invasion and the chemotherapy process with a three-dimensional dynamic multi-scale model

다중물리(multi-physics), 다중성분(multi-components), 다중스케일(multi-scale) 모델을 기반으로 3차원 암세포 증식과 chemotherapy 모델을 개발하여 암세포 증식과정 및 chemotherapy에 대한 정량적 연구 및 예측기술을 개발

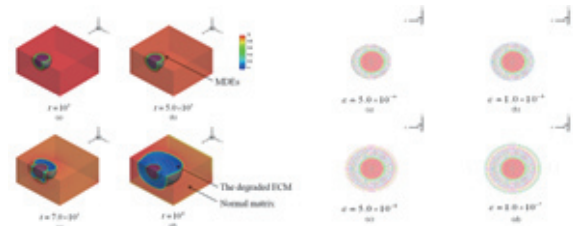


Fig. 17 The degraded evolution of the ECM and The distributions of MDEs when the rate of MDEs release by cancer cells.

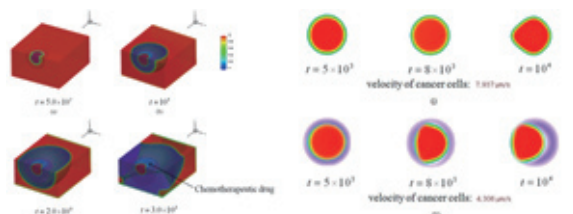


Fig. 18 The evolution sequence of chemotherapeutic drug diffusion and Morphological changes of cancer cells are affected without chemotherapeutic drug and cancer cells are affected by chemotherapeutic drug .

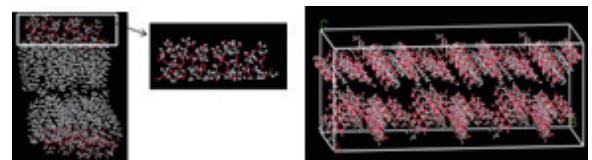


Fig. 19 Multiscale analysis to estimate interface energy at the cell membrane on Molecular Dynamics

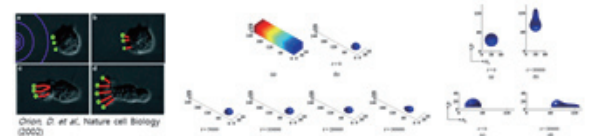


Fig. 20 Evolution sequence and morphological change of a crawling cell in the chemotactic condition. The cell is subjected to the linear chemiattractant gradient field where α is 3.5.

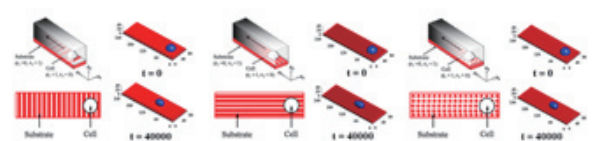


Fig. 21 Evolution sequence of a crawling cell on the geometrically patterned substrates. The cell is subjected to the linear chemoattractant gradient field where where α is 3.5.

• 다중물리 & 다중스케일 시스템 연구실 Multiphysics & Multiscale Systems Laboratory

지도교수	김동철				
연구실 위치	AS701	전화번호	705-8643	홈페이지	http://mmslab.sogang.ac.kr
연구실 방장	송지환	전화번호	010-7313-0300	이 메 일	pennyhard@sogang.ac.kr

■ 기본연구방향

다중물리 & 다중스케일 시스템 연구실은 김동철 교수님 지도하에 다중물리 & 다중스케일 시스템의 다양한 응용 연구를 진행하고 있습니다. 우리 연구실의 주 연구 분야로는 1. Computational mechanics, 2. Multiphysics modeling & simulation, 3. Computational bioengineering, 4. Multiscale modeling & simulation 이 있습니다.

■ 최근 수행된 연구과제

1. 지능재료 시스템의 멀티스케일 설계 기술 개발, 한국과학재단, 기초연구사업
2. 3차원 동적 다중스케일 모델 개발을 통한 암세포 증식 및 치료과정 예측기술 개발, 한국과학재단, 기초연구사업
3. 다중물리 융합 해석 기술, 한국과학재단 기초연구사업
4. 핵연료 지지격자 공정해석 및 설계 융합 시스템 개발, 한국과학재단, 원자력 연구개발사업
5. 차량 충돌해석을 위한 무요소/유한요소 기법의 접목기술 개발, 현대자동차
6. 알루미늄 실린더 블록/헤드 WET BLAST 공법 개발, 현대자동차

■ 최근 대표 발표논문 목록

1. Zhang L, Song J, Kim D, A Study on the Interfacial Effect on the Cancer-Cell Invasion, Journal of Applied Physics 2011;109:074702
2. Song J, Kim D, Three-Dimensional Chemotaxis Model for a Crawling Neutrophil, Physical Review E 2010;82:051902

■ 연구실 구성원



송지환
(박사과정)
Jihwan Song
(Ph.D program)



한규현
(박사과정)
Quhon Han
(Ph.D program)



장리난
(석박사통합과정)
Linan Zhang
(Unified Ph.D and Master program)



양명석
(석사과정)
Myeongseok Yang
(Master program)



김수일
(석사과정)
Suil Kim
(Master program)



배지예
(석사과정)
Jiyeah Bae
(Master program)



이우주
(학부연구생)
Woojoo Lee
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	지능재료 시스템의 멀티스케일 설계 기술 개발		
주무기관	한국과학재단 (기초연구사업 중견연구자지원 핵심연구)	연구자역할	공동
연구비	50,000,000원	연구기간	2011.09.01~2012.08.31
주요 참여 대학원생	송지환, Zhang Linan, 양명석		

연구과제명	다중물리 융합 해석 기술		
주무기관	한국과학재단 (기초연구사업 선도연구센터(ACE)육성사업 이공학분야(S/ ERC))	연구자역할	공동
연구비	53,000,000원	연구기간	2011.03.01~2012.02.28
주요 참여 대학원생	송지환, Zhang Linan		

연구과제명	핵연료 지지격자 공정해석 및 설계 융합 시스템 개발		
주무기관	한국과학재단 (원자력연구개발사업 원자력기술개발 고유강점기술육성)	연구자역할	공동
연구비	50,000,000원	연구기간	2011.07.06~2012.07.5
주요 참여 대학원생	한규현, 송지환		

연구과제명	차량 충돌해석을 위한 무요소/유한요소 기법의 접목기술 개발		
주무기관	현대자동차	연구자역할	책임
연구비	41,000,000원	연구기간	2011.07.01~2011.11.30
주요 참여 대학원생	이우주, 송지환		

연구과제명	알루미늄 실린더 블록/헤드 WET BLAST 공법 개발		
주무기관	현대자동차	연구자역할	공동
연구비	40,000,000원	연구기간	2011.05.01~2010.12.31
주요 참여 대학원생	양명석		

◆ 최근 특허 실적

특허명	암세포 거동 모델링 방법 및 장치			
발명자	김동철, 송지환, Zhang Linan			
특허지역	국내	특허유형	출원	출원번호 10-2011-0016785
발명 참여 대학원생	송지환, Zhang Linan			

특허명	유형세포의 거동 모델링 방법 및 장치			
발명자	김동철, 송지환			
특허지역	국내	특허유형	출원	출원번호 10-2011-0016791
발명 참여 대학원생	송지환			

특허명	흡착세포의 거동 모델링 방법 및 장치			
발명자	김동철, 송지환			
특허지역	국내	특허유형	출원	출원번호 10-2011-0016793
발명 참여 대학원생	송지환			

◆ 최근 대표논문

A study on the interfacial effect on the cancer-cell invasion

Linan Zhang, Jihwan Song, Dongchoul Kim

책임

Journal of Applied Physics

109, 074702 (2011)

Cancer-cell invasion is a complex biological process involving cell migration through the extracellular matrix, which is driven by haptotaxis, and the interactions between cancer cells and the surrounding matrix. In this paper, a three-dimensional haptotaxis model that simulates the migration of a cancer cell population, including cell-cell adhesion and cell-matrix adhesion, is proposed. We employ a diffuse interface model that incorporates the mechanism of haptotaxis and the interface energy of cancer cells as well as that between cancer cells and the matrix. The semi-implicit Fourier spectral scheme is applied for high efficiency and numerical stability. The simulations systematically reveal the dynamics of cancer-cell migration and the effect of interface energy on the invasion of cancer cells.

Three-dimensional chemotaxis model for a crawling neutrophil

Jihwan Song, Dongchoul Kim

책임

Physical Review E

82, 051902 (2010)

Chemotactic cell migration is a fundamental phenomenon in complex biological processes. A rigorous understanding of the chemotactic mechanism of crawling cells has important implications for various medical and biological applications. In this paper, we propose a three-dimensional model of a single crawling cell to study its chemotaxis. A single-cell study of chemotaxis has an advantage over studies of a population of cells in that it provides a clearer observation of cell migration, which leads to more accurate assessments of chemotaxis. The model incorporates the surface energy of the cell and the interfacial interaction between the cell and substrate. The semi-implicit Fourier spectral method is applied to achieve high efficiency and numerical stability. The simulation results provide the kinetic and morphological traits of a crawling cell during chemotaxis.

Laboratory for Applied Fluid Mechanics



Professor Seongwon Kang (강성원)
Mechanical Engineering, Sogang University
AR611A



Numerical Methods for Complex Flows

날개 형상 주위의 3차원 난류 유동 현상 해석

Immersed boundary (IB) 방법 및 Hybrid RANS+LES 기법 등 최신의 수치 해석 기법을 이용하여 실험을 대체하는 고정확도의 수치 해석을 수행

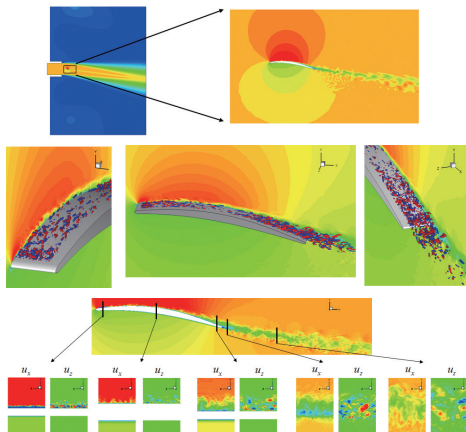


Fig. 1 Contours of the velocity for the flow around VALEO airfoil

Turbulent Flows with Multi-Material Heat Transfer

Conjugate heat transfer around a cylinder

다중물리(multi-physics) 현상을 해석하기 위한 Immersed boundary 방법을 개발하여 전도와 난류가 복합된 유동의 고정확도 계산을 수행

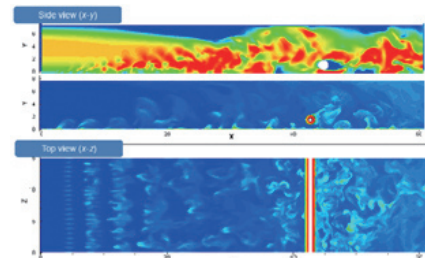


Fig. 2 Contours of the velocity and temperature

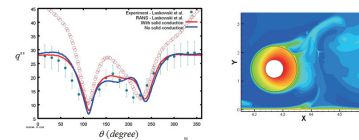


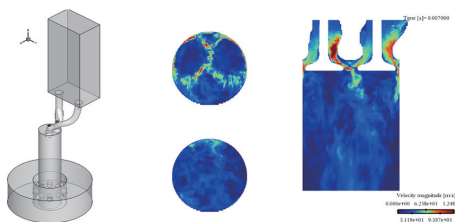
Fig. 3 Comparison of the local heat flux with the experiment and RANS

Flows in internal combustion engine

연소가 포함된 내연기관 내의 유동 해석

차세대 고효율 소형 엔진의 개발에 중요한 내연기관 내의 열유동 해석을 수행하며 고정확도 해석을 통해 실험 비용 절감 및 성능의 최적화를 수행할 수 있음

PSA flow bench case



GM flow bench case

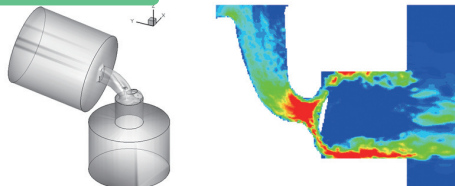


Fig. 4 Engine models and contours of the velocity

Flows inside a gas turbine

DLR turbine combustor 내부의 유동 해석

가스터빈 내부의 유동은 열/유체/연소/소음 문제가 동반된 복잡한 다중 현상 문제로서 항공 및 발전 분야에서 다양한 적용 분야를 가지고 있습니다.

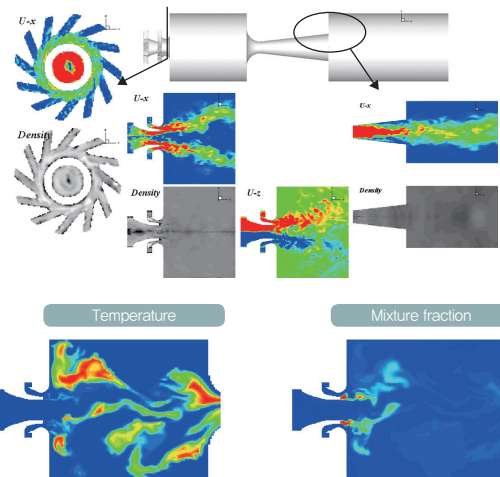


Fig. 5 Contours of various flow variables inside the DLR combustor

• Numerical methods for complex flows

LES of a turbulent flow around an airfoil

Analysis of a turbulent flow around a low-speed automotive fan using high fidelity simulation techniques for complex geometries such as Immersed boundary (IB) method and Hybrid RANS+LES

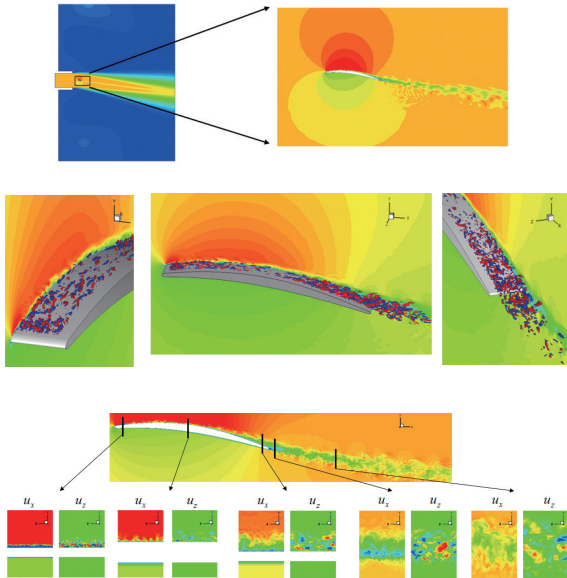


Fig. 1 Contours of the velocity for the flow around VALEO airfoil

• Turbulent flows with multi-material heat transfer

Conjugate heat transfer around a cylinder

DNS and modeling of conjugate heat transfer phenomena with turbulent convection and solid conduction

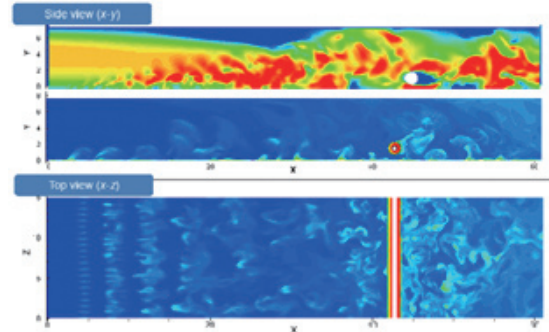


Fig. 2 Contours of the velocity and temperature

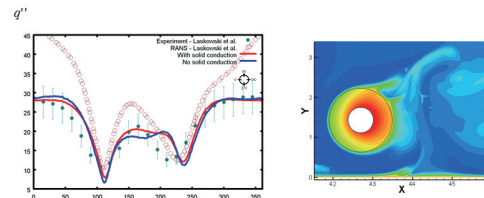


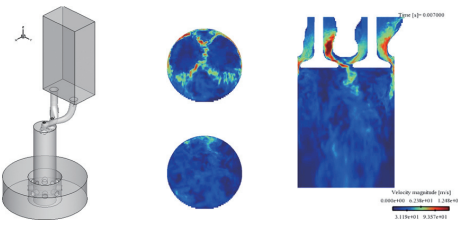
Fig. 3 Comparison of the local heat flux with the experiment and RANS

• Flows in Internal Combustion Engine

LES of flows inside an internal combustion engine

Accurate simulations of turbulent flows with combustion inside an internal combustion engine to provide a useful tool and insights for engine development

PSA flow bench case



GM flow bench case

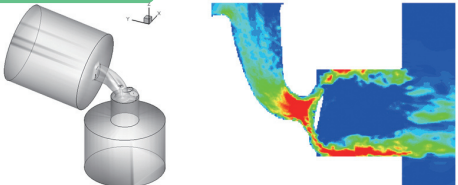


Fig. 4 Engine models and contours of the velocity

• Flows Inside a Gas Turbine

LES of flows combustion phenomena inside a DLR combustor

High fidelity simulations of turbulent combustion phenomena inside a gas turbine combustor to accurately predict the combustion instability and propagation of acoustic waves

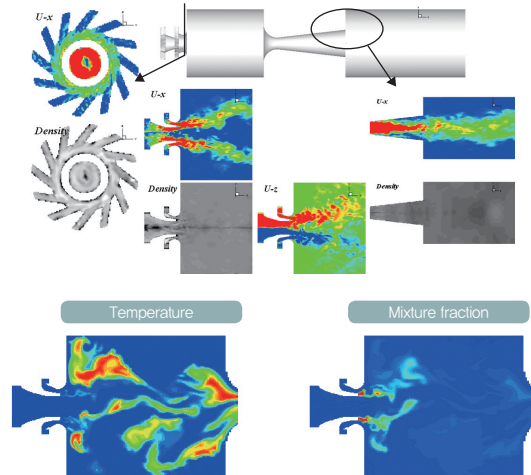


Fig. 5 Contours of various flow variables inside the DLR combustor

• 응용유체역학 연구실 Applied Fluid Mechanics Laboratory

지도교수	강성원				
연구실 위치	AR611A	전화번호	02-705-7972	홈페이지	
연구실 방장	N/A	전화번호	N/A	이메일	N/A

■ 기본연구방향

1. Turbulent flows with heat transfer and combustion
2. Internal combustion engine / Gas turbine
3. Numerical methods for complex flows

■ 최근 수행된 연구과제

1. 바이오 가스 연소기를 위한 개선된 대와류 모사 해석 기술 개발, 한국연구재단 (교육과학기술부)
2. 다중현상 CFD 연구센터, 선도연구센터 공학분야 (ERC), 한국연구재단 (교육과학기술부)
3. 고정확도 수치해석 기법을 이용한 에어컨 실내기 난류 유동 소음 예측 기술, LG전자
4. 복잡한 유동에서 열 및 물질 전달을 위한 가상 경계법의 개발, 서강대학교

■ 최근 대표 발표논문 목록

1. Kang S, Iaccarino G, Ham F. 2009 "DNS of Buoyancy-Dominated Turbulent Flows on a Bluff body using the Immersed Boundary Method" Journal of Computational Physics, Vol. 228, pp. 3189-3208.
2. Kang S, Iaccarino G, Ham F, Moin P. 2009 "Prediction of Wall-Pressure Fluctuation in Turbulent Flows with an Immersed Boundary Method" Journal of Computational Physics, Vol. 228, pp. 6753-6772.
3. Kang S, Iaccarino G, Moin P. 2009 "Accurate Immersed-Boundary Reconstructions for Viscous Flow Simulations" AIAA Journal, Vol. 47, pp. 1750-1760.
4. Jung, J.H., Kang, S., Hur, N. 2011 "A Numerical Study of a Torque Converter with Various Methods for the Accuracy Improvement of Performance Prediction" Progress in Computational Fluid Dynamics, Vol. 11, No. 3/4, pp. 236-243.
5. Lee, S.H., Hur, N., Kang, S. 2011 "A Numerical Analysis of a Drop Impact on the Liquid Film by using a Level Set Method" Journal of Mechanical Science and Technology, in Press.

■ 연구실 구성원



강한별
(학부연구생)
Han byoll Kang
(Undergraduate program)



김다영
(학부연구생)
Da young Kim
(Undergraduate program)



손창근
(학부연구생)
Chang Keun Son
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	바이오 가스 연소기를 위한 개선된 대와류 모사 해석 기술 개발		
주무기관	교육과학기술부 한국연구재단	연구자역할	공동
연구비	50,000,000원	연구기간	2010.03.01~2011.02.28
주요 참여 대학원생			

연구과제명	다중현상 CFD 연구센터, 선도연구센터 공학분야 (ERC)		
주무기관	교육과학기술부 한국연구재단	연구자역할	책임
연구비	50,000,000원	연구기간	2010.03.01~2011.02.28
주요 참여 대학원생			

연구과제명	고정확도 수치해석 기법을 이용한 에어컨 실내기 난류 유동 소음 예측 기술		
주무기관	LG전자	연구자역할	책임
연구비	30,000,000원	연구기간	2011.07.01~2012.06.30
주요 참여 대학원생			

연구과제명	복잡한 유동에서 열 및 물질 전달을 위한 가상 경계법의 개발		
주무기관	서강대학교	연구자역할	책임
연구비	14,000,000원	연구기간	2010.11.01~2011.10.31
주요 참여 대학원생			

◆ 최근 대표논문

DNS of Buoyancy-Dominated Turbulent Flows on a Bluff body using the Immersed Boundary Method

Kang S, Iaccarino G, Ham F.

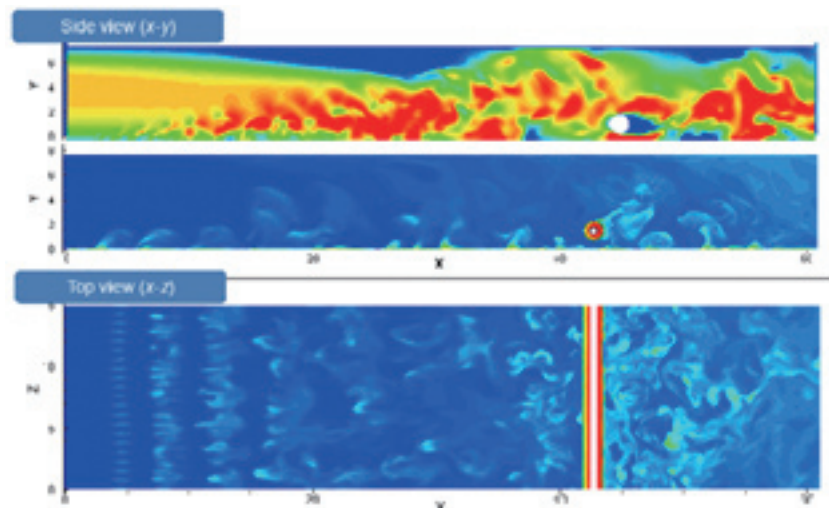
책임

Journal of Computational Physics

Vol. 228, pp. 3189–3208

ABSTRACT

The immersed boundary (IB) method is used to study a turbulent flow around a heated cylinder. This problem involves complexities such as transition, turbulent natural convection, and interaction of fluid convection and solid conduction. In order to enforce the velocity boundary condition at the IB, a second-order reconstruction method is employed. A Hermite-type interpolation is applied to reconstruct the temperature field across the fluid-solid interface. The present approach has been verified by solving two conjugate heat transfer problems with known analytical solutions and shows an improved result compared to previous methods based on linear temperature reconstruction. For the conjugate heat transfer problem around a circular cylinder, the predicted local Nusselt number shows a good agreement with the experiment. The turbulent Prandtl number near the cylinder shows that the Reynolds analogy is invalid in the present problem, which explains the large discrepancy of the RANS simulation compared to the experimental result.



A Numerical Study of a Torque Converter with Various Methods for the Accuracy Improvement of Performance Prediction

Jung, J.H., Kang, S., Hur, N.

공동

Progress in Computational Fluid Dynamics

Vol. 11, No. 3/4, pp. 236-243.

ABSTRACT

A comparative study was carried out on the numerical method for the performance prediction of a torque converter. The influence of different methods for simulation of part motion such as the frozen rotor, sliding mesh and mixing plane method was investigated. In addition, the influence of viscosity variation with temperature was studied by a thermo-fluid analysis for the accuracy improvement of the performance prediction. The preliminary computations were carried out to be independent of mesh density and numerical scheme. The results predicted by using the frozen rotor and sliding mesh method for the relative motion of blades agree well with experimental data, whereas the mixing plane method induces larger difference. The viscosity variation with temperature also affects the accuracy of the performance prediction. From these results, most suitable method was proposed for numerical analysis of torque converter.

A numerical analysis of drop impact on liquid film by using a level set method

Lee, S.H., Hur, N., Kang, S.

공동

Journal of Mechanical Science and Technology

Vol.25, No.10, pp.2567-2572.

ABSTRACT

Splashing and spreading of a liquid by drop impact on liquid film depends on the impact velocity, drop size, drop properties and liquid film thickness. These parameters can be summarized by three main dimensionless parameters: Weber number, Ohnesorge number and non-dimensional film thickness. Upon impact of a drop on liquid film, these parameters influence the shape of the splash and the formation and propagation of the crown. In the present study, the splashing and spreading resulting from drop impact on liquid film has been numerically investigated by using a Level Set method for the interface tracking of the two-phase flow simulation. For various dimensionless parameters, characteristics of the crown formation and spreading were predicted, and the results were found to show good agreement with available experimental data in the earlier stage of crown formation and show some discrepancies in the later stage of crown spreading due to the present 2D axi-symmetric computation, which cannot predict the secondary drops.



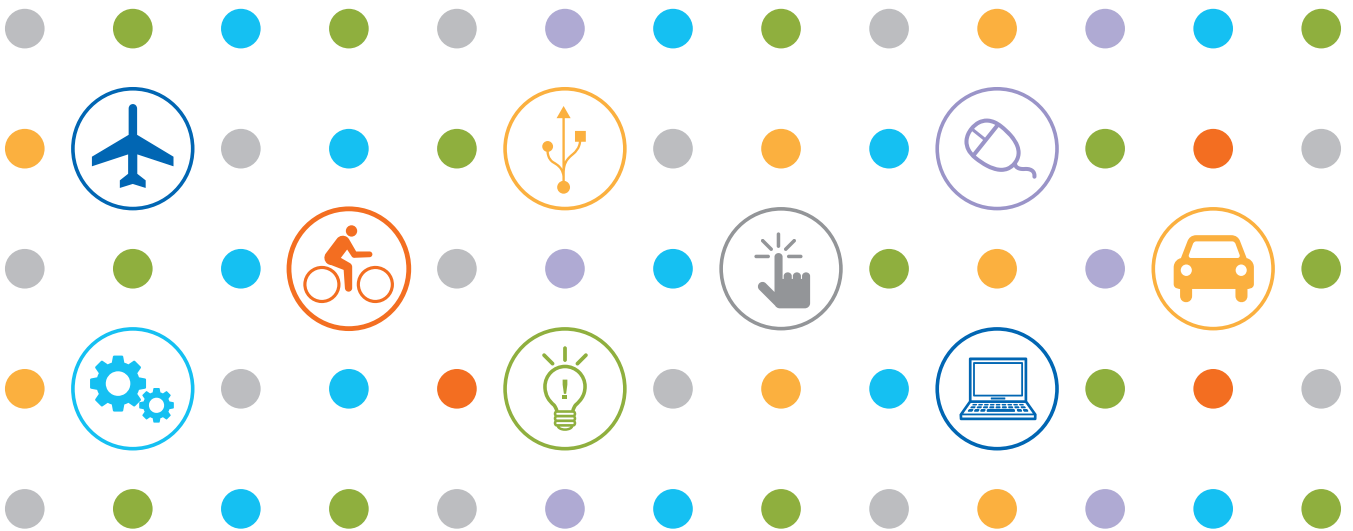
engineering



industry



technology



The Department of Mechanical Engineering

IV. 연구실 소개(3)

Research Laboratories

3. 에너지공학 연구그룹

Research on Energy Science

- 1) 열공학 연구실 _ 82
Thermal Engineering Laboratory
- 2) 다상 열전달 연구실 _ 64
Sogang Multiphase Heat Transfer Laboratory
- 3) 에너지-워터 넥서스 연구실 _ 87
Sogang Energy-Water Nexus (SEWN) Laboratory

Thermal Engineering Laboratory



Professor Siyoung Jeong
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- 열공학이란 열역학, 유체역학 및 열전달 등의 공학적 기초 이론으로 실제 공학 장치인 에너지 시스템에 적용하는 기계공학의 연구주제 중 하나입니다. 열공학의 주된 과제는 이렇게 특정한 목적을 가지고 사이클화 되어 작동하는 장치들을 보다 효율적, 안정적, 지속적으론 운전하게 하기 위한 개념 및 방법을 연구하는 것입니다.
- 열공학 연구실에서는 열역학을 바탕으로 흡수식 냉동 시스템, CO₂ 냉동 시스템, 연료 전지 자동차의 BOP, 태양열을 이용한 하이브리드 시스템에 대한 연구를 진행하고 있습니다.

• Hybrid Heat Pump

폐열이용 고온제조 하이브리드 히트펌프 기술개발



하이브리드 히트 펌프는 일반적인 흡수식 히트펌프에 증기압축 사이클을 추가한 히트 펌프이다. 열원을 이용해 냉각효과를 얻을 수 있는 일반적 흡수식 히트펌프에 비해 낮은 열원을 이용할 수 있다는 장점이 있다. 따라서 제한된 하이브리드 히트펌프는 일반적인 증기 압축 히트 펌프보다 낮은 압축비와 높은 COP를 가질 수 있게 된다.

하이브리드 히트펌프의 시스템 해석을 위해 EES를 사용하여 수치적 연구를 수행한다. 또한 시스템 내부 상태를 확인하기 위해 내부 농도측정 장치를 개발한다. 본 연구에서 제안된 물-암모니아 용액의 포화증기압을 이용한 측정 장치는 저렴한 비용으로 설치되어 정확한 정보를 줄 수 있을 것이다.

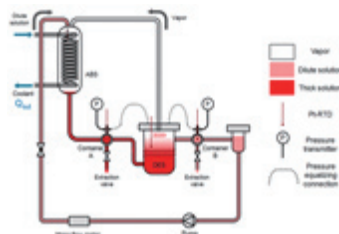


Fig. 1 Experimental setup for concentration measurement of ammonia aqueous solution

• Cold-Start Characteristics in PEMFC Stacks

친환경 연료전지자동차 핵심부품 및 시스템 기술 개발

– 저온 운전 기술 및 통합 열관리 시스템 기술 개발



저온의 환경에 노출되어 있는 연료전지자동차의 경우 연료전지 스택 내부에서 일어나는 반응으로 생성된 수분이 얼어 성능의 저하, 시동 소요시간의 지연과 같은 문제가 발생할 수 있다. 이를 방지하기 위하여 높은 온도의 EG(Ethylene Glycol) 용액을 스택 내부에 순환시켜 언급된 문제를 해결 할 수 있다.

본 연구에서는 EG 용액의 유량과 온도의 효과를 실험과 해석을 통해 평가하고자 한다. 그에 따른 기대 효과로 연료전지자동차의 냉시동 성능 향상에 대한 중요한 요인을 확인할 수 있을 것으로 예상된다.

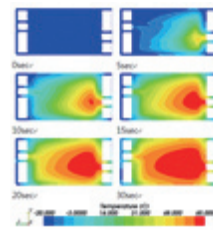


Fig. 2 Temperature profile of stack

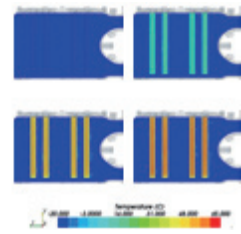


Fig. 3 Temperature profile of COD

• Development of CO2 Evaporator

환경친화적 자연냉매인 CO2를 적용한 고효율 냉난방 시스템 개발



이산화탄소는 환경친화적이고 높은 열적 특성을 가지고 있기 때문에 차세대 냉매로 각광받고 있다. 이산화탄소를 냉매로 사용하는 시스템에 적용할 수 있는 고효율 마이크로 채널 증발기를 개발하기 위하여, 마이크로관을 이용한 평행류형 이산화탄소 증발기에 대한 연구가 수행되고 있다. 평행류형 증발기는 그 성능향상을 위해 효율적인 냉매 분배가 가능해야 한다. 다양한 입구와 출구의 위치 조건에서 실험을 중심으로 연구되고 있으며, 연구되는 증발기는 안정성, 저비용, 높은 효율을 가질 수 있을 것이라 예상된다.

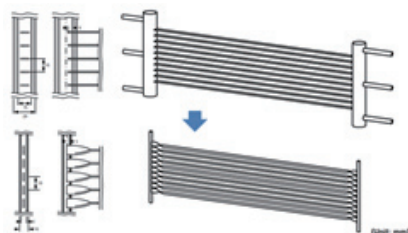


Fig. 4 Engine models and contours of the velocity

• Hybrid Desiccant Cooling /Heating System Utilizing Solar Energy

태양열 이용 제습식-압축식 하이브리드 히트펌프 원천기술 개발



태양열을 이용한 제습식-압축식 하이브리드 히트펌프는 제습기와 증기 압축 냉동기, 태양 에너지 저장원으로 구성되어 있다. 습도가 높은 지역에서, 제습 시스템은 공기중의 수증기를 효과적으로 제거함으로 압축식 냉각시스템보다 효율적으로 잠열부하를 줄일 수 있다. 더욱이 본 시스템에서는 제습 용액이 태양 에너지에 의해서 다시 재생되기 때문에 높은 COP를 얻을 수 있다. EES(Engineering Equation Solver)를 이용해 시스템 내부를 흐르는 각 유체의 조건에 따른 최적의 시스템 운전 조건에 대한 연구가 수행되었다.

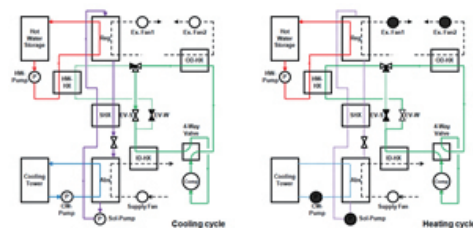


Fig. 5 Contours of various flow variables inside the DLR combustor

- Thermal engineering has been playing an significant role in the development of modern industries and technologies. It has revolutionized man's way of thinking in power generation and industrial manufacturing processes.
- Thermal Engineering Laboratory of Mechanical Engineering at Sogang University lets students take cognizance of broad applications of thermal engineering fundamentally and comprehensively.
- It covers the subjects of thermodynamics, refrigeration, heat transfer, and thermal system optimization. Its present research area includes absorption refrigeration systems, CO2 refrigeration systems, BOP of fuel cell vehicles and hybrid desiccant system utilizing solar energy.

• Hybrid Heat Pump

Development of Absorption-Compression Hybrid Heat Pump System Using Waste Heat

KITECH 한국에너지기술연구원
Korea Institute of Energy Research

A hybrid heat pump combines the absorption technology to a conventional vapor compression heat pump. The lower temperature of heat source can be used in the hybrid heat pump than the conventional vapor compression heat pump; the heat source is used to obtain cooling effect. Therefore, a hybrid heat pump has a lower compression ratio and a higher system COP than the conventional vapor compression heat pump.

The system performance of the hybrid heat pump is numerically investigated using EES. Moreover, the device for measuring concentration of internal system is developed. The measurement device using saturation pressure of water-ammonia solution is installed with cheap expenses and can provide exact information of experiment.

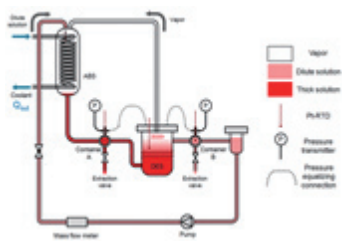


Fig. 1 Experimental setup for concentration measurement of ammonia aqueous solution

• Cold-Start Characteristics in PEMFC Stacks

Cold Startup and Thermal Management System for FCEV

HYUNDAI
Drive your way™

In the cold start of a FC vehicle, the PEMFC stacks should be heated to a desired temperature or the ice in the stacks should be melted. Generally, high temperature EG (Ethylene Glycol) solution is circulated through the stacks to melt the ice in the stacks as quickly as possible.

In this study, the effect of the flow rate and the temperature of EG solution is both numerically and experimentally investigated. This study is expected to provide important information to improve the cold start of fuel cell vehicles.

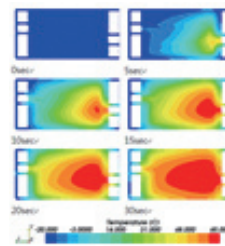


Fig. 2 Temperature profile of stack

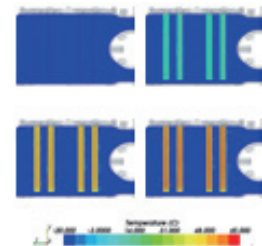


Fig. 3 Temperature profile of COD

• Development of CO2 Evaporator

A Study on the Evaporation Heat Transfer of CO2

SAMSUNG
ELECTRONICS

CO2 refrigeration systems have lots of benefits, because carbon dioxide is environment friendly and has good thermal characteristics. To develop a high efficient micro channel evaporator, the refrigerant distribution in a multi-tube CO2 evaporator is investigated at the 3rd stage (2008-2011) of the research.

Various inlet and exit positions are tested and it is expected that the progress of this system might result in the development of the micro channel heat exchangers with better environmental acceptability, safety, lower cost, and high performance.

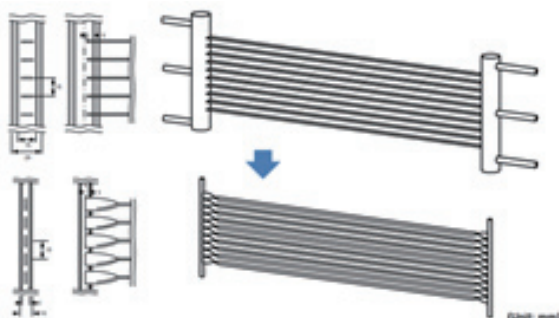


Fig. 4 Engine models and contours of the velocity

• Hybrid Desiccant Cooling /Heating System Utilizing Solar Energy

Development of Desiccant-Compression Hybrid Heat Pump System Using Solar Energy

KITECH 한국에너지기술연구원

Hybrid desiccant cooling system utilizing solar energy is composed of a liquid desiccant dehumidifier, a vapor compression cooler, and solar energy storage. In high humidity region, the latent cooling load can be effectively covered by the desiccant system. The COP of the system is greatly improved, since the solution is regenerated by solar energy. In heating mode, solar energy is supplied to the evaporator of the vapor compression refrigeration cycle increasing the heating COP significantly.

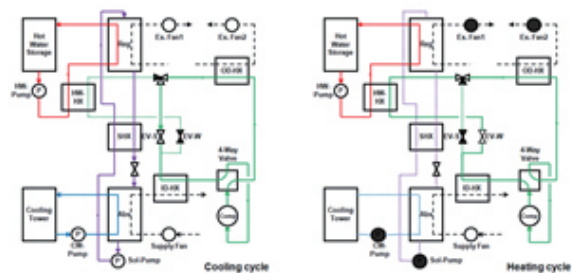


Fig. 5 Contours of various flow variables inside the DLR combustor

• 열공학 연구실 Thermal Engineering Laboratory

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■ 기본연구방향

1. 고효율, 친환경 열기관 개발
2. 고효율 히트펌프 시스템 해석 및 실험
 - 열원을 이용하여 냉방을 하는 흡수식 히트펌프의 고효율 운전조건 해석
 - 저온의 열원을 이용할 수 있는 흡수식-압축식 하이브리드 히트펌프 기술개발
3. 연료전지 자동차 시스템 열해석
 - 연료전지 자동차의 냉시동 특성 연구
4. 친환경 자연냉매를 이용하는 시스템 개발
 - CO₂를 냉매로 이용하는 압축식 히트펌프의 증발기에 대한 실험적 연구 수행

■ 최근 수행된 연구과제

1. 폐열이용 고온제조 하이브리드 히트펌프 기술개발
2. 환경친화적 자연냉매인 CO₂를 적용한 고효율 냉난방 시스템 개발
3. EES를 이용한 2중효용 흡수식 히트펌프 해석

■ 최근 대표 발표논문 목록

1. Jeong S, Park D. Evaporative Heat Transfer of CO₂ in a Smooth and a Micro-Grooved Miniature Channel Tube, Heat Transfer Engineering 2009;30:582-589
2. Lee JH, Oh BK, Choi BK, Jeong S, Choi JW. Electrical Detection-Based Analytic Biodevice Technology, Bio Chip Journal 2010; 4:1-8
3. Jeong S, Jungul Park, Jimmy M. Kim, Seungwoo Park. Effect Microfluidic mixing using periodically induced secondary potential in electroosmotic flow, Journal of Electrostatics 2011; 69:429-434
4. Jeong S, Seo HW. Warming up Characteristics of a PEMFC Stack, International Symposium on Transport Phenomena 2010

■ 연구실 구성원



김대환
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(석사과정)
Ho Sung-hwan
(Master program)



서동환
(석사과정)
Seo Dong-hwan
(Master program)



권유나
(학부연구생)
Kwon Yu-na
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	폐열이용 고온제조 하이브리드 히트펌프 기술개발		
주무기관	한국 에너지 기술 연구원	연구자역할	책임
연구비	90,000,000원	연구기간	2010.10.1~2011.9.30
주요 참여 대학원생	서동환, 김대환		

연구과제명	온실가스 배출 전망 및 감축잠재량 예측, 분석, 평가 기술 개발		
주무기관	환경부	연구자역할	공동
연구비	32,727,273원	연구기간	2011.7.1~2012.2.29
주요 참여 대학원생	권유나		

◆ 최근 대표논문

Evaporative Heat Transfer of CO₂ in a Smooth and a Micro-Grooved Miniature Channel Tube

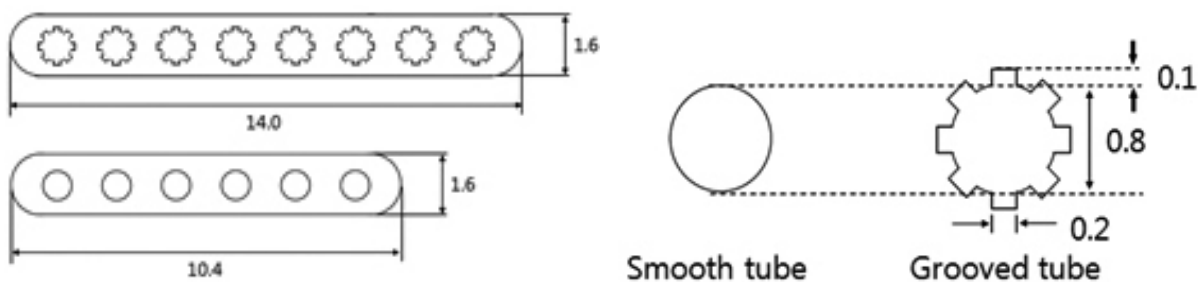
정시영, 박동호

책임

Heat Transfer Engineering

30 (7), 582–589 (2009)

Grooved surfaces are widely used to enhance heat transfer. In this study, micro-grooves are applied to miniature channels to improve the evaporative heat transfer of CO₂. To evaluate the effect of micro-grooves in miniature channels, heat transfer characteristics are investigated for the smooth multi-channel tube with 0.8 mm channel diameter and the grooved multi-channel tube with the same diameter and 8 micro-grooves. The tests were carried out at the evaporation temperatures of 0, 5 and 10 °C; mass flux between 400 and 800 kg/m²s; and heat flux of 12–18 kW/m². At lower qualities ($x < 0.3$), heat transfer was considerably enhanced by the grooves, however, the micro-grooves showed negative effect in heat transfer at higher qualities. A significant heat transfer enhancement was obtained at high evaporating temperature. Also, heat transfer was enhanced at lower heat and mass flux. The HTC's measured were compared with several correlations. A new correlation was developed to predict the dryout quality in miniature channel tubes more accurately.



Cross section of the tested micro tubes

Effect Microfluidic mixing using periodically induced secondary potential in electroosmotic flow

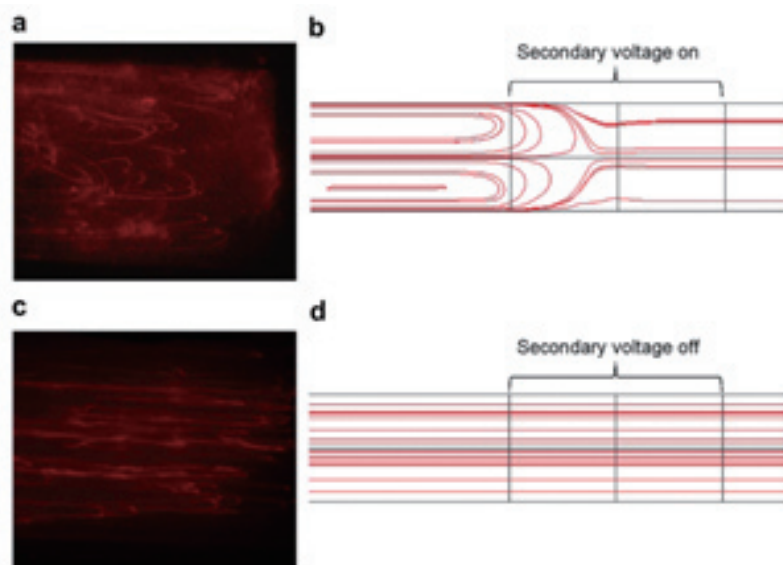
정시영, 박정열, 김만석, 박승우

책임

Journal of Electrostatics

69, 423–434 (2011)

This research develops a novel microfluidic mixing in a simple manner: An electrode was installed between two primary electrodes that generate DC fields and induce electroosmotic flow (EOF). While EOF was introduced by DC fields from the two primary electrodes, the active mixing could be achieved if potential was supplied to the secondary anode. Normal EOF was recovered as soon as the supply of potential to the secondary anode was terminated. By periodically repeating the on/off phase of the driving potential to the secondary anode, oscillating and vortex swirling flow patterns occurred and vigorous and efficient mixing was obtained.



Comparison of imaged particle path lines for fluorescent particles with streamlines from our simulation results.

Electrical Detection-Based Analytic Biodevice Technology

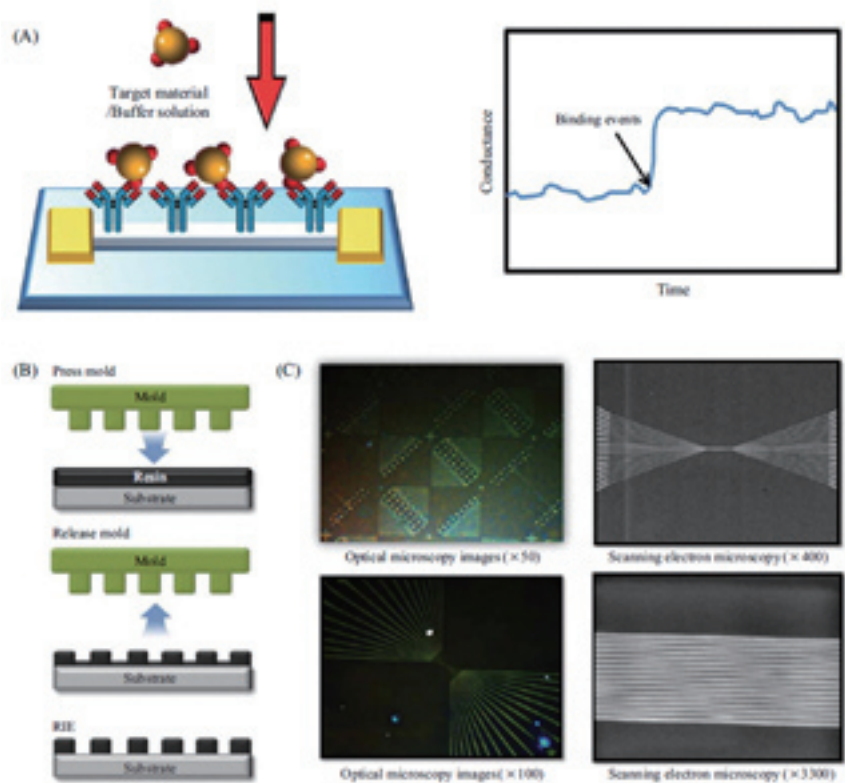
이진호, 오병근, 최범규, 정시영, 최정우

공동

Bio Chip Journal

4, 1-8 (2010)

Numerous traditional detection technologies such as fluorescence-based methods and enzymelinked immune-sorbent assay (ELISA) have been evaluated for the measurement of biological binding events. However, conventional detection methods are unsuitable for miniaturization and are unsatisfactory candidates for integration into hand-held sensors. Thus, electrical detection of biological binding events, such as protein-protein interaction and DNA hybridization, has emerged as an alternative method to currently used colorimetric and fluorescence-based methods. Due to its response time, cost effectiveness, high sensitivity, and ease of integration with semiconductor technology, the demand for this technology is increasing. This article reviews electrical detection systems focusing on electrical detection-based nanowire biosensors, protein chip based on electrical detection systems, and cell chip based on electrochemical detection methods.



(A) Schematic of a Si nanowire-based FET device configured as a sensor with antibody receptors, where the binding of a protein with negative net charge yields an increase in the conductance. (B) Schematic diagram of nanoimprint lithography. (C) Optical microscope image and SEM image of fabricated nanowire.

Sogang Energy-Water Nexus Laboratory

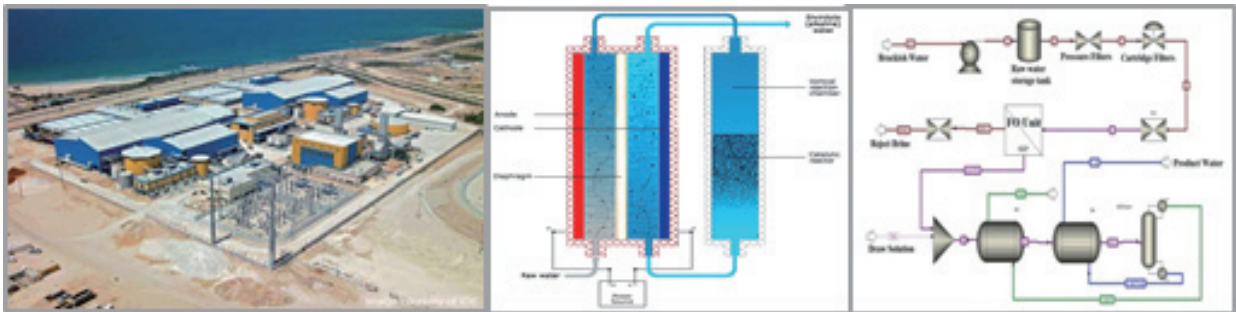


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Mechanical Engineering, Sogang University
AS505, <http://energy.sogang.ac.kr>

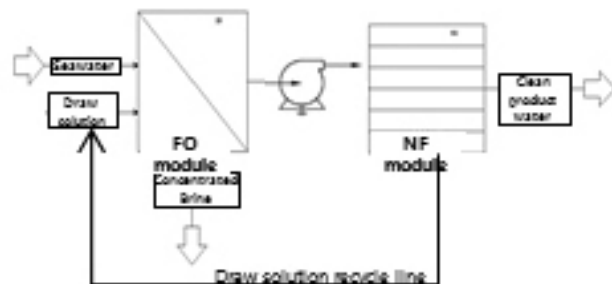


• Water ← Energy Viewpoint

- Exergoeconomic evaluation of seawater desalination plants

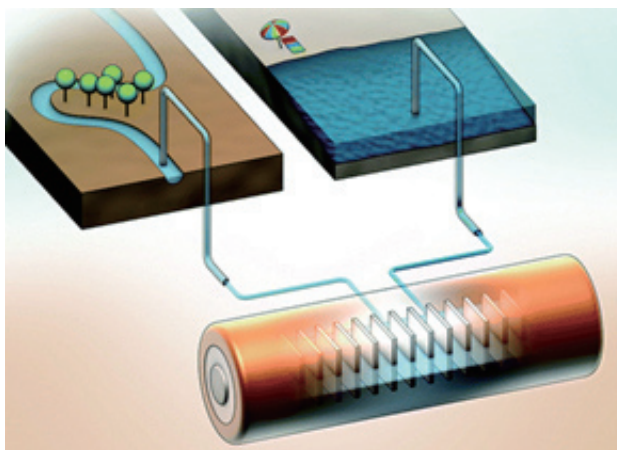


- Forward osmosis-based hybrid water treatment

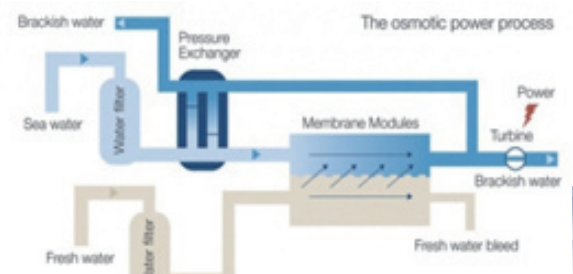


• Energy ← Saline Water

- Reverse electrodialysis

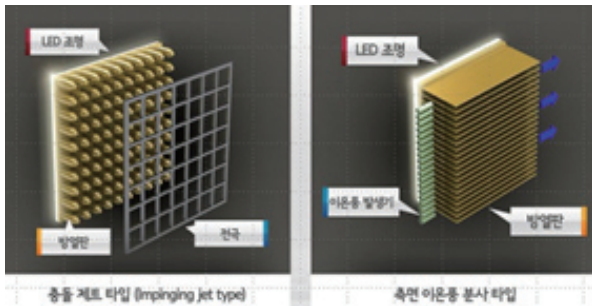


- Pressure-retarded osmosis

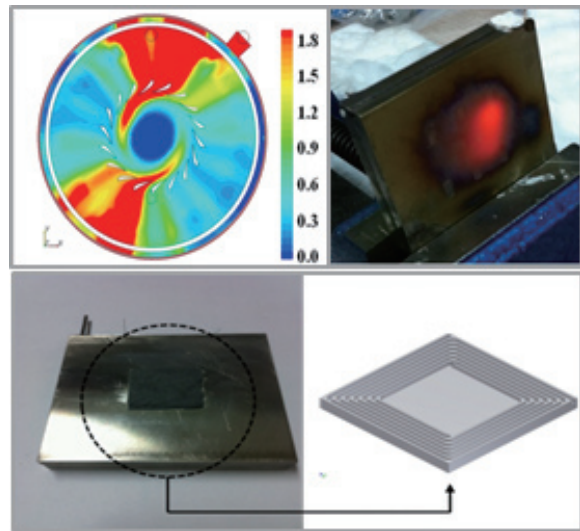


• Energy

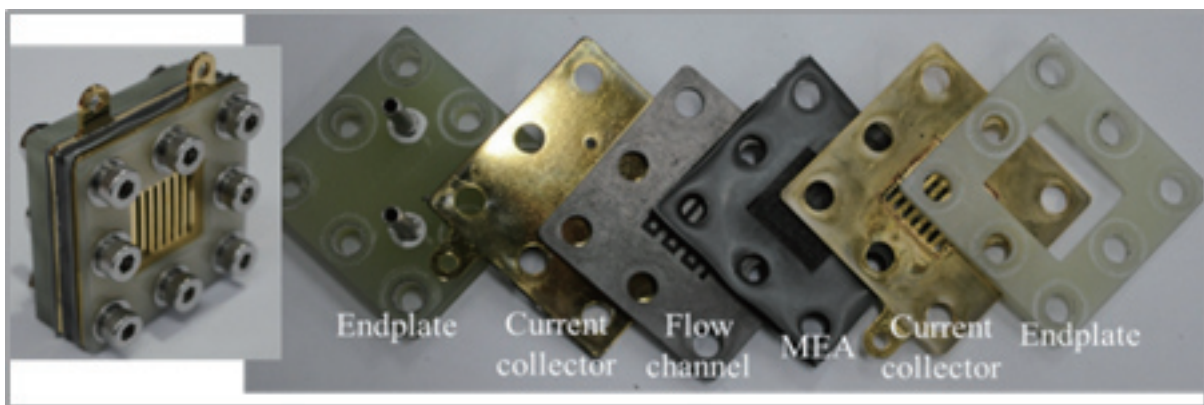
■ LED cooling



■ Micro-combustion

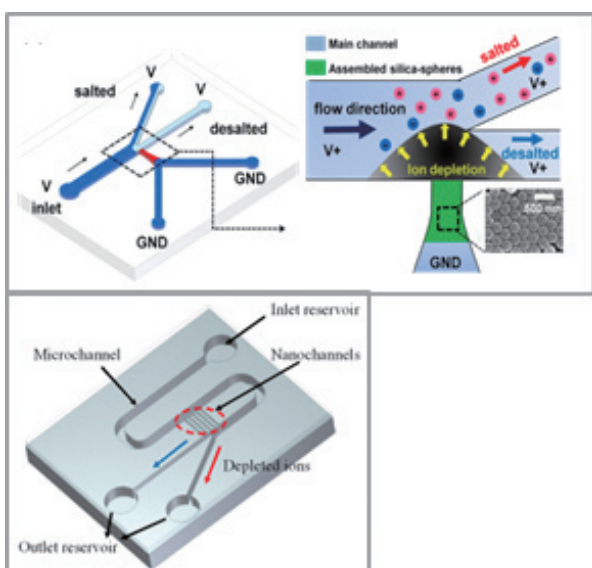


■ Portable fuel cells

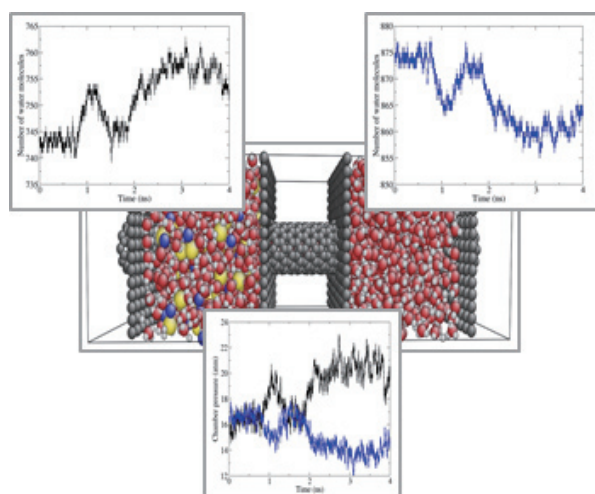


• Water

■ Nanochannel desalination



■ MD on membranes



• 에너지 워터 넥서스 연구실 Sogang Energy-Water Nexus Laboratory

지도교수	김대중				
연구실 위치	AS507	전화번호	02-715-8644	홈페이지	http://energy.sogang.ac.kr
연구실 방장	권길성	전화번호	010-4723-6494	이메일	kks840214@sogang.ac.kr

■ 기본연구방향

1. 마이크로 유체/에너지 기계: 마이크로 펌프, 마이크로 믹서, 휴대용 연료전지, 초소형 가스터빈 등 미소 유체기계와 미소 에너지 장치를 개발함
2. 수처리 연구: 삼투 현상에 대한 기초 연구와 정삼투 방식의 해수담수화 플랜트에 대한 연구
3. 나노 유체공학 시뮬레이션: 분자동역학을 이용한 나노 스케일에서의 유체 거동에 대한 시뮬레이션 연구

■ 최근 수행된 연구과제

1. 정삼투식 담수 공정기술 개발, Eco-Ener 플랜트 경쟁력 확보사업, 지식경제부
2. 다중현상 CFD 연구센터, 선도연구센터 공학분야 (ERC), 한국연구재단(교육과학기술부)
3. 전계효과를 이용한 제어기능을 가진 미소유체 삼투압 구동장치의 개발, 일반연구자 지원사업(기본), 한국연구재단(교육과학기술부)
4. 무소음 첨단 냉각 방식을 이용한 고효율, 고효율 LED 조명 장치 개발, 서울특별시
5. 나노채널을 이용한 삼투와 전기삼투 기반 해수담수화 기술 개발, 일반연구자 지원사업(기본), 한국연구재단(교육과학기술부)

■ 최근 대표 발표논문 목록

1. Cannon J.J, Tang D, Kim D. Competitive Entry of Sodium and Potassium into Nanoscale Pores, Journal of Physical Chemistry B 2010; 114:12252-12257
2. Kwon K, Kim D. Characterization of electroosmotic pumps using methanol/water mixtures with various compositions, Sensors and Actuators A: Physical 2010; in press
3. Lee S.J, Kim D. Millisecond-order rapid micromixing with non-equilibrium electrokinetic phenomena, Microfluid Nanofluid

■ 연구실 구성원



권길성
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이승준
(박사과정)
Seung Jun Lee
(Ph.D Program)



Dai Tang
(박사과정)
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박철우
(석사과정)
Chul Woo Pakr
(Master Program)



강 호
(석사과정)
Ho Kang
(Master Program)



Longnan Li
(석사과정)
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한재석
(석사과정)
Jaesuk Han
(Master Program)



한창현
(학부연구생)
Changheon Han
(Undergraduate Program)

◆ 최근 수행 연구과제

연구과제명	다중현상 CFD 연구센터		
주무기관	한국연구재단 선도연구센터 공학분야 (ERC)	연구자역할	공동
연구비	50,000,000원	연구기간	2010.03.01~2012.02.28
주요 참여 대학원생	Dai Tang, 박철우		

연구과제명	정삼투식 담수 공정기술 개발		
주무기관	지식경제부 한국산업기술평가관리원	연구자역할	책임
연구비	50,000,000원	연구기간	2011.10.01~2012.09.30
주요 참여 대학원생	김용혁, 박철우		

연구과제명	무소음 침탄 냉각 방식을 이용한 고출력, 고용량 LED 조명 장치 개발		
주무기관	서울특별시	연구자역할	책임
연구비	80,000,000원	연구기간	
주요 참여 대학원생	이승준		

연구과제명	나노채널을 이용한 삼투와 전기삼투 기반 해수담수화 기술 개발		
주무기관	한국연구재단 일반연구지원사업 (기초)	연구자역할	책임
연구비	50,000,000원	연구기간	2011.05.01~2014.04.30
주요 참여 대학원생	권길성, Longnan Li		

◆ 최근 대표논문

Competitive Entry of Sodium and Potassium into Nanoscale Pores

James J. Cannon, Dai Tang, Nahmkeon Hur, and Daejoong Kim

책임

Journal of Physical Chemistry B

114 (38), 12252 (2010)

We have studied the competitive entry of potassium and sodium into carbon nanotubes using molecular dynamics simulations. Our results demonstrate how a combination of strong sodium hydration coupled with strong potassium-chlorine interaction leads to enhanced potassium selectivity at certain diameters. We detail the reasons behind this, and show how variation of nanotube diameter can cause a switch to sodium selectivity, or even cause a decrease in overall ion entry despite an increase in diameter. These results demonstrate the importance of considering inter-ion dependence in the theoretical study of pore selectivity and show that, with careful design, the practical separation of sodium and potassium is possible using diameter variation alone

12252

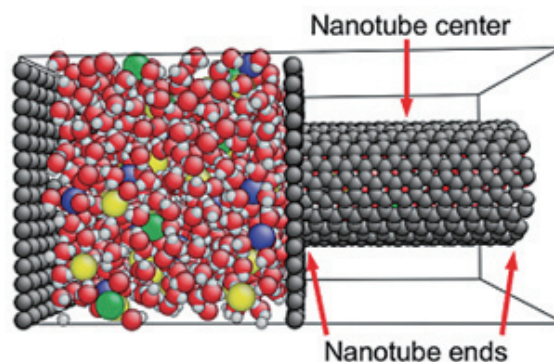
J. Phys. Chem. B 2010, 114, 12252–12256

Competitive Entry of Sodium and Potassium into Nanoscale Pores

James J. Cannon,^{1,2} Dai Tang,¹ Nahmkeon Hur,^{1,2} and Daejoong Kim^{1,2,3}¹Department of Mechanical Engineering, Sogang University, 1 Shinsu-dong, Mapo-gu, Seoul, 121-742, Republic of Korea, and ²Multi-Phenomena CFD ERC, Sogang University, 1 Shinsu-dong, Mapo-gu, Seoul, 121-742, Republic of Korea

Received: May 19, 2010; Revised Manuscript Received: August 13, 2010

We have studied the competitive entry of potassium and sodium into carbon nanotubes using molecular dynamics simulations. Our results demonstrate how a combination of strong sodium hydration coupled with strong potassium-chlorine interaction leads to enhanced potassium selectivity at certain diameters. We detail the reasons behind this, and show how variation of nanotube diameter can cause a switch to sodium selectivity, or even cause a decrease in overall ion entry despite an increase in diameter. These results demonstrate the importance of considering inter-ion dependence in the theoretical study of pore selectivity and show that, with careful design, the practical separation of sodium and potassium is possible using diameter variation alone.



Characterization of electroosmotic pumps using methanol/water mixtures with various compositions

Kilsung Kwon, and Daejoong Kim

책임

Sensors and Actuators A: Physical

Accepted

We experimentally studied porous glass electroosmotic (EO) pumps with methanol/water mixtures of varying compositions. We characterized their performance in terms of maximum flow rate, maximum current, and maximum pressure. They all show a linear dependency on an applied voltage, consistent with an EO pump model. We then normalized these performance parameters with the applied voltage to see their dependency on the methanol concentration. We compared these normalized parameters for the full range of methanol concentrations from pure water (deionized water) to pure methanol. The maximum flow rate per voltage shows a nonlinear dependency, while maximum current per voltage and maximum pressure per voltage change monotonically with the methanol concentration. We attribute this dependency mainly to viscosity, which also changes non-monotonically with the methanol concentration. Viscosity would thus be a key property in EO pumping of methanol/water mixtures.

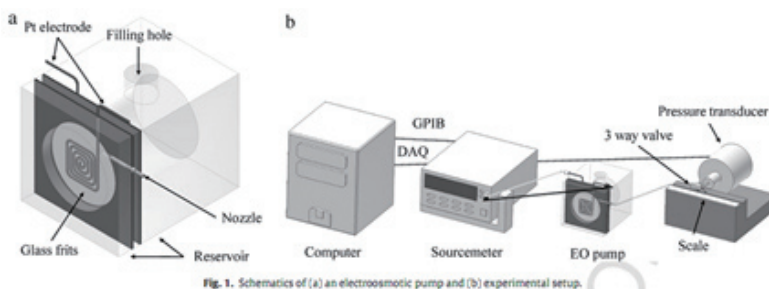
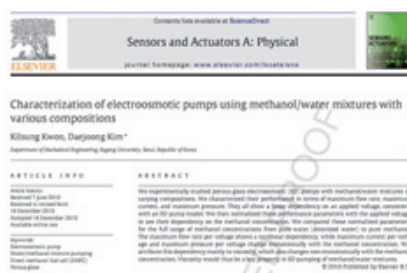


Fig. 1. Schematics of (a) an electroosmotic pump and (b) experimental setup.

Millisecond-order rapid micromixing with non-equilibrium electrokinetic phenomena

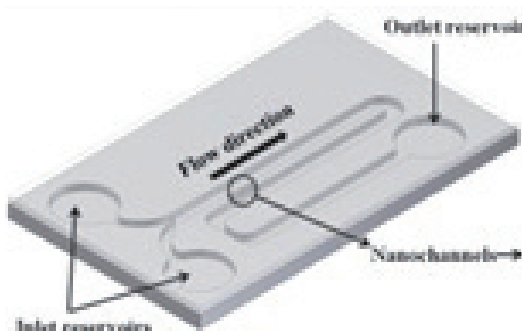
Seung Jun Lee, and Daejoong Kim

책임

Microfluid Nanofluid

Accepted

We report an active micromixer utilizing vortex generation due to non-equilibrium electrokinetics near micro/nanochannel interfaces. Its design is relatively simple, consisting of a U-shaped microchannel and a set of nanochannels. We fabricated the micromixer just using a two-step reactive ion etching process. We observed strong vortex generation in fluorescent microscopy experiments. The mixing performance was evident in a combined pressure-driven and electroosmotic flows, compared to the case with a pure pressure-driven flow. We characterized the micromixer for several conditions: different applied voltages, ion concentrations, flow rates, and nanochannel widths. The experimental results show that the mixing performance is better with a higher applied voltage, a lower ion concentration, and a wider nanochannel width. We quantified the mixing characteristics in terms of mixing time. The lowest mixing time was two millisecond with the voltage of 230 V and potassium chloride solutions of 0.1 mM. We expect that the micromixer is beneficial in several applications requiring rapid mixing.



Nanochannel type	Type 1	Type 2	Type 3	Type 4
Microscopy picture				
Number of Nanochannels	10 of 100 μm wide nanochannels	3 of 100 μm wide and 3 of 50 μm wide nanochannels	7 of 100 μm wide and 7 of 50 μm wide nanochannels	100 of 100 μm wide nanochannels
Length of interfacing area	1000 μm	2500 μm	12000 μm	10000 μm



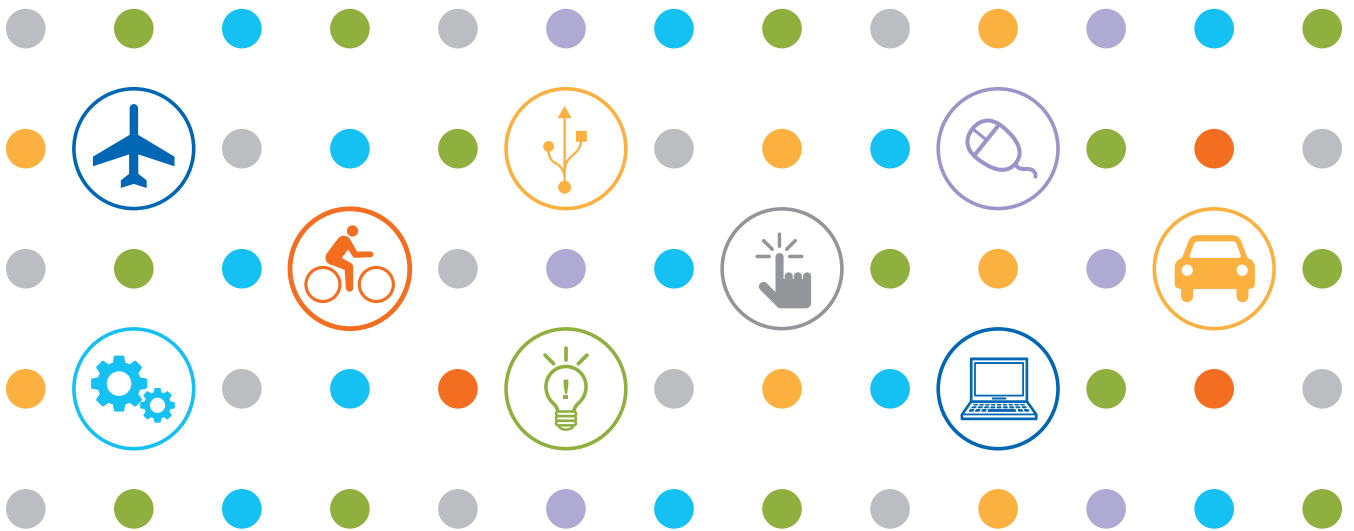
engineering



industry



technology



The Department of Mechanical Engineering

IV. 연구실 소개(4)

Research Laboratories

4. 메카트로닉 시스템 연구그룹

Dynamic Systems, Controls and Mechatronics

- 1) 정밀제어 및 인간 메카트로닉스 연구실 _ 94
Precision Control & Human Mechatronics Laboratory
- 2) 바이오모방 및 정밀기기 연구실 _ 33
Biomimetics and Precision Device Laboratory
- 3) 자동차 메카트로닉스 및 바이오 역학 연구실 _ 128
Automotive Mechatronics & Bio Mechanics Lab
- 4) CAD/CAM 연구실 _ 121
CAD/CAM Laboratory
- 5) 로봇시스템 제어 연구실 _ 100
Robotic Systems Control Laboratory

Precision Control & Human Mechatronics Laboratory



Professor Doyoung Jeon (전도영)
Mechanical Engineering, Sogang University
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• 장애인/노약자 하지 운동 보조용 입는 로봇 SUBAR 개발

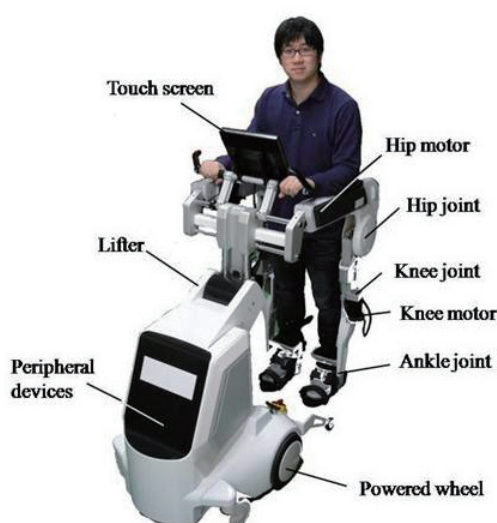


Fig. 1 입는로봇 SUBAR의 시스템 구성

입는 로봇 SUBAR

- 노약자 및 장애인의 보행/기립동작 보조용 착용식 로봇 개발
- 착용자의 로봇: 전기모터로 고관절과 슬관절 운동 능동적 보조
- 외골격 로봇: 전기모터로 고관절과 슬관절 운동 능동적 보조
- 캐스터워커: 균형유지, 기립보조 및 무거운 부품 운반

주요 연구내용

- 외골격 로봇의 운동 메커니즘 설계 최적화
- 센서 데이터를 기반으로 한 착용자의 동작의도 감지
- 착용자 질환에 따른 맞춤형 로봇 제어 알고리즘 구현
- 족저부 압력센서를 이용한 착용자의 동적 안정성 평가
- 외골격 시스템을 이용한 수중동작 효과 구현

• 중증 장애인용 하지 운동/재활훈련 로봇 시스템 개발



Fig. 2 휠체어 결합형 하지 운동/재활훈련 시스템

중증 장애인용 하지 운동/재활훈련 로봇 시스템 개발

- 척수손상 및 뇌졸중 장애인의 하지 운동/재활훈련 보조
- 하지 외골격과 전동휠체어의 결합된 형태로 하지의 능동적 운동 및 전동 휠체어의 고유기능 보유
- 장시간 침상/휠체어 생활 하는 중증장애인의 혈액/소화기 순환 및 운동기능 회복 효과 기대

주요 연구내용

- 12자유도 외골격 로봇의 관절 메커니즘 최적화
- 휠체어부와 외골격부의 동기제어 시스템 구현
- 위험상황 판단 및 대처를 위한 모니터링 시스템 연구
- 전문가시스템 기반 지능형 운동/재활훈련 알고리즘 연구
- 운동부하 조절기능 다자유도 임피던스 제어 알고리즘 연구

• 근로자 힘 증강용 상지 입는 로봇 개발



Fig. 3 상지 로봇 시스템 구성

근로자용 착용식 상지로봇

- 조립라인에서 현장 작업자의 상지 근력을 지원하여 작업 능력을 향상시키는 착용식 상지 로봇 시스템
- 40kg 정도의 중량물을 착용자가 최대 5kg 정도만 느낀 상태로 핸들링이 가능하도록 작업자의 상지 근력 지원

주요 연구내용

- 작업 공정별 기능 구현을 위한 기구학/동역학 해석
- 에너지 효율을 고려한 관절 자유도 설계 최적화
- 작업자의 의도를 반영한 근력증강용 제어 시스템 연구

• 캡슐형 내시경의 조직 채취 및 Human-mechatronics 개발

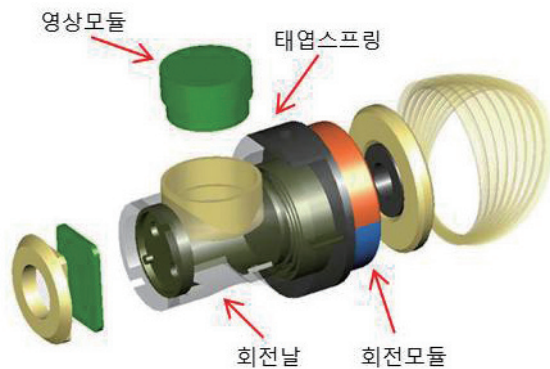


Fig. 4 캡슐형 내시경 구성도

캡슐형 내시경

- 알약처럼 삼키는 것으로 내부의 병변 진단이 가능한 비침습적 방법의 내시경 장치
- 직경 12mm, 길이 28mm이며 영상모듈, 자율주행모듈 및 조직 채취 장치 포함

주요 연구내용

- 초소형 장내 병변 조직 채취 메커니즘 연구
- 장내 병변 모니터링용 영상모듈 조작장치 구현
- 캡슐형 내시경의 자율주행 메커니즘 연구

• 롤 금형 가공기 등 CNC 공작기계의 초정밀 서보제어 소프트웨어 개발

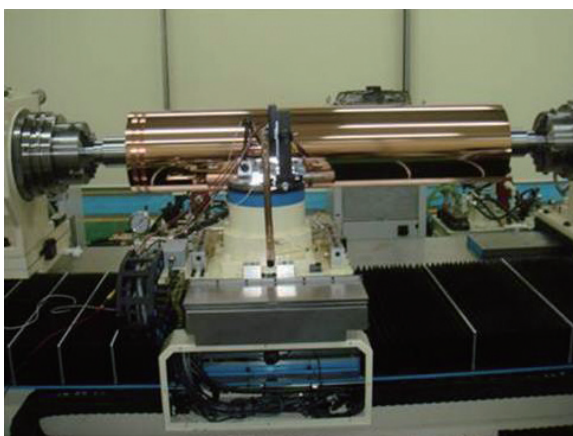


Fig. 5 롤 금형 가공기 시스템

롤 금형 가공기

- 대형 LCD 광학 필름의 저각 양산을 위한 롤 성형을 위해 롤 금형에 미세 패턴을 정밀하게 가공하는 장치
- 마이크로 단위의 미세패턴을 정밀하게 가공하기 위하여 초정밀, 고속이송이 가능한 제어기 필요

주요 연구내용

- 외관관측자, 압력인 제어를 이용한 초정밀 서보제어 알고리즘 개발
- 피드백 제어기 계수 자동튜닝 알고리즘 개발
- FTS(Fast Tool Servo)의 동기제어기 구현

• 정밀제어 및 인간 메카트로닉스 연구실 Precision control & human mechatronics Laboratory

지도 교수	전도영				
연구실 위치	R614	전화번호	703-0126	홈페이지	http://biomecha.sogang.ac.kr
연구실 방장	황범수	전화번호	010-2976-9950	이 메 일	bshwang@sogang.ac.kr

■ 기본연구방향

- 중증 장애인의 상지 및 하지 동작보조 입는 로봇 개발 및 이를 이용한 재활공학 연구
- 근로자 힘 증강용 입는 로봇 시스템 연구 및 로봇 하드웨어와 소프트웨어 연구 개발
- CNC 공작기계 및 초정밀 고속 서보시스템 소프트웨어 개발
- MR 유체 응용, 캡슐형 내시경 등 초소형 Human-mechatronics 제품 개발
- 컴퓨터를 이용한 인체신호 무선감지 및 인간과 기계의 상호작용 연구

■ 최근 수행된 연구과제

1. 중증장애인용 QoLT기반 휠체어결합형 하지 운동/재활훈련 시스템 개발, 지식경제부
2. 산업노동 지원을 위한 근로자용 착용식 로봇시스템 개발, 지식경제부

■ 최근 대표 발표논문 목록

1. Hwang B., Kang Y., Jeon D. Introduction of Wearable Robot SUBAR for Lower-limb Assistance, In Proc. 26th Japanese Conference on the Advanced of Assistive and Rehab. Tech, 2011.
2. 문지혜, 김중현, 전도영. 족저압 측정을 통한 보행의 동적 안정성 평가. 한국정밀공학회 추계학술대회, 2011.
3. 손호정, 전도영. 외골격 슬관절의 길이 가변형 메커니즘 연구. 한국정밀공학회 추계학술대회, 2011.
4. Kim D., Jeon D. Fuzzy-logic control of cutting forces in CNC milling processes using motor currents as indirect force sensors, Precision Engineering 2011;35:143-152.
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6. Kong K., Moon H., Hwang B., Jeon D., Tomizuka M. Impedance Compensation of SUBAR for Back-Drivable Force Mode Actuation, IEEE Transaction of Robotics 2009;5:512- 521.

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◆ 최근 수행 연구과제

연구과제명	중증장애인용 QoLT기반 휠체어결합형 하지 운동/재활훈련 시스템 개발		
주무기관	지식경제부 한국산업기술평가관리원	연구자역할	책임
연구비	2,100,000,000원(525,000,000원/년)	연구기간	2010.06.01~2014.05.31
주요 참여 대학원생	황범수, 배종욱, 문지혜, 박인테, 유창연		

연구과제명	산업노동 지원을 위한 근로자용 착용식 로봇시스템 개발		
주무기관	지식경제부 한국산업기술평가관리원	연구자역할	책임
연구비	500,000,000 원(100,000,000원/년)	연구기간	2010.04.01~2015.03.31
주요 참여 대학원생	황범수, 강용석, 손호정		

◆ 최근 특허 실적

특허명	가변형 회전중심 메커니즘을 보유한 슬관절 보조장치			
발명자	전도영, 황범수			
특허지역	국내	특허유형	출원	출원번호 10-2011-0042481
발명 참여 대학원생	황범수			

특허명	길이가변형 메커니즘을 보유한 슬관절 보조장치			
발명자	전도영, 손호정			
특허지역	국내	특허유형	출원	등록번호 10-2011-0042483
발명 참여 대학원생	손호정			

특허명	와이어 장력 유지 장치 및 방법			
발명자	전도영, 배종욱			
특허지역	국내	특허유형	출원	출원번호 10-2011-003593
발명 참여 대학원생	배종욱			

특허명	신발 밑창 및 이를 이용한 족저압 측정 장치와 방법			
발명자	전도영, 송창우			
특허지역	국내	특허유형	출원	출원번호 10-2011-003594
발명 참여 대학원생	송창우			

특허명	상지 근력지원 시스템			
발명자	전도영, 강용석			
특허지역	국내	특허유형	출원	등록번호 10-2011-003598
발명 참여 대학원생	강용석			

특허명	와이어 구동방식 외골격 로봇과 그 구동방법			
발명자	전도영, 배종욱			
특허지역	국내	특허유형	출원	출원번호 10-2011-003596
발명 참여 대학원생	배종욱			

특허명	전동식 이동기구 기반 통합 근력지원 시스템				
발명자	전도영, 강용석				
특허지역	국내	특허유형	출원	출원번호	10-2011-0042480
발명 참여 대학원생	강용석				

◆ 최근 대표논문

Introduction of the Wearable Robot SUBAR for Lower-Limb Assistance

Beomsoo Hwang, Yongsuk Kang, Doyoung Jeon

책임

In Proc. 26th Japanese Conference on the Advanced of Assistive and Rehab. Tech.

171-172 (2011)

Recently, the wearable robot or powered exoskeleton systems attract a great attention as a device for human motion support. Exoskeletal robots are used to increase the muscle power of soldiers and labors, and to provide means of physical assistance in daily lives or rehabilitation training for the disabled people.

For examples, the HAL[1] was developed for both human power augmentation and rehabilitation training. The BLEEX[2] was designed to help soldiers to carry heavy loads. The Lokomat[3] is a commercialized robotic orthosis for gait training. The Rewalk[4] is the powered exoskeleton which allows paraplegic patient to walk with clutches.

This paper describes the wearable robot, SUBAR[5] (Sogang University's Biomedical Assistive Robot), which assists the lower-limb motion such as walking and standing up of elderly people and patients.



〈Assistive robots developed by Prof. Jeon's Laboratory (Sogang University)〉

Fuzzy-logic control of cutting forces in CNC milling processes using motor currents as indirect force sensors

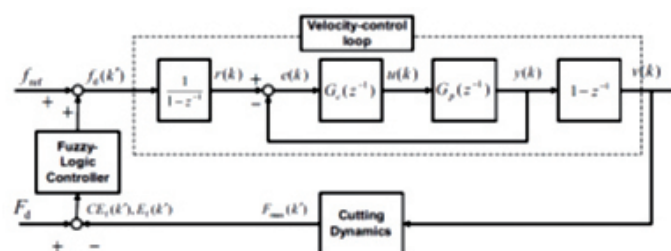
Dohyun Kim, Doyoung Jeon

책임

Precision Engineering

35, 143-152 (2011)

A fuzzy-logic controller (FLC) is designed to automatically adjust feed rate in order to regulate the cutting force of milling processes in a vertical machining center. The FLC has a double-loop structure, consisting of the inner PD (proportional-derivative) velocity-control loop for a feed servo and the outer fuzzylogic force-control loop. Reference cutting forces are well maintained in both numerical simulation and experiments when the cutting-depth profile of an aluminum workpiece (Al6061-T6) is varying step-wise or continuously. In order to replace expensive and impractical tool dynamometers, ac-induction-motor currents in the feed system and the spindle system are analyzed, and then compared as a cutting-force sensor. The bandwidth of both systems are not high enough to sense the cutting dynamics for common spindle speeds. Thus, quasi-static quantities (i.e., average or maximum resultant cutting force per spindle revolution) are compared instead. The spindle-motor current is chosen because quasi-static sensitivity is much higher (i.e., 5.415×10^{-3} vs. 2.128×10^{-4} A/N). Reference cutting forces (230 and 330 N) are well maintained when the depth of cut is less than 4mm.



〈Block diagram of the fuzzy-logic cutting-force controller〉

Monitoring Method of Interactive Torque between Human and Robot in Exoskeleton Systems

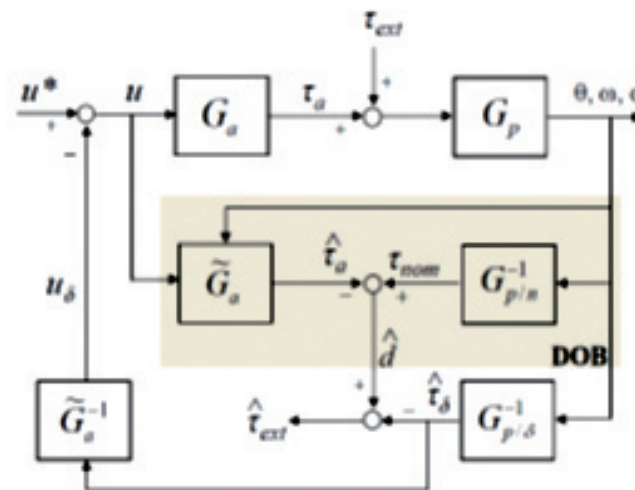
Beomsoo Hwang, Hyosang Moon, Doyoung Jeon

책임

IEEE International Conference on Rehabilitation Robotics

283-288 (2009)

In this paper, a model based interactive torque estimation method for exoskeletons is proposed. For this purpose, the dynamic model based disturbance observer (DOB) is adopted to estimate the interactive torque instead of using force/torque sensors. Also, a parameter identification method is applied to enhance the precision of estimated torque against various uncertainties in the dynamic model. In order to classify interactive torque from the estimated disturbance signal of DOB, the information on generated actuator torque is required. By the actuator impedance model, the generated actuator torque can be estimated precisely. The proposed methods were implemented in SUBAR (Sogang University's Biomedical Assist Robot) and verified by experiments.



〈Block diagram of the model based interactive torque estimation method〉

Control of an Exoskeleton for Realization of Aquatic Therapy Effects

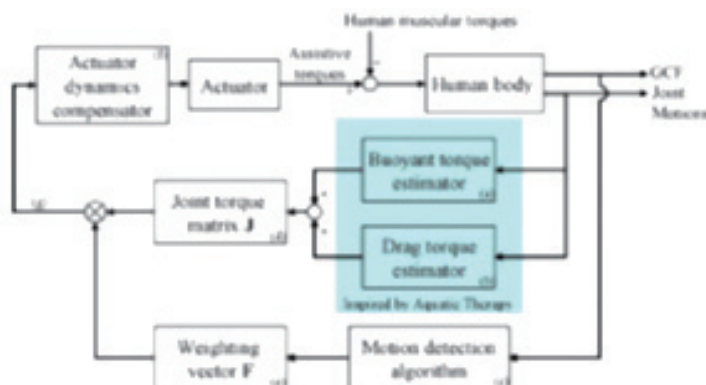
Kyoungchul Kong, Hyosang Moon, Doyoung Jeon, M. Tomizuka

공동

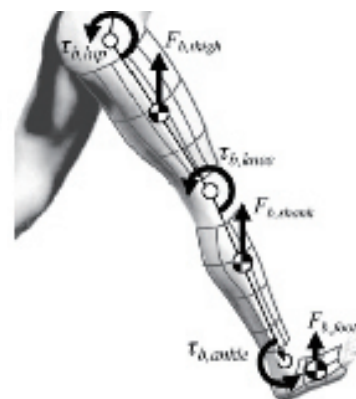
IEEE Transactions on Mechatronics

15 (2), 191-200 (2010)

Exoskeletons are attracting great attention as a new means of rehabilitation devices. In such applications, control algorithms of exoskeletons are often inspired by nature for natural and effective assistance for patients. In this paper, a control algorithm inspired by aquatic therapy is introduced. Aquatic therapy provides various beneficial effects for rehabilitation based on useful properties of water, e.g., buoyancy and drag. The proposed controller calculates joint torques equivalent to the buoyant and drag forces. Then, an exoskeleton-type assistive device generates the calculated joint torques to provide the similar effects as aquatic therapy. In this paper, the Sogang University biomedical assist robot is utilized as a testbed. This paper also discusses the mechanical impedance of actuators, which obstructs implementation of controllers in practice. The resistive forces generated by actuators are precisely modeled and compensated to realize the control algorithm inspired by aquatic therapy correctly and effectively.



〈Block diagram of overall control structure〉



〈Schematic plot of buoyant torque on each joint〉

Robotic Systems Control Laboratory



서강대학교
SOGANG UNIVERSITY

Professor Kyoungchul Kong(공경철)
Mechanical Engineering, Sogang University
AS503, <http://robotics.sogang.ac.kr>



• 로보틱스 연구

센서 및 신호처리 연구

로봇이 인간과 상호작용하는데 필요한 정보를 수집하고, 로봇 본체의 동역학적 상태를 측정하기 위한 수단으로써 센서 및 신호처리 연구가 필수적임. 가속도센서, 자이로스코프 등의 기계적인 물리량을 측정하는 센서를 조합하여 로봇이 필요로 하는 정보를 추출하는 방법을 개발 중임.

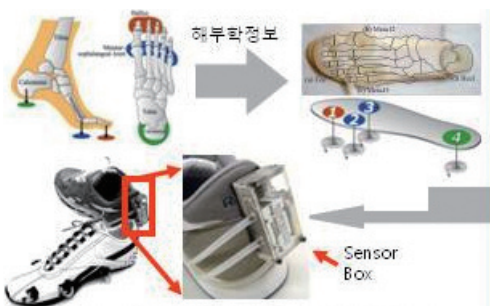


Fig. 1 하지보조로봇이 사용자의 동작형태를 구분하도록 하는 신발센서

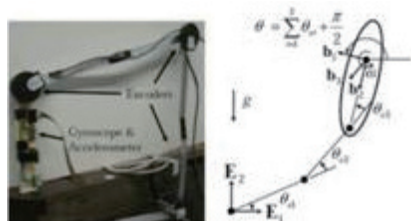


Fig. 2 로봇의 자세각도를 내부의 센서 정보만으로 추정하는 방법 개발

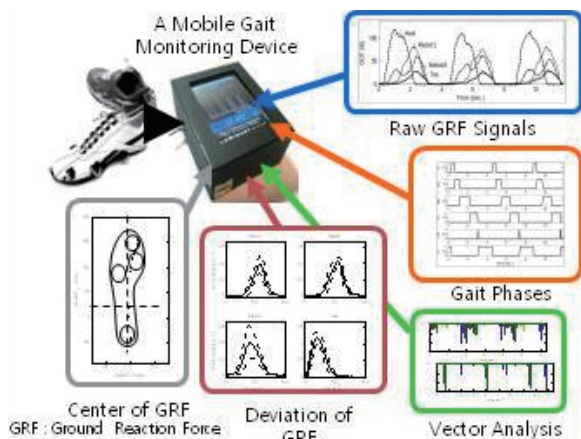


Fig. 3 신발 센서의 응용사례로써, 여러 가지 분석된 정보를 소형 디스플레이를 통해 환자에게 보여줌으로써 자가재활훈련이 가능하도록 하는 모바일 보행 모니터링 장치 (Mobile Gait Monitoring Device)

재활 및 보조로봇 개발

로보틱스 기술을 바탕으로 사람과 여러 가지 방법으로 상호작용하는 로봇시스템을 개발 중. 특히 구동기의 역구동성(Back-Drivability)을 구현하여 정밀한 보조력 생성이 가능한 보조로봇, 케이블을 이용한 재활로봇, 링크시스템으로 보행 동작을 구현하는 로봇 등을 개발하였음.



Fig. 4 역구동성이 보장되는 하지 보행보조로봇

큰 토크를 출력함과 동시에 역구동성(Back-Drivability)을 보장하기 위한 구동기 설계 및 제어기술. 역구동성이 보장되는 보조로봇은 구동기에 의한 마찰력 및 저항력을 발생시키지 않음. 사람이 발생시키는 근력이 제어알고리즘의 입력에 포함되므로 측정/추정이 필요함. Human-in-the-loop의 특성상, 구동기의 동역학적 특성이 제어기 설계에 반드시 고려되어야 함.

Actuator module 4kg End-effector < 200g



Fig. 5 케이블로 구동되는 상지 재활장치

케이블을 이용한 동력전달방식을 이용하여, 사용자가 직접 구동기 무게를 지탱하지 않도록 하고 근거리에서 보조/재활을 위한 동력을 전달하며 충분한 운동반경(Range of Motion)을 확보함.



Fig. 6 링크시스템 기반의 하지 재활장치

• 제어시스템 연구

로봇을 위한 강인제어기 개발

로봇이 원하는 동작을 수행하기 위한 경로 생성법과 제어기 설계방법을 연구하고, 제어기 설계에 필요한 로봇의 모델링에 관한 연구를 수행함. 특히 인간과 상호작용하는 로봇의 경우 모델 부정확성을 보상하고 안정성을 보장하기 위한 강인제어방법 연구 중.

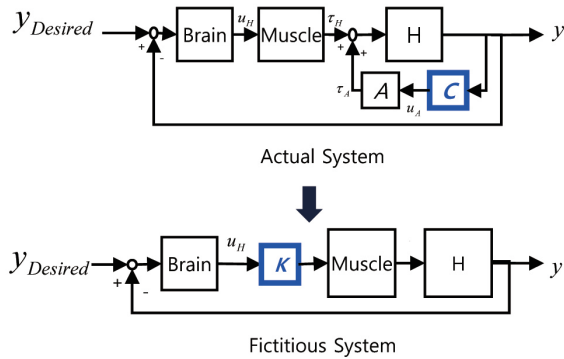
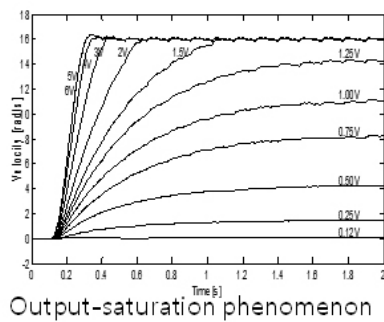


Fig. 7 하지보조로봇을 제어하기 위한 가상변수방법

실제 보조로봇의 제어기 (C)를 설계하기 위해 인간의 동작 제어루프에 가상의 변수 (K)가 있다고 가정하고, 그에 상응하는 제어기를 도출하는 방법



Output-saturation phenomenon

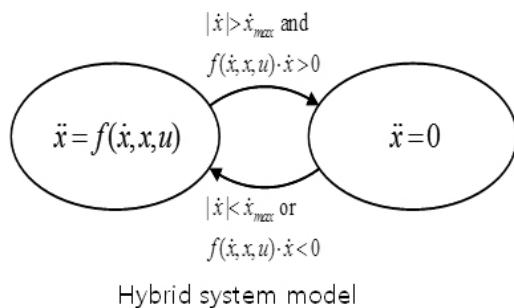


Fig. 8 구동기의 출력제한현상 모델링

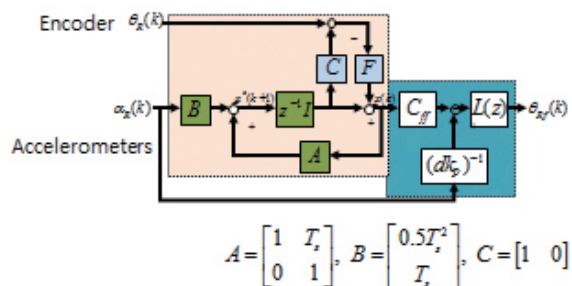


Fig. 9 여러 개의 센서로부터 측정된 정보를 이용하여 구동기의 대역폭을 증가시키기 위한 제어방법

• 에너지 시스템 연구

에너지 재생형 구동기 개발

모바일 로봇이 에너지를 효율적으로 사용하여 사용시간을 극대화하고 환경으로부터 에너지를 재생하여 사용할 수 있도록 하는 방법을 연구 중. 특히 보조로봇이 인간의 동작으로부터 동적에너지를 재생하여 효율성을 향상시키는 방법을 연구 중.

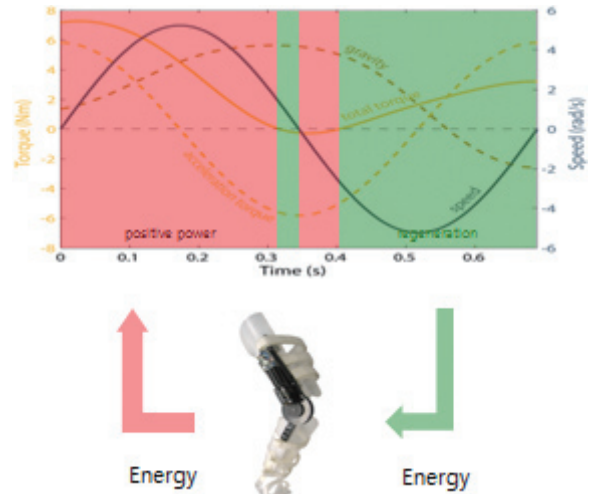


Fig. 10 에너지 재생형 하지보조로봇 개념도

사람의 동작은 에너지를 공급해야 하는 능동형 동작과, 에너지 재생이 가능한 수동형 동작으로 구분됨. 에너지 재생형 하지보조로봇은 수동형 동작에서 에너지를 재생하여 능동형 동작을 보조하는 시스템

• 무인자동차 주행방법 개발

무인자동차 제어 방법 개발

센서를 통해 수집된 데이터를 처리하여 얻은 주행 신호를 바탕으로 정밀한 모터제어를 통해 무인자동차를 주행. 램프, 매트랩 등 다양한 프로그램을 사용하여 무인 차량이 원하는 목적지까지 안전하게 가기 위해 필요한 최적화된 모델을 개발 중. 3D 시뮬레이션을 통해 고안된 모델 및 알고리즘을 실험 및 평가.

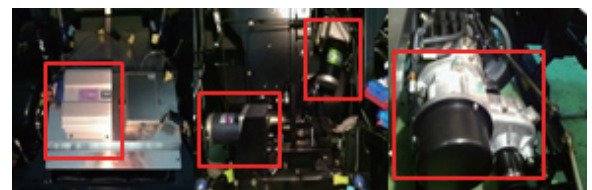


Fig. 11 전기차 내부의 메인 컨트롤러 및 제어 모터

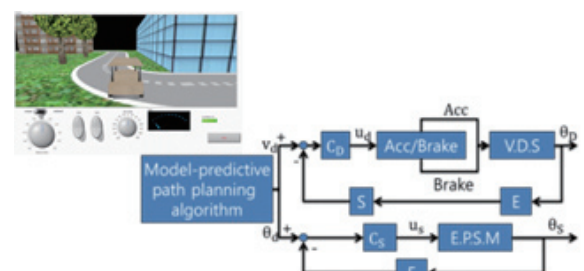


Fig. 12 무인자동차 3D 시뮬레이션 및 제어 알고리즘 연구

• 로봇 시스템 제어 연구실 Robotic Systems Control Laboratory

지 도 교 수	공경철				
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연구실 방장	나병훈	전화번호	701-9684	이 메 일	kckong@sogang.ac.kr

■ 기본연구방향

1. 인간과 상호작용하는 로봇을 위한 센서, 신호처리, 로봇시스템연구.
2. 로봇 및 메카트로닉 시스템의 에너지 효율을 향상시키기 위한 제어방법 개발.
3. 모바일 로봇의 강인제어 방법연구 및 모델 부정확성 보상연구.
4. 무인자동차 제어방법 및 알고리즘 개발.

■ 최근 수행된 연구과제

1. 신체센서네트워크 기반의 재활 및 건강모니터링 장치 개발
2. 개방형 아키텍처 기반의 도시형 스마트 무인 자동차 핵심 기술 개발

■ 최근 대표 발표논문 목록

1. K. KONG, J. Bae, and M. Tomizuka, "A Compact Rotary Series Elastic Actuator for Knee Joint Assistive System," IEEE/ASME Transactions on Mechatronics, to be published in December, 2011
2. J. Bae, K. KONG, and M. Tomizuka, "A Mobile Gait Monitoring System for Abnormal Gait Diagnosis and Rehabilitation: A Pilot Study for Parkinson's Disease Patients," ASME Journal of Biomechanical Engineering, 2011
3. K. KONG, H. C. Kniep, and M. Tomizuka, "Output Saturation in Electric Motor Systems: Identification and Controller Design," ASME Journal of Dynamic Systems, Measurement, and Control, Vol. 132 / 051002, 2010
4. K. KONG, H. Moon, D. Jeon, and M. Tomizuka, "Control of an Exoskeleton for Realization of Aquatic Therapy Effects," IEEE/ASME Transactions on Mechatronics, Vol. 15, No. 2, pp. 191-200, 2010
5. K. KONG and M. Tomizuka, "Control of Exoskeletons Inspired by Fictitious Gain in Human," IEEE/ASME Transactions on Mechatronics, Vol. 14, No. 6, pp. 689-698, 2009
6. K. KONG and M. Tomizuka, "A Gait Monitoring System Based on Air Pressure Sensors Embedded in a Shoe," IEEE/ASME Transactions on Mechatronics, Vol. 14, No. 3, pp. 358-370, 2009
7. K. KONG, H. Moon, B. Hwang, D. Jeon, and M. Tomizuka, "Impedance Compensation of SUBAR for Back-Drivable Force Mode Actuation," IEEE Transactions on Robotics, Vol. 25, No. 3, pp. 512-521, 2009
8. K. KONG, J. Bae, and M. Tomizuka, "Control of Rotary Series Elastic Actuator for Ideal Force Mode Actuation in Human-Robot Interaction Applications," IEEE/ASME Transactions on Mechatronics, Vol. 14, No. 1, pp. 105-118, 2009
9. K. KONG and D. Jeon, "Design and Control of an Exoskeleton for the Elderly and Patients," IEEE/ASME Transactions on Mechatronics, Vol. 11, No. 4, pp. 936-942, 2006
10. K. KONG and D. Jeon, "Design and Control of a Novel Tendon-Driven Exoskeletal Power Assistive Device," Journal of Control, Automation, and Systems Engineering, Vol. 11, No. 11, 2005

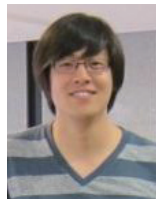
■ 연구실 구성원



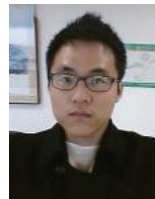
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◆ 최근 수행 연구과제

연구과제명	신체센서네트워크 기반의 재활 및 건강모니터링 장치 개발		
주무기관	서강대학교	연구지역	책임
연구비	15,000,000원	연구기간	2011.05.01~2012.04.30
주요 참여 대학원생	나병훈, 정평국		

연구과제명	개방형 아키텍처 기반의 도시형 스마트 무인 자동차 핵심 기술 개발		
주무기관	서강대학교	연구지역	공동
연구비	21,000,000원 (1년단위)	연구기간	2011.03.01~2016.02.28
주요 참여 대학원생	이중범, 송석기		

◆ 최근 특허 실적

특허명	보행보조 토크제어 방법 및 보행보조장치			
발명자	공경철, 나병훈, 전도영			
특허지역	국내	특허유형	출원	출원번호
발명 참여 대학원생	나병훈			10-2011-0121748

◆ 최근 대표논문

Gait Phase-Based Control for a Rotary Series Elastic Actuator Assisting the Knee Joint	
Joonbum Bae, Kyoungchul Kong, Masayoshi Tomizuka	공동
ASME Journal of Medical Devices	2011, Vol. 5 / 031010-1-6

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Gait Phase-Based Control for a Rotary Series Elastic Actuator Assisting the Knee Joint

Actuators for physical human-robot interaction (pHRI) such as rehabilitation or assistive systems should generate the desired torque precisely. However, the resistive and inertia loads inherent in the actuators (e.g., friction, damping, and inertia) set challenges in the control of actuators in a force/torque mode. The resistive factors include nonlinear effects and should be considered in the controller design to generate the desired force accurately. Moreover, the uncertainties in the plant dynamics make the precise torque control difficult. In this paper, nonlinear control algorithms are exploited for a rotary series elastic actuator to generate the desired torque precisely in the presence of nonlinear resistive factors and modeling uncertainty. The sliding mode control smoothed by a boundary layer is applied to enhance the robustness for the modeling uncertainty without chattering phenomenon. In this paper, the rotary series elastic actuator (RSEA) is installed on the knee joint of an orthosis, and the thickness of the boundary layer is changed by gait phases in order to minimize the torque error without the chattering phenomenon. The performance of the proposed controller is verified by experiments with actual walking motions. [DOI: 10.1115/1.4004793]

A Compact Rotary Series Elastic Actuator for HumanAssistive Systems

Kyoungchul Kong, JoonbumBae,Masayoshi Tomizuka

IEEE/ASME Transactions on Mechatronics

책임

2011/ 1-10

IEEE/ASME TRANSACTIONS ON MECHATRONICS

A Compact Rotary Series Elastic Actuator for Human Assistive Systems

Kyoungchul Kong, *Member, IEEE*, Joonbum Bae, *Student Member, IEEE*, and Masayoshi Tomizuka, *Fellow, IEEE*

Abstract—Precise and large torque generation, back drivability, low output impedance, and compactness of hardware are important requirements for human assistive robots. In this paper, a compact rotary series elastic actuator (cRSEA) is designed considering these requirements. To magnify the torque generated by an electric motor in the limited space of the compact device, a worm gear is utilized. However, the actual torque amplification ratio provided by the worm gear is different from the nominal speed reduction ratio due to friction, which makes the controller design challenging. In this paper, the friction effect is considered in the model of cRSEA, and a robust control algorithm is designed to precisely control the torque output in the presence of nonlinearities such as the friction. The mechanical design and dynamic model of the proposed device and the design of a robust control algorithm are discussed, and actuation performance is verified by experiments. Experimental results with a human subject are also presented to show the performance of the cRSEA while interacting with humans.

Index Terms—Embedded system, force mode actuation, human assistive systems, mechanical impedance, series elastic actuator.

I. INTRODUCTION

HUMAN assistive robots, i.e., systems that assist human motions with actuation capabilities, have been intensively developed in recent years based on mechatronic and robotic

(e.g., friction and backlash) make the precise torque control challenging.

To overcome such drawbacks of the geared motors while taking advantage of their superior controllability and high power-mass density, series elastic actuators have been devised [6]–[8]. The series elastic actuators are actuator modules that consist of an electric motor and a spring. The spring placed between the actuator and the human joint plays the role of a torque sensor as well as an energy buffer, which allows the precise control of the generated torque. Since the spring is able to immediately store the impact forces exerted from the human joint, compliance can also be easily guaranteed depending on the control algorithm.

In our previous work, a rotary series elastic actuator (RSEA) and its robust control algorithm were presented in the IEEE/ASME TRANSACTIONS ON MECHATRONICS [9]. The RSEA utilizes a torsional spring and a geared dc motor. A disturbance observer was applied to precisely control the RSEA in the presence of nonlinearities in the geared motor and model uncertainties caused by human–robot interactions. The proposed methods have shown good performance in practice (i.e., back drivability, low impedance, precise torque control, etc.) and have applied to actual assistive robots.

A Mobile Gait Monitoring Systemfor Abnormal Gait Diagnosis andRehabilitation: A Pilot Study forParkinson Disease Patients

JoonbumBae, Kyoungchul Kong, Nancy Byl, Masayoshi Tomizuka

ASME Journal of Biomechanical Engineering

공동(교신)

2011, Vol. 133 / 041005

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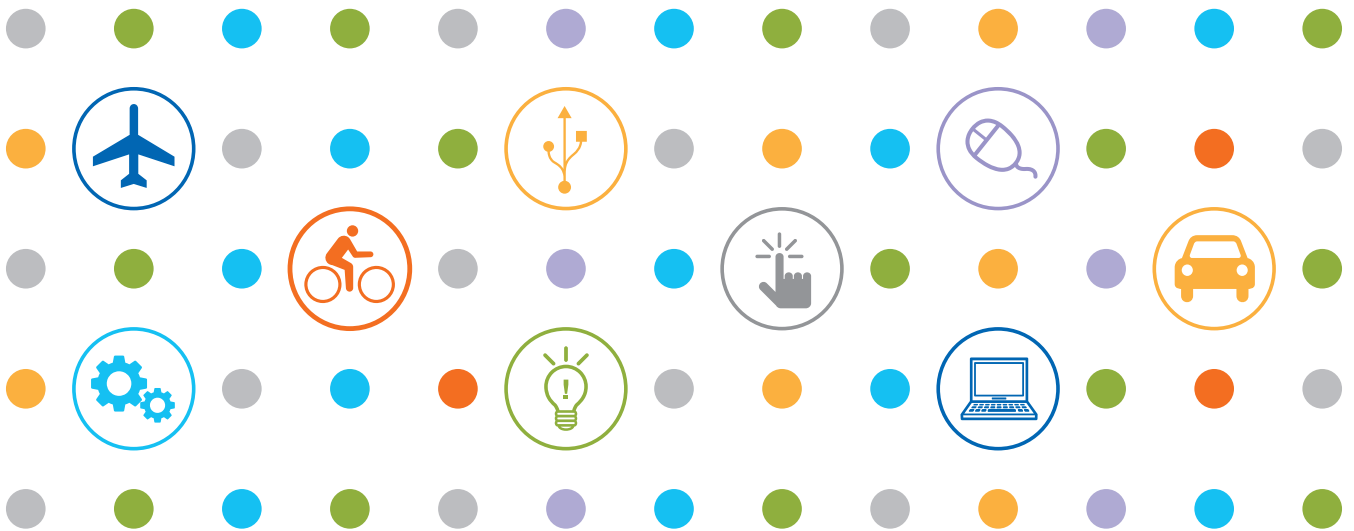
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A Mobile Gait Monitoring System for Abnormal Gait Diagnosis and Rehabilitation: A Pilot Study for Parkinson Disease Patients

Conventional gait rehabilitation treatment does not provide quantitative information on abnormal gait kinematics, and the match of the intervention strategy to the underlying clinical presentation may be limited by clinical expertise and experience. Also the effect of rehabilitation treatment may be reduced as the rehabilitation treatment is achieved only in a clinical setting. In this paper, a mobile gait monitoring system (MGMS) is proposed for the diagnosis of abnormal gait and rehabilitation. The proposed MGMS consists of Smart Shoes and a microsignal processor with a touch screen display. It monitors patients' gait by observing the ground reaction force (GRF) and the center of GRF, and analyzes the gait abnormality. Since visual feedback about patients' GRFs and normal GRF patterns are provided by the MGMS, patients can practice the rehabilitation treatment by trying to follow the normal GRF patterns without restriction of time and place. The gait abnormality proposed in this paper is defined by the deviation between the patient's GRFs and normal GRF patterns, which are constructed as GRF bands. The effectiveness of the proposed gait analysis methods with the MGMS has been verified by preliminary trials with patients suffering from gait disorders. [DOI: 10.1115/1.4003525]



The Department of Mechanical Engineering

IV. 연구실 소개(5)

Research Laboratories

5. 마이크로/나노 시스템 연구그룹

Research on Micro/Nano Systems

- 1) 전산역학 연구실 _ 106
Computational Mechanics Laboratory
- 2) MSM 연구실 _ 39
Sogang Microsystems & Smart Material Laboratory
- 3) 나노바이오시스템 및 메니폴레이션 연구실 _ 47
NanoBiosystems and Manipulation Laboratory
- 4) 나노 정밀 계측 연구실 _ 111
Nanoscale Precision Sensing Laboratory

Computational Mechanics Laboratory



Professor Hyungyil Lee (이형일)
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• Micro/Nano-Indentation Tests

Developments of Multipurpose Indentation Theory and Indentation Tester Using Finite Element Analysis

■ Indentation tester

Tester to evaluate the mechanical property of material from the load–displacement relationship obtained by indenting the material surface

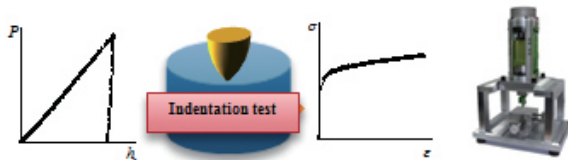


Fig. 1 Nano-indentation system

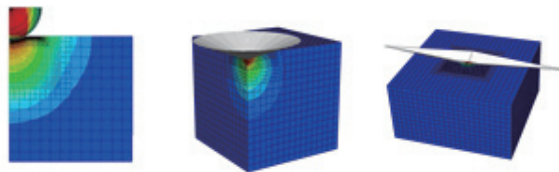


Fig. 2 FE models of nano-indentation

■ Application



Fig. 3 Application of nano-indentation
(a) Film-on-substrate system
(b) Indentation crack and (c) Residual stress

• Evaluation of Fracture Toughness

Evaluation of Fracture Toughness using Indentation Test

– Evaluation of Fracture Toughness with measurement of indentation load and crack length

$$K_{IC} = \alpha \left(\frac{E}{H} \right)^{1/2} \left(\frac{P_{\max}}{c^{3/2}} \right)$$

– Measurement of crack patterns and length with material property, indentation depth and indenter angle using Cohesive interface model

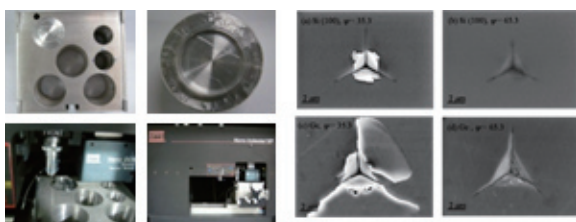


Fig. 1 Nano-indentation cracking (a) Nano-indentation system and (b) SEM micrographs

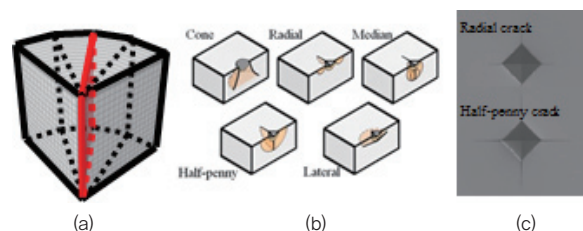


Fig. 2 FE simulation (a) FE model of 3D Vickers indentation (b) Morphologies of indentation cracks and (c) Surface crack morphologies (FE Analysis)

• Optimum Stamping Process and Mold Design

Development of Formability Estimation Model

- Construction of the forming limit diagram of Zircaloy-4 and Zirlo for stamping of spacer grids of Nuclear fuel rod
- Development of the FL evaluation model
- Establishment for prediction of FLD based on FE Analysis



Fig. 1 Formability test

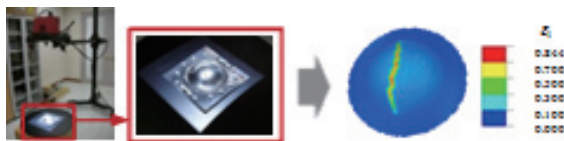


Fig. 2 White light scanning systems and distribution of major strain

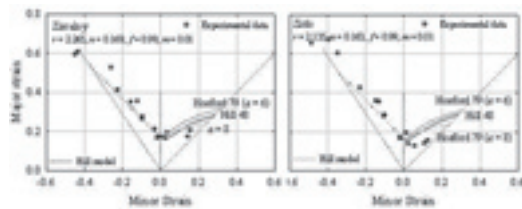


Fig. 3 Forming limit diagram of Zircaloy-4 and Zirlo

Spacer Grid Stamping Process analysis

- FE Analysis of residual stress/displacement and crack initiation
- Optimized mold design based on analysis tolerance between shape & mold

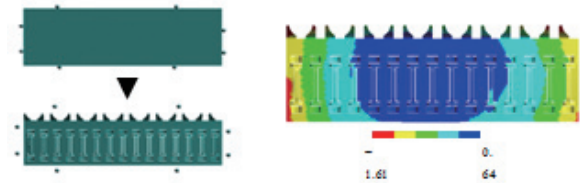


Fig. 1 FE simulation of spacer grids

- Analysis Product shape made by mold shape & springback



Fig. 2 U-bending benchmarking problem using (a) ABAQUS and (b) AutoForm

• Optimal Design for a High-efficiency Composite Material Pressure Tank

Fatigue Life Evaluation of Composite Pressure Vessel for CNG / Hydrogen Fuel Tanks Considering Autofrettage

- A Study on Optimum Evaluation Method for Filament Winding
- Development of Light-weighted 700 bar Type III Pressure Vessel Using FEM
- Fatigue Life Improvement with by Optimizing the Autofrettage Process

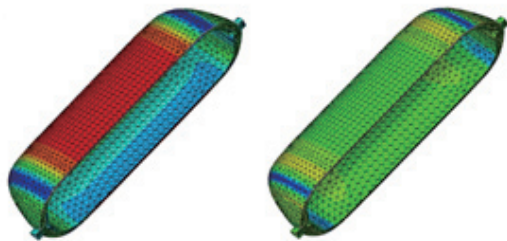


Fig. 1 Design of the CNG Fuel Tanks

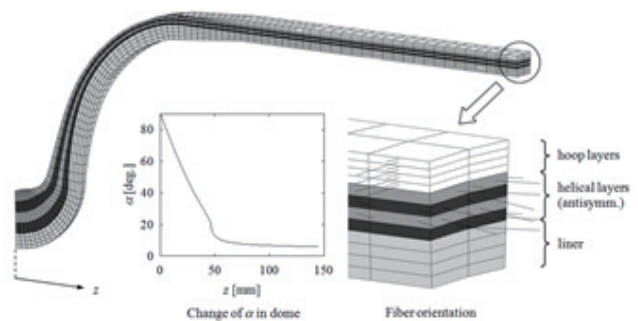


Fig. 2 FE model of pressure vessel

• 전산역학 연구실 Computational Mechanics Laboratory

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■ 기본연구방향

본 연구실은 ABAQUS를 사용한 유한요소해석을 통해 점용접 구조해석, 복합재료 및 이종접합재에서의 계면 파괴역학, Line-spring 유한요소를 이용한 배관 파손해석, 자동차 서브프레임의 공리적 설계, 방전 가공기 변형해석 등의 과제들을 수행해 왔다. 현재 수행중인 주요과제에는 핵연료 지지격자 공정해석, 지지격자재 재료 성형한계예측, 나노소재 국부 고유역학특성 평가를 위한 이론/실험/수치해석 융합기술, 복합소재 수소압력용기 피로수명 예측이 있다.

■ 최근 수행된 연구과제

1. 나노소재 국부 고유 역학특성 평가를 위한 이론 / 실험 / 수치해석 융합, 한국과학재단
2. 핵연료 지지격자 공정해석 및 설계 융합 시스템 개발, 한국과학재단
3. 유한요소해 및 인장시험에 기초한 재료의 진응력-진변형률 선도 획득, 대경테크 주식회사
4. 재료물성 및 잔류응력 평가를 위한 향상된 압입이론 개발, 한국과학재단
5. 변형률 속도를 고려한 초탄성 고무 물성평가 압입이론 및 압입시험기 개발, 서울특별시 시정개발연구원 부설산학연지원센터

■ 최근 대표 발표논문 목록

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2. Cheong S and Lee H, Crack-tip Opening Angle-based Numerical Implementation for Fully Plastic Crack Growth Analyses, Journal of Mechanical Science and Technology 2011; 25:1201-1206
3. Hyun HC, Kim M, Lee JH, and Lee H, A Dual Conical Indentation Technique Based on FEA Solutions for Property Evaluation, Mechanics of Materials 2011; 43:313-331
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5. Lee JH, Lee H, Hyun HC and Kim M, Numerical Approaches and Experimental Verification of the Conical Indentation Techniques for Residual Stress Evaluation, Journal of Materials Research 2010;25:2212-2223
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7. Lee JH, Kim T and Lee H, A Study on Robust Indentation Techniques to Evaluate Elastic-plastic Properties of Metals, International Journal of Solids and Structures 2010;47:647-664
8. Kim T, Lee JH, Lee H and Cheong S, An Area-average Approach to Peening Residual Stress under Multi-impacts Using a Three-dimensional Symmetry-cell Finite Element Model with Plastic Shots, Materials and Design 2010;30:50-59

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임동규
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김동욱
(석사과정)
Dong wook Kim
(Master program)



김하성
(석사과정)
Ha sung Kim
(Master program)

◆ 최근 수행 연구과제

연구과제명	나노소재 국부 고유 역학특성 평가를 위한 이론 / 실험 / 수치해석 융합		
주무기관	재단법인 한국연구재단	연구자역할	책임
연구비	126,875,000원	연구기간	2011.09.01~2012.08.31
주요 참여 대학원생	현홍철, 김민수, Rickhey Felix, 임동규		

연구과제명	핵연료 지지격자 공정해석 및 설계 융합 시스템 개발		
주무기관	재단법인 한국연구재단	연구자역할	책임
연구비	222,500,000원	연구기간	2011.05.01~2012.04.30
주요 참여 대학원생	현홍철, 김민수, 서윤미, 김동욱, 김하성		

◆ 최근 대표논문

A Dual Conical Indentation Technique Based on FEA Solutions for Property Evaluation	
Hong Chul Hyun, Minsoo Kim, Jin Haeng Lee and Hyungyil Lee	책임
Mechanics of Materials	43 (6), 313–331 (2011)

ABSTRACT

The sharp indenters such as Berkovich and conical indenters have a geometrical self-similarity so that we can obtain only one parameter from an indentation loading curve, which makes different materials have the same load–displacement relation. Most studies to evaluate elastic–plastic properties by using the geometrical self-similar indenter have therefore tried to use dual/plural indentation techniques, on the basis of the concept of representative strain/stress varying with the indenter angle. However, any suggested representative concept is not universally operative for real materials. In this work, we suggest a method of material property evaluation without using the concept of representative strain. We begin the work by studying the characteristics of load–depth curves of conical indenters via finite element (FE) method. From FE analyses of dual-conical indentation, we investigate the relationships between indentation parameters and load–depth curves. The projected contact diameter is expressed as a function of the indenter angle, tip-radius, and material properties, which allows us to simply predict the elastic modulus. Two mapping functions for two indenter angles (45 and 70.3) are presented to find the two unknowns (yield strain and strain-hardening exponent) via dual indentation technique. The method provides elastic modulus, yield strength and strain-hardening exponent with an average error of less than 5%. The method is valid for any elastically deforming indenters. We also discuss the sensitivity of measured properties to the load–displacement curve variation, and the difference between conical and Berkovich indenters.

A Simple but Effective FE Model with Plastic Shot for Evaluation of Peening Residual Stress and its Experimental Validation	
Taehyung Kim, Hyungyil Lee, Hong Chul Hyun and Sunghwan Jung	책임
Materials Science and Engineering A	528, 5945–5954 (2011)

ABSTRACT

We propose a practical finite element (FE) model for evaluation of peening residual stress. The model aims to produce a solution approaching the endeavored 3D FE solution. We investigate the effect of physical factors including material damping, dynamic friction and strain rate. The kinematical factors including shot diameter and impact velocity are also considered. Integrating those factors and plastic shots, we set up an effective FE model. Based on the arc height and coverage matching with the Almen saturation curve, impact velocity needed for FE analysis is determined. The model is found to provide the solution comparable with the 3D multi-impact FE solution and the experimental XRD result.

Crack-tip Opening Angle-based Numerical Implementation for Fully Plastic Crack Growth Analyses

Sunghwan Jung and Hyungyil Lee

책임

Journal of Mechanical Science and Technology

25 (5), 1201–1206 (2011)

ABSTRACT

This study introduces implementation of a nodal release technique into a FEM/continuum model to enable simulation of fully plastic crack growth. The nodal release technique is implemented in the user-defined element form on the symmetry line of a deeply single-edge cracked specimen so that the force at the crack-tip node on the symmetry line is made zero after several steps upon the satisfaction of a chosen fracture criterion, and an incremental crack extension is achieved. The fracture criterion adopts the crack-tip opening angle (CTOA) which is determined from the specimen's loading geometry [1]. For evaluation of the present model, the crack growth simulation results from the present FEM model were compared to those from the line-spring model of Lee and Parks [2].

Crack-tip Field Characterization of Crack-tip Opening Angle-based Crack Growth Plane Strain Single-edge Cracked Specimen Subject to Pure extension

Sunghwan Jung and Hyungyil Lee

공동

Journal of Mechanical Science and Technology

25 (5), 1207–1212 (2011)

ABSTRACT

The objective of this work is to study the crack-tip field of plane strain fully plastic crack growth of a single-edge cracked specimen subject to pure extension. The nodal release technique [1] was implemented into an FEM model so that the nodes arranged in the crack path are released. The fracture criterion for the crack growth in the model adopts the loading geometry-based crack-tip opening angle (CTOA) proposed in the work of Ref. [2]. The crack-tip field from the CTOA-based crack growth was investigated and characterized with a slip line field. It was observed that the backface configuration of the specimen, which evolves with the crack growth, is engaged in the formation of the shear band and, as a result, significantly elevates the triaxiality at the crack-tip during the crack growth.

Nanoscale Precision Sensing Laboratory



Professor Jungchul Lee (이정철)
Mechanical Engineering, Sogang University
AS710, <http://npsl.sogang.ac.kr>



• Heated Atomic Force Microscope Cantilevers

미소 열원이 내장된 원자력 현미경 캔틸레버 개발

마이크로 미세 열원 내장 원자력 현미경 캔틸레버의 최적화, 변위센서의 통합과 병렬화를 위한 설계, 공정 개발 및 제작에 관한 연구를 수행.

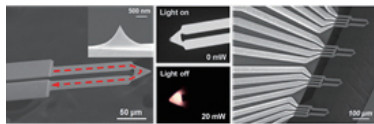


Fig. 1 Heated atomic force microscope (AFM) cantilevers have an integrated microscale heater near atomically sharp tip. Heated AFM cantilevers can be arrayed and other functional elements such as piezoresistive strain gauge can be integrated.

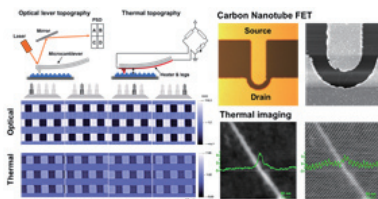


Fig. 2 Heated AFM cantilevers enable new topographic sensing relying on thermal resistance modulation and can be applied to various nanoscale thermal metrology and manufacturing.

• Suspended Microchannel Resonators

미세 유동 채널이 내장된 마이크로 캔틸레버 질량 센서 개발

마이크로 및 나노 유동 채널을 내장한 마이크로 캔틸레버 질량 센서의 최적 설계, 공정 개발, 및 제작에 관한 연구를 수행.

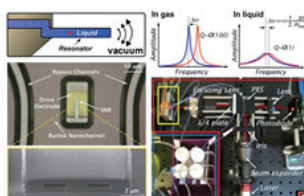


Fig. 3 Suspend microchannel resonator greatly improves mass resolution by putting liquid samples inside the resonator while it vibrates in vacuum. The quality factor of $\sim 15,000$ and mass resolution of ~ 1 fg have been achieved.

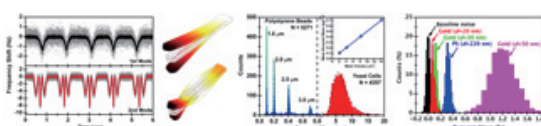


Fig. 4 SMRs measure mass of a variety of synthetic nanoparticles and cells including mammalian cells, yeast, bacteria, virus, etc. Unprecedented high precision mass sensing can be achieved by employing higher eigenmodes and scaling down to nanochannels can improve the mass resolution.

• Microcantilever Thermogravimetry

마이크로 캔틸레버를 기반으로 한 열적 물성치 측정 장치 개발

마이크로 미세 열원과 변위 센서를 내장한 캔틸레버를 이용, 서브 picogram 분해능을 갖는 마이크로 스케일 thermogravimetry의 개발.

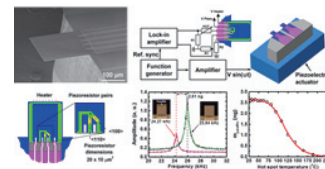


Fig. 5 Microcantilevers with integrated heater and piezoresistor are well suited for microscale thermogravimetry applications. Developed microcantilever thermogravimetry can measure analyte mass changes at different temperatures without requiring external heater and displacement sensor.

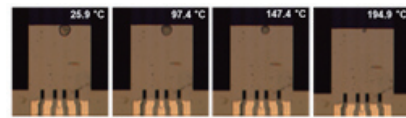


Fig. 6 A paraffin sample loaded near the free end of the cantilever evaporates as the cantilever temperature increases. Microscale thermogravimetry can perform high resolution analysis while consuming extremely small quantity of samples.

• MEMS Differential Scanning Calorimetry

멤스 열용량계의 개발

멤스 공정을 이용하여 nano- /picogram 질량의 화학 샘플의 열용량을 측정할 수 있는 Differential scanning calorimetry 에 대한 연구를 수행.

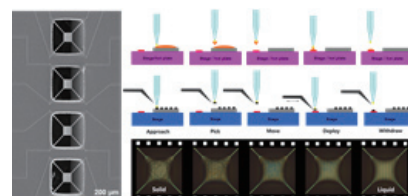


Fig. 7 MEMS Differential scanning calorimetry (μ DSC) is constructed with single crystal silicon micro hotplates. Nanogram level sample handling schemes are developed to load samples on micro hotplates. μ DSC enables thermo dynamic quantifications on ng $\sim$ pg samples within less than 1 min.

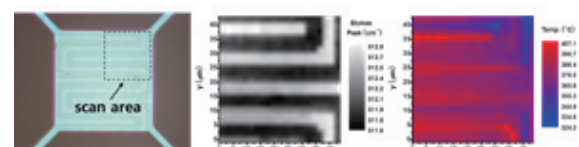


Fig. 8 Various optical measurements (FTIR, Raman spectroscopy, etc.) are easily combined on μ DSC for simultaneous optical and thermal interrogation.

• Heated Atomic Force Microscope Cantilevers

Development and application of heated AFM cantilevers

Design optimization of heated AFM cantilever, integration of strain gauges onto heated cantilever, and large array of head cantilevers

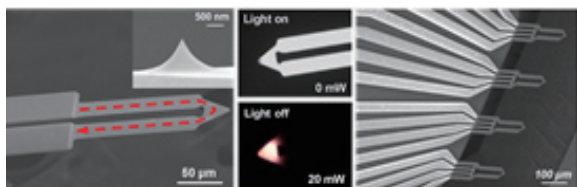


Fig. 1 Heated atomic force microscope (AFM) cantilevers have an integrated microscale heater near atomically sharp tip. Heated AFM cantilevers can be arrayed and other functional elements such as piezoresistive strain gauge can be integrated.

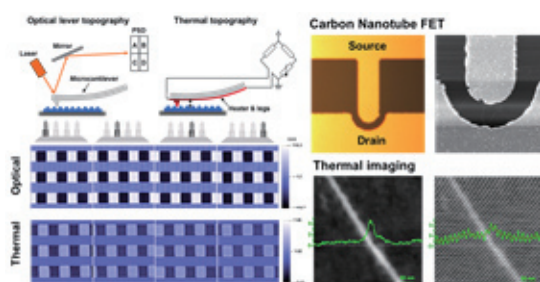


Fig. 2 Heated AFM cantilevers enable new topographic sensing relying on thermal resistance modulation and can be applied to various nanoscale thermal metrology and manufacturing.

• Suspended Microchannel Resonators

Development of microcantilever mass sensor with integrated microfluidics

Design optimization of micro- and nanofluidics integrated microcantilever mass sensors, process development and fabrication

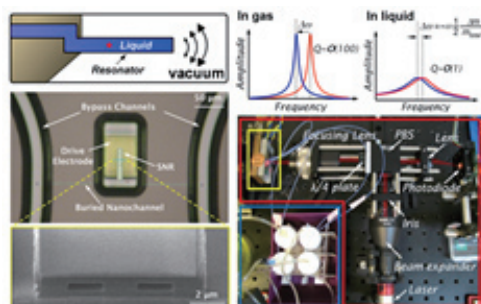


Fig. 3 Suspend microchannel resonator greatly improves mass resolution by putting liquid samples inside the resonator while it vibrates in vacuum. The quality factor of $\sim 15,000$ and mass resolution of ~ 1 fg have been achieved.

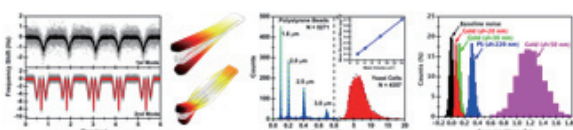


Fig. 4 SMRs measure mass of a variety of synthetic nanoparticles and cells including mammalian cells, yeast, bacteria, virus, etc. Unprecedented high precision mass sensing can be achieved by employing higher eigenmodes and scaling down to nanochannels can improve the mass resolution.

• Microcantilever Thermogravimetry

Development of microcantilever based nanothermal metrology

Development of sub-picogram resolution thermogravimetry using microheated and strain gauge equipped microcantilevers

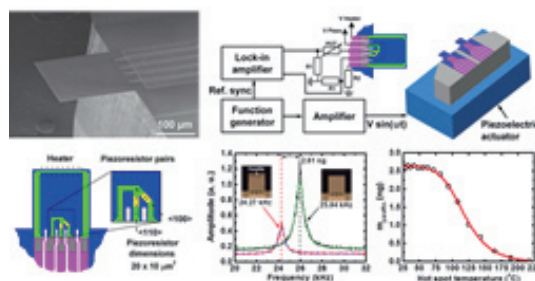


Fig. 5 Microcantilevers with integrated heater and piezoresistor are well suited for microscale thermogravimetry applications. Developed microcantilever thermogravimetry can measure analyte mass changes at different temperatures without requiring external heater and displacement sensor.

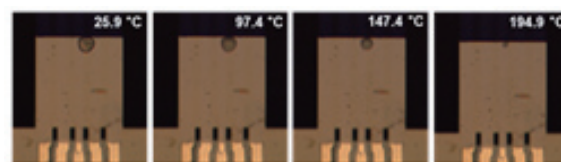


Fig. 6 A paraffin sample loaded near the free end of the cantilever evaporates as the cantilever temperature increases. Microscale thermogravimetry can perform high resolution analysis while consuming extremely small quantity of samples.

• MEMS Differential Scanning Calorimetry

Development of MEMS calorimetry

Development of MEMS differential scanning calorimetry enabling picogram analysis

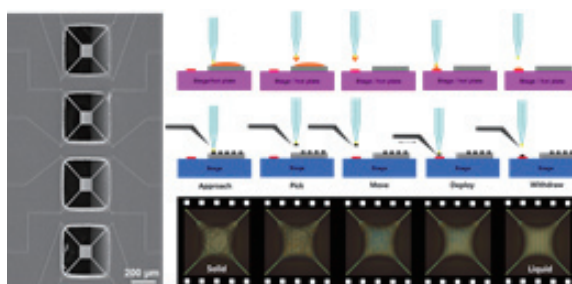


Fig. 7 MEMS Differential scanning calorimetry (μ DSC) is constructed with single crystal silicon micro hotplates. Nanogram level sample handling schemes are developed to load samples on micro hotplates. μ DSC enables thermodynamic quantifications on ng $\sim$ pg samples within less than 1 min.

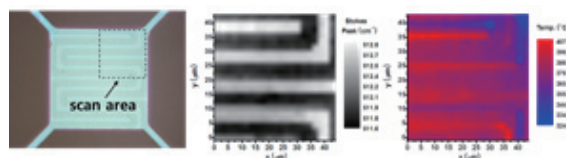


Fig. 8 Various optical measurements (FTIR, Raman spectroscopy, etc.) are easily combined on μ DSC for simultaneous optical and thermal interrogation.

• 나노 정밀 계측 연구실 Nanoscale Precision Sensing Laboratory

지도교수	이정철				
연구실 위치	AS710	전화번호	02-705-7973	홈페이지	http://npsl.sogang.ac.kr
연구실 방장	이 일	전화번호	010-2769-6680	이 메 일	jayclee@sogang.ac.kr

■ 기본연구방향

유동채널이 내장된 MEMS/NEMS 캔틸레버를 기반으로 하는 바이오 및 케미컬 센서의 개발에 관한 연구에 주력하고 있고 이와 더불어 탐침이 부착된 원자력 현미경용 캔틸레버에 기능성 전극, 스트레인 게이지, 또는 고온의 마이크로스케일 열원을 통합하여 새로운 나노스케일 측정/계측 방법과 생산 및 공정에 대한 연구를 진행하고 있습니다.

■ 최근 수행된 연구과제

1. 단일 바이러스 검출용 서브 아토그램급 분해능을 갖는 나노 유동채널 공진 질량 센서 개발, 한국연구재단
2. 나노입자의 질량 및 열 물성치 측정을 위한 히터가 내장된 나노유동채널 공진구조물 개발, 한국연구재단
3. 정밀 나노입자 입도 분석 장치 개발, 서강대학교

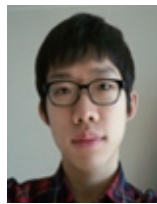
■ 최근 대표 발표논문 목록

1. Sader JE, Burg TP, Lee J, Manalis SR. Energy dissipation in microfluidic beam resonators: Effect of Poisson's ratio. Physical Review E 2011;84:026304
2. Lee J, Bryan AK, Manalis SR. High precision mass sensing using microchannel resonators in the second vibration mode. Review of Scientific Instruments 2011;82:023704
3. Lee J, Chunara R, Shen W, Payer K, Babcock K, Burg TP, Manalis SR. Suspended Microchannel Resonators with Piezoresistive Sensors. Lab on a Chip 2011;11:645-651

■ 연구실 구성원



이 일
(석사과정)
Lee il
(Master program)



김주현
(학부연구생)
Kim joohyun
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	단일 바이러스 검출용 서브 아토그램급 분해능을 갖는 나노 유동채널 공진 질량 센서 개발		
주무기관	재단법인 한국연구재단	연구자역할	책임
연구비	49,758,000원	연구기간	2011.05.01~2012.04.30
주요 참여 대학원생	이 일, 김주현		

연구과제명	나노입자의 질량 및 열 물성치 측정을 위한 히터가 내장된 나노유동채널 공진 구조물 개발		
주무기관	재단법인 한국연구재단	연구자역할	책임
연구비	126,000,000원	연구기간	2011.09.01~2012.08.30
주요 참여 대학원생	이 일, 김주현		

◆ 최근 대표논문

Energy dissipation in microfluidic beam resonators: Effect of Poisson's ratio

John E. Sader, Thomas P. Burg, Jungchul Lee, and Scott R. Manalis

공동

Physical Review E

84, 026304 (2011).

ABSTRACT

Dissipation of mechanical energy underlies the sensitivity of many nanomechanical devices, with environmental effects often having a significant effect. One case of practical relevance is the interaction of elastic beam resonators with fluid, which is known to dramatically increase energy dissipation. Recently, we investigated energy dissipation in a different class of elastic beam resonator that embeds a microfluidic channel in its interior. In this paper, we examine the effect of the beam material Poisson ratio on these devices and discover that it can strongly affect energy dissipation—this is in direct contrast to conventional cantilever beams immersed in fluid. Increasing the Poisson ratio in these microfluidic devices is found to decrease energy dissipation, with the incompressible material limit providing minimum energy dissipation. Our paper establishes that, in this limit, placement of the fluid channel away from the beam neutral axis has negligible effect on energy dissipation in many cases of practical interest. The physical implications of these findings are discussed, and a detailed comparison with available experimental results is provided.

High precision mass sensing using microchannel resonators in the second vibration mode

Jungchul Lee, Andrea K. Bryan, Scott R. Manalis

공동

Review of Scientific Instruments

82, 023704 (2011).

ABSTRACT

An intrinsic uncertainty in particle mass sensing with the suspended microchannel resonator results from variation in a particle's position near the free end of the resonator. To circumvent this error we employ the second flexural bending mode. This mode exhibits additional frequency peaks while particles pass over the antinode, a point where the frequency shift is insensitive to the lateral position of the particle. We measure polystyrene beads with the first and second modes and confirm that the second mode sensing provides a narrower mass histogram. For 3 μm diameter beads, second mode sensing at the antinode improves the coefficient of variation in buoyant mass from 1.76 % to 1.05 % for population measurements and from 1.40 % to 0.53 % for a single trapped particle.

Suspended microchannel resonators with piezoresistive sensors

Jungchul Lee, Rumi Chunara, Wenjiang Shen, Kris Payer, Ken Babcock, Thomas P. Burg, and Scott R. Manalis

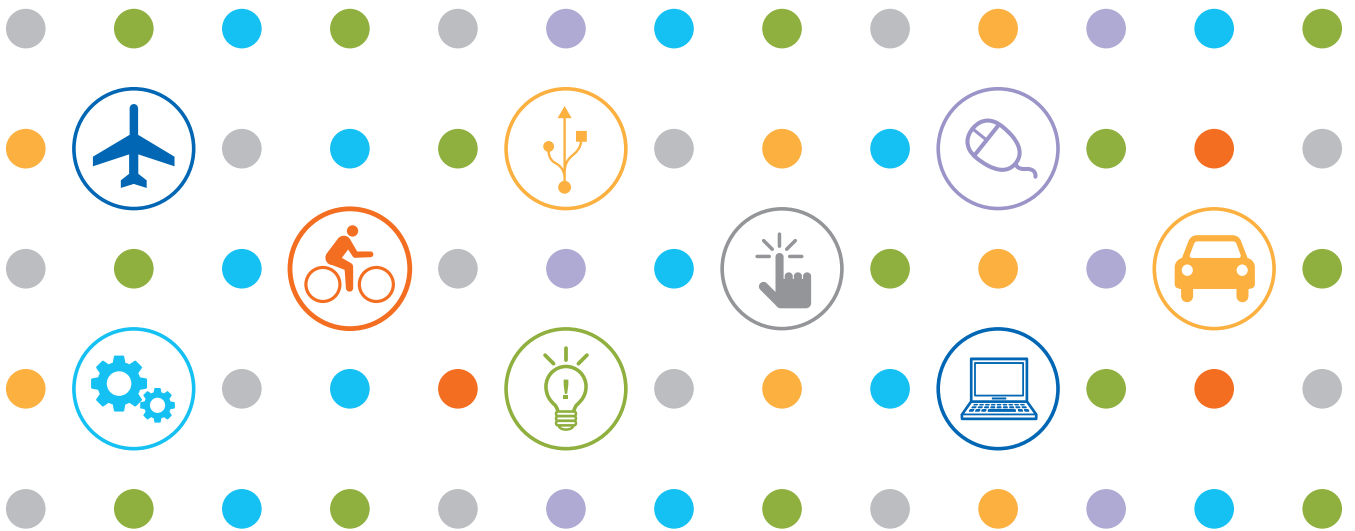
공동

Lab on a Chip

11, 645–651 (2011).

ABSTRACT

Precision frequency detection has enabled the suspended microchannel resonator (SMR) to weigh single living cells, single nanoparticles, and adsorbed protein layers in fluid. To date, the SMR resonance frequency has been determined optically, which requires the use of an external laser and photodiode and cannot be easily arrayed for multiplexed measurements. Here we demonstrate the first electronic detection of SMR resonance frequency by fabricating piezoresistive sensors using ion implantation into single crystal silicon resonators. To validate the piezoresistive SMR, buoyant mass histograms of budding yeast cells and a mixture of 1.6, 2.0, 2.5, and 3.0 μm diameter polystyrene beads are measured. For SMRs designed to weigh micron-sized particles and cells, the mass resolution achieved with piezoresistive detection (~ 3.4 fg in a 1 kHz bandwidth) is comparable to what can be achieved by the conventional optical-lever detector. Eliminating the need for expensive and delicate optical components will enable new uses for the SMR in both multiplexed and field deployable applications.



The Department of Mechanical Engineering

IV. 연구실 소개(6)

Research Laboratories

6. 고급가공기술 연구그룹

Research on Advanced Manufacturing Technologies

- 1) 정형가공 연구실 _ 116
Net Shape Manufacturing Laboratory
- 2) 전산역학 연구실 _ 106
Computational Mechanics Laboratory
- 3) CAD/CAM 연구실 _ 121
CAD/CAM Laboratory

Net Shape Manufacturing Laboratory



Professor Naksoo Kim (김낙수)
Mechanical Engineering, Sogang University
AS603, <http://nslab.sogang.ac.kr>



• Process Analysis and Design

고강도 고강성 노트북 케이스를 위한 단조 성형 기법 개발/

Development of Forging Processing technique for High Strength and High Stiffness Notebook Case.



현재의 절삭공정으로 제작되는 알루미늄 case를 보다 저렴하고 생산성이 높은 제작 공정으로 개발.

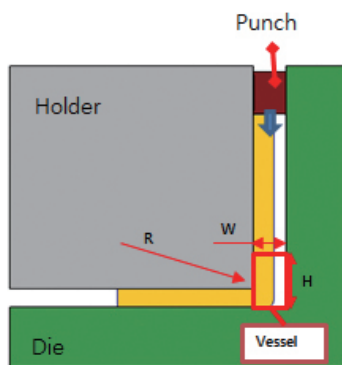


Fig. 1 Sizing processing 2D-model.

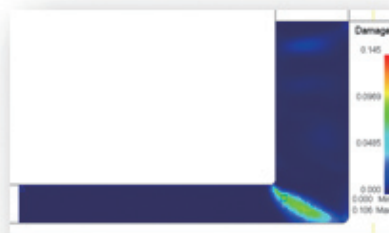


Fig. 2 Contour of damage distribution in sizing simulation

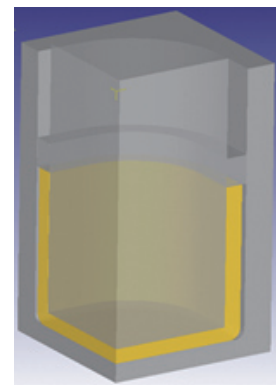


Fig. 3 Sizing simulation

도장 후변형 해석 기술 개발 (ERC산업체대응)/

Development of Analysis Technique for prediction of Deformation in Dipping process



자동차 차체 전체를 도색하기 전에 거치는 도장 공정. 큰 탱크에 차체 전체를 담갔다가 빼는 작업 후에 후드에 후변형이 발생하는 문제를 해결.



Fig. 4 painting processing.



Fig. 5 simulation for obtaining stiffness of hood.

핵 연료 지지격자 공정해석 및 설계 융합 시스템 개발/

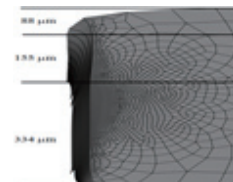
Development of Integrated System of Process Analysis and Design for Nuclear Fuel Spacer Grid



핵연료 지지격자체의 성형시 발생하여 제품의 품질에 영향을 미치는 burr 나 sliver 등의 발생을 예측하고, 성형결함을 최소화하기 위해 유한요소해석을 통해 블랭킹공정 해석모델을 정립하고, 공정변수를 최적화시켜 지지격자의 생산성과 품질을 향상시킬 수 있는 지지격자 공정해석 및 설계 융합 시스템 개발



Fig. 6 Spacer grid (left) and sheared edge formation after blanking process (right)



• Development of Computational Programs

회전성형기술 (링 압연)의 해석 프로그램 효율 및 수렴성 향상/

Improvement of efficiency and convergence of Rotational Process FEA Program(SHAPE-RR)



금속 소재를 이용해 공구를 회전시키면서 얇은 두께를 가지는 축대칭 튜브 형태의 제품을 가공하는 회전성형 공정에서 가공시 발생하는 소재 결함과 공구에 걸리는 응력예측을 위한 회전 성형 가공 해석 소프트웨어 개발

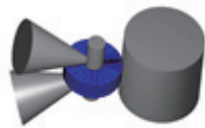
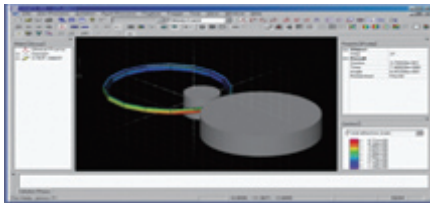


Fig. 7 Ring rolling program SHAPE-RR

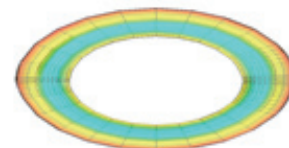
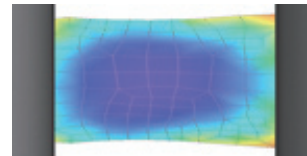


Fig. 8 Shape deformation of ring rolling process predicted by SHAPE-RR programs

Multi-directional roll forming process 공정 수치해석 프로그램 개발/

Development of numerical analysis program for the multi-directional roll forming process



고강도강의 성형성, 생산성을 향상시키고 활용성 및 부가가치를 높이기 위해 Roll forming 부품 단면의 폭, 높이가 변화하는 Multi-directional roll forming(or flexible roll forming) 기술에 대한 전용 공정해석 툴을 개발.

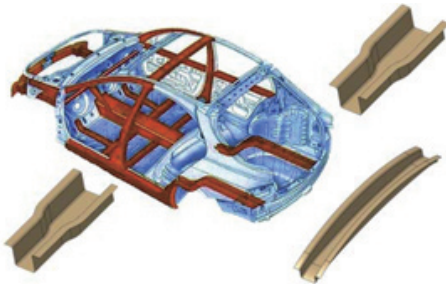


Fig. 9 painting processing.

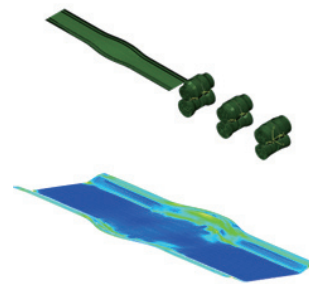


Fig. 10 simulation for obtaining stiffness of hood.

• Research Interest

광탄성 화상처리를 이용한 응력측정 방법 연구/

A study on the method of measuring stress using the photoelastic image processing



사출성형 공정 후 플라스틱 사출부품에 존재하는 잔류응력을 현장에서 쉽고 정확하게 평가하기 위해 광탄성 (photoelasticity) 화상처리기술을 적용하여 투명 및 불투명 제품의 잔류응력을 측정하며, 수치유동해석 S/W 와 열-점탄성 응력해석 S/W 의 연계를 통해 제품의 잔류응력 평가

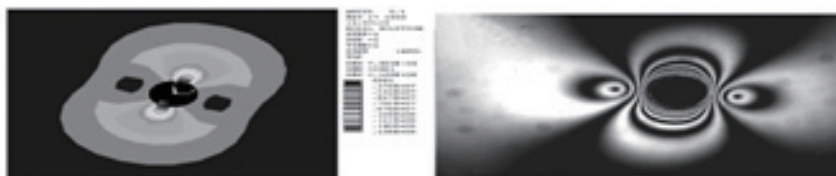


Fig. 11 Photoelasticity fringe pattern

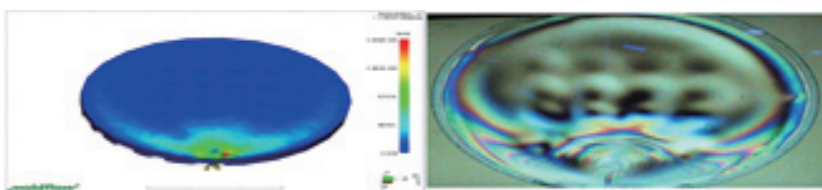


Fig. 12 Birefringence image (left) and fringe pattern (right)

• 정형가공 연구실 Net Shape Manufacturing Laboratory

지도교수	김낙수				
연구실 위치	AS601	전화번호	+82-2-705-8635	홈페이지	http://hsmlab.sogang.ac.kr
연구실 방장	차완기	전화번호	+82-10-9136-3718	이메일	coolcwg@sogang.ac.kr

■ 기본연구방향

1. 유한요소법을 이용한 생산공정 해석
2. 최적설계기법을 이용한 공정 최적화
3. 금속, 플라스틱, 유리 재료의 변형거동에 대한 역공학

■ 최근 수행된 연구과제

1. 회전성형기술(링압연)의 해석 프로그램 효율 및 수렴성 향상, 일광테크㈜
2. 고강도 고강성 노트북 케이스를 위한 단조 성형 기법 개발, 삼성전자㈜
3. Multi-directional roll forming process 공정 수치해석 프로그램 개발, 포스코㈜
4. 도장 후변형 해석 기술 개발 (ERC산업체대응), 현대자동차㈜
5. 핵연료 지지격자체 성형 결함 최소화, 한국연구재단

■ 최근 대표 발표논문 목록

1. K. Shin, S. Chi and N. Kim, Prediction of Flow Stress of Metallic Material and Interfacial Friction Condition at High Temperature Using Inverse Analysis, Journal of Mechanical Science and Technology 2010;24:639-648.
2. T. Kim, J. Suh, N. Kim and M. Lee, Optimum Conditions for Parallel Translation of Maxillary Anterior Teeth Under Retraction Force Determined with the Finite Element Method, American Journal of Orthodontics and Dentofacial Orthopedics 2010;137:639-647.
3. M. Oh, M. Lee and N. Kim, Robust Design of Roll-Formed Slide Rail Using Response Surface Method, Journal of Mechanical Science and Technology 2010;24:2545-2553.
4. S. Seo, M. Lee, S. Kim and N. Kim, Robust optimum design of bearingless rotation motor using the Kriging Model, International Journal of Precision Engineering and Manufacturing 2011;12:1043-1050.
5. J. Cho, M. Lee, S. Park, S. Hong and N. Kim, Prediction of thermal deformation considering the residual stresses for PMMA-TSP laminated structure, Journal of Mechanical Science and Technology, 2011.
6. H. Lee, J. Wang, S. Park, S. Hong and N. Kim, Analysis of Excessive Deformation Behavior of a PMMA-Touch Screen Panel Laminated Material in a High Temperature Condition, KOREA-AUSTRALIA RHEOLOGY JOURNAL, 2011.
7. J. Wang, N. Kim and H. Lee, On the Ductile Fracture Model in Shearing Process of Zircaloy Sheet for Nuclear Fuel Spacer Grids, 2011.

■ 연구실 구성원



김홍래
(박사과정)
Hong-lae Kim
(Ph.D program)



Jin Kai
(석사과정)
(Master program)



왕재윤
(석사과정)
Jaeyoon Wang
(Master program)



차완기
(석사과정)
Wan-gi Cha
(Master program)



황지훈
(석사과정)
Jihoon Hwang
(Master program)



김지섭
(석사과정)
Jisup Kim
(Master program)



정현수
(석사과정)
Hyunsoo Jung
(Undergraduate program)



남승완
(석사과정)
Seungwan Nam
(Master program)



하지선
(학부연구생)
Jisun Ha
(Undergraduate program)



엄준수
(학부연구생)
Joonsoo Eom
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	회전성형기술 (링 압연)의 해석 프로그램 효율 및 수렴성 향상/Improvement of efficiency and convergence of Rotational Process FEA Program(SHAPE-RR)		
주무기관	일광테크(주)	연구자역할	책임
연구비	43,000,000 원	연구기간	2011.04.01~2011.09.30
주요 참여 대학원생	김홍래, Jin Kai		

연구과제명	고강도 고강성 노트북 케이스를 위한 단조 성형 기법 개발/ Development of Forging Processing technique for High Strength and High Stiffness Notebook Case.		
주무기관	삼성전자(주)	연구자역할	책임
연구비	30,000,000원	연구기간	2011.07.15~2011.10.28
주요 참여 대학원생	김홍래, 정현수		

연구과제명	Multi-directional roll forming process 공정 수치해석 프로그램 개발/ Development of numerical analysis program for the multi-directional roll forming process		
주무기관	포스코(주)	연구자역할	책임
연구비	55,000,000원	연구기간	2011.06.01~2012.01.31
주요 참여 대학원생	차완기		

연구과제명	도장 후변형 해석 기술 개발 (ERC산업체대응)/ Development of Analysis Technique for prediction of Deformation in Dipping process		
주무기관	현대자동차(주)	연구자역할	공동책임
연구비	60,000,000원	연구기간	2011.07.01~2012.06.30
주요 참여 대학원생	김지섭		

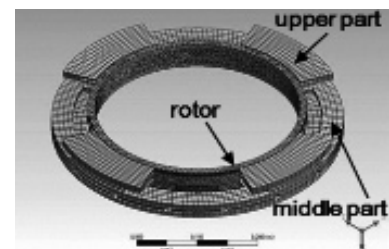
연구과제명	핵연료 지지격자 공정해석 및 설계 융합 시스템 개발/ Development of Integrated System of Process Analysis and Design for Nuclear Fuel Spacer Grid		
주무기관	한국연구재단	연구자역할	참여
연구비	325,000,000원	연구기간	2011.05.01~2012.04.30
주요 참여 대학원생	왕재윤, 황지훈		

◆ 최근 대표논문

Robust optimum design of bearingless rotation motor using the Kriging Model	
Sungil Seo, Munkyu Lee, Sangjo Kim and Naksoo Kim	책임
International Journal of Precision Engineering and Manufacturing	12 (6), 1043-1050 (2011)

ABSTRACT

Recently, bearingless rotation motors have become widely popular in office automation (OA) and factory automation (FA) systems due to their simple structure, high speed of operation, and high precision in positioning. In this study, a bearingless rotation motor was designed to have a large torque and levitation force because these are generally considered as indicators of motor performance. The torque and levitation force of the bearingless rotation motor can be calculated by a commercial finite element method (FEM) program, ANSYS. To robustly design the bearingless rotation motor, first, the effective design parameters were selected; we set a table of orthogonal arrays, including the design variables and parameters. The Kriging model was applied to formulate the cost function of the regression model, which can be used to evaluate the motor performance. By minimizing the cost function, it was possible to quickly realize a robust optimum design of a bearingless rotation motor. As a result, the performance of the motor was improved with regard to the torque and levitation force.



Prediction of thermal deformation considering the residual stresses for PMMA-TSP laminated structure

Junghyun Cho, Moonkyu Lee, Seonmi Park, Seokmoo Hong and Naksoo Kim

책임

Journal of Mechanical Science and Technology

2011

ABSTRACT

The use of PMMA plates is limited by typical features of the plates. When the plate is conjugated with other material, it is mostly deformed at high temperature while remaining stable if the plate is homogeneous. In this paper, deformation of PMMA especially that made from injection molding at high temperature is described. In addition, the relocation of the injection gate in order to minimize the deformation is studied. The main cause of the deformation is found to be residual stresses, and it can be predicted by inverse engineering which is described in the paper. Further study of residual stresses among different injection gates is made, and deformations of the PMMA-TSP laminated plate according to those locations are measured. In conclusion, one of the ways to reduce deformation at high temperature is to locate the injection gate at a symmetrical position of the plate.



Analysis of Excessive Deformation Behavior of a PMMA-Touch Screen Panel Laminated Material in a High Temperature Condition

Hyeon Lee, Jaeyoon Wang, Seon-Mi Park, Seokmoo Hong and Naksoo Kim

책임

KOREA-AUSTRALIA RHEOLOGY JOURNAL

2011

ABSTRACT

In this study, the bending and twisting deformations of a laminated material composed of PMMA (Poly Methyl Methacrylate) and TSP (Touch Screen Panel) were analyzed at a high temperature condition. At similar conditions, a PC (Polycarbonate)/TSP material had little deformation, but the PMMA-TSP material showed excessive bending deformation with twisting. To determine the factors that cause the deformation, 5 factors relating to material properties were systematically analyzed using FE (Finite element) analysis. The results demonstrated that variations in each of the 5 factors affect the deformation of material, and the strongest influence on the deformation behavior of the material at high temperature comes from the CTE, residual stress, and the creep effect. The validity of the analytical research was confirmed by comparing not only differences in the material properties of PMMA and PC, but also by comparing the results of the FE analysis of PMMA-TSP and PC-TSP. In the analysis, it was discovered that CTE, creep coefficient, and residual stress are the most significant causes of deformation of the laminated material.

On the Ductile Fracture Model in Shearing Process of Zircaloy Sheet for Nuclear Fuel Spacer Grids

Jaeyoon Wang, Naksoo Kim and Hyunggil Lee

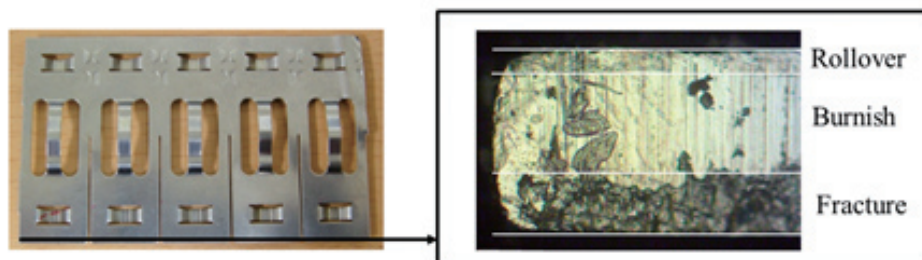
책임

Metals and Materials International

2011

ABSTRACT

Features of sheared edges are predicted based on material properties of Zircaloy obtained from the tensile test and the ductile fracture model such as Gurson-Tvergaard-Needleman (GTN) and Johnson-Cook model. The sheared edges formations are numerically analyzed in each ductile model. An appropriate ductile fracture model is selected to study the relative depth of sheared edges with respect to process parameters. The tendency of failure parameters that are affected by sheared edges and fracture duration is investigated. We applied changes on parameters of failure models to show that the punch force curve and the ratio of characteristic lengths could be coincided, which led us to conclude that GTN and Johnson-Cook models are equivalent. In Johnson-Cook model, however, the characteristic length of sheared edges does not change as each failure parameter reaches a critical value. Hence, the FE prediction model for forming defects is developed using GTN failure model. Finally, the characteristic length of sheared edges have been measured using the FE prediction model for shearing process parameters such as punch velocities, clearance, and tool wear. Our results showed that the punch-die clearance is the most significant factor that affects forming defects when compared to other factors.



CAD/CAM Laboratory



Professor Cheolsoo Lee (이철수)
Mechanical Engineering, Sogang University
AS708, <http://hompi.sogang.ac.kr/cadcam>



• Computer Aided Manufacturing

Micro-EDM(Electric Discharge Machining)

Micro-scale가공을 위한 정밀 EDM 가공기 개발과 Micro Device 제작을 위한 Micro EDM 가공 관련 기술 개발
(Developing High-precision EDM Machine for Micro-scale Manufacturing and Related Technologies of Micro EDM for Manufacturing Micro Devices)



Fig. 1 Micro-EDM Experimental results

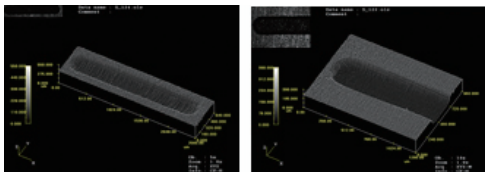
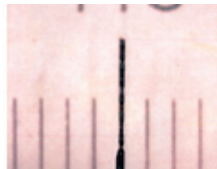


Fig. 2 Micro Channel Measurement results(Confocal Laser Microscope)

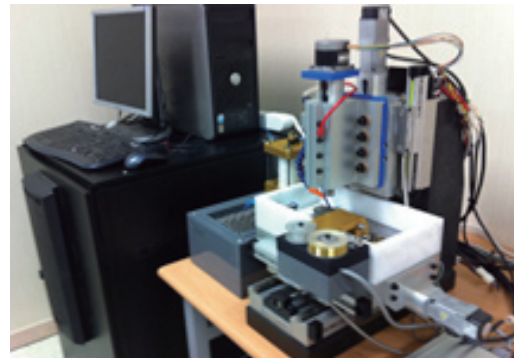
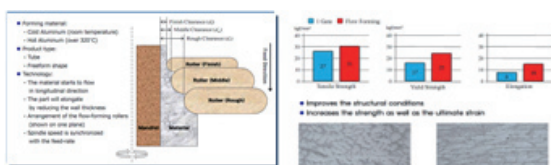


Fig. 3 Micro-EDM Machine

Developing Flow-Forming Machine



기존 휠에 비하여 Mechanical structure condition이 대폭 향상된 Hybrid Al-Alloy Wheel Forming Machine의 개발(Developing Hybrid Al-Alloy Wheel Forming Machine Which Is Improved In Mechanical structure Condition Compared to Existing Wheel)

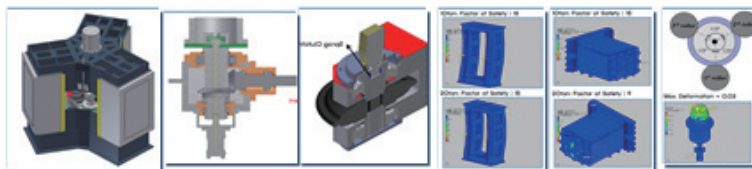
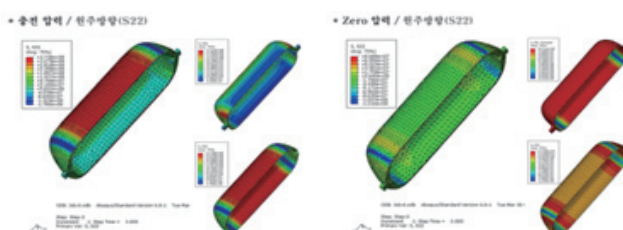


Fig. 4 Methodology of Flow-Forming Machining & Material Property Comparison

Fig. 5 Machine Tools Design & CAE Structure Analysis

• Computer Aided Design & Engineering

Design CNG Composite Container



CAD와 CAE를 이용한 알루미늄, carbon Fiber, Al-Alloy소재의 무 용접 고압용기의 설계 및 내구성 분석
(Design and Stress Analysis of Carbon Fiber, Al-Alloy Non Welding Container Using CAD & CAE)

Fig. 6 FEM analysis of CNG Tank

• CNC Controller

CNC Controller Development

High-speed Machining, Automatic Normal Axis Control, Real-time Path Viewing 등이 통합된 CNC Controller의 개발을 통한 가공성능 향상 (Improving Performance of Manufacturing through Developing CNC Controller Which High-speed Machining, Automatic Normal Axis Control and Real-time Path Viewing are integrated)

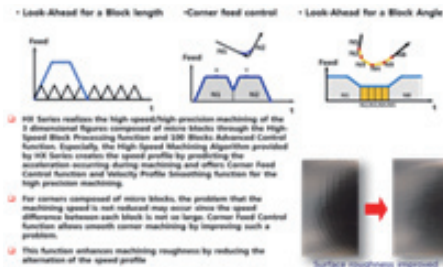


Fig. 7 Methodology of High-Speed Machining Control & results

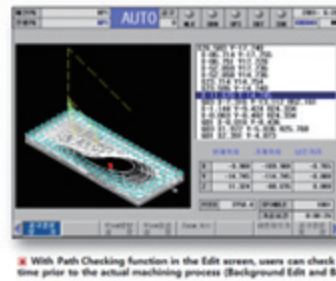
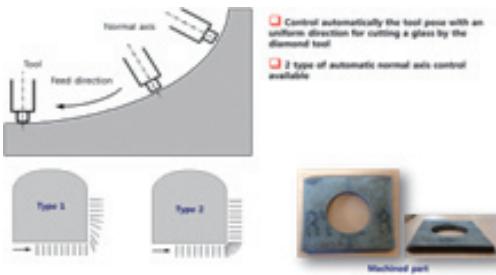


Fig. 8 Automatic Normal Axis Control & Real Time Path Viewing

• Positron Emission Tomography

Developing Auto Radiopharmaceutical Synthetic System

One-button push type, One-box형태 및 PLC내장 PET용 방사선 의약품의 자동 합성-정제-제제의 자동화된 신개념 융합 시스템 설계 및 개발 (Design and Developing of Auto Radiopharmaceutical Synthetic System and One-button Push Type, One-box Form)

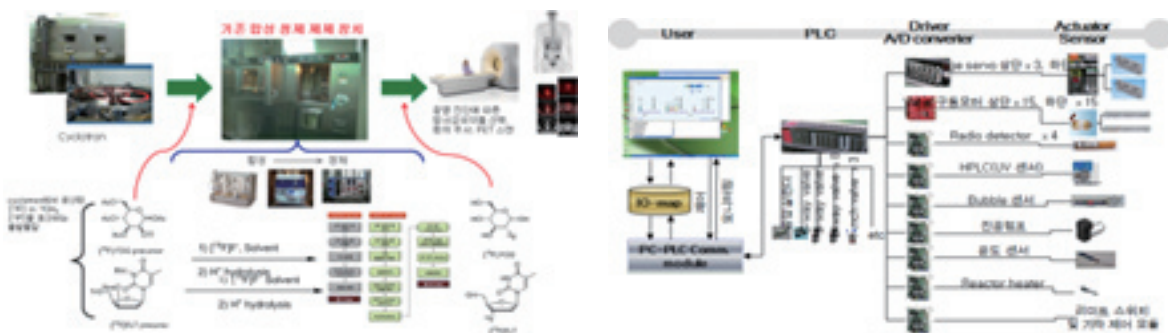


Fig. 9 PET Process CYCLE & Device Layout

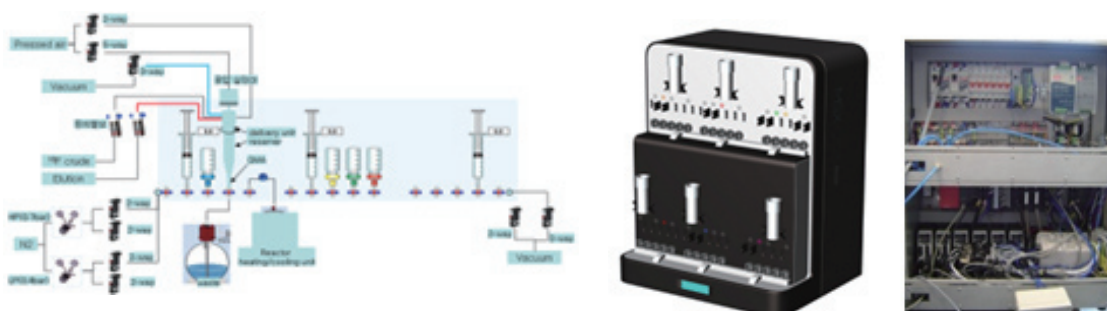


Fig. 10 [18F]FDG synthesis modeling grid & Proto Type of PET SYSTEM

• CAD/CAM 연구실 Sogang University CAD/CAM Laboratory

지도교수	이철수				
연구실 위치	AS708	전화번호	705-8646	홈페이지	http://hompi.sogang.ac.kr/cadcam
연구실 방장	최용찬	전화번호	010-3368-3795	이 메 일	ferusequus@gmail.com

■ 기본연구방향

1. 설계: CAD/CAE S/W를 이용한 제품 형상 모델링 및 최적화 알고리즘을 이용한 CNC Controller 개발
2. 분석: 유한요소 해석(Finite Element Analysis: FEA)을 이용한 CNG용기의 안정성 분석 및 자동차 휠(Wheel)가공기의 성능분석
3. 생산/가공: 고강도 Wheel 제조용 Wheel-Forming Machine의 생산을 위한 공정 연구

■ 최근 수행된 연구과제

1. 의료용 의약품 자동함성 시스템 개발, 교육과학기술부
2. 마이크로 가공 기술(Micro-Machining Technology: MMT)를 바탕으로 하는 마이크로 기계가공(Micro-Machining)과 마이크로 방전가공(Micro-EDM) 기술을 이용한 Micro Device 등의 가공 및 제작, 서강대학교

■ 최근 대표 발표논문 목록

1. Lee CS, Heo EY, Kim DW, Lee JY, F. FrankChen, High speed pocket milling planning by feature-based machining area partitioning 2011;27:706~713
2. Lee CS, Lee JH, Geometric Modeling and Tool Path Generation of Model Propellers with a Single Setup Change, International Journal of Manufacturing Technology 2010;50:253~263
3. Lee CS, Generation of Velocity Profiles with Speed Limit of Each Axis for High-Speed Machining using Look-Ahead Buffer, International Journal of Prediction Engineering and Manufacturing 2010;11:201~208
4. Lee CS, Tool Path Generation for a Four-Axis Machine to Engrave Letters on Tire Sidewall Molds, International Journal of Precision Engineering and Manufacturing 2009;10:75~82
5. Lee CS, Kim DS, Phan TT, 2D Curve Offset Algorithm for Pockets with Islands using a Vertex Offset, International Journal of Precision and Manufacturing 2009;10:127~135
6. Lee CS, Geometric Equation and Machining Method for the Sidewall of a Piston, International Journal of Precision and Manufacturing 2009;10:3~6

■ 연구실 구성원



허은영
(연구교수)
Eun-Young Heo
(Research Prof.)



김종민
(연구교수)
Jong-Min Kim
(Research Prof.)



김상조
(박사과정)
Sang-Jo Kim
(Ph.D program)



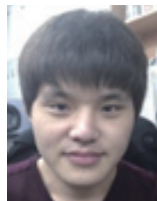
최용찬
(석사과정)
Yong-Chan Choi
(Master program)



이희승
(석사과정)
Hee-Seung Lee
(Master program)



이경복
(학부연구생)
Gyeong-Bok Lee
(Undergraduate program)



변경태
(학부연구생)
Kyung-Tae Byun
(Undergraduate program)



송여일
(학부연구생)
Yeo-Il Song
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	PET용 방사성의약품 고수율 자동 합성 시스템 융합 기술 개발		
주무기관	한국연구재단 신기술융합형성장동력사업 첨단의료기기사업본부	연구자역할	책임
연구비	603,333,333원	연구기간	2011.07.01~2012.06.30
주요 참여 대학원생			

연구과제명	화학반응용 정밀제어가 가능한 분리형 마이크로파 반응기의 개발		
주무기관	중소기업청	연구자역할	공동
연구비	14,000,000원	연구기간	2011.06.01~ 2012.05.31
주요 참여 대학원생			

◆ 최근 특허 실적

특허명	이송 경로 제어가 가능한 F-18 표지 방사성 의약품 합성				
발명자	이철수, 지대윤, 허은영, 김종민, 김희섭, 이병세				
특허지역	국내	특허유형	출원	출원번호	10-2011-0091501
발명 참여 대학원생					

특허명	F-18 표지 방사성 의약품 합성 장치용 카세트				
발명자	이철수, 지대윤, 김종민, 허은영, 김희섭, 이병세				
특허지역	국내	특허유형	출원	출원번호	10-2011-0091502
발명 참여 대학원생					

특허명	방사선 의약품 제조장치				
발명자	이철수				
특허지역	국외	특허유형	출원	출원번호	PCT/KR2011/005931
발명 참여 대학원생					

특허명	분리형 공진기를 이용한 온도 모니터링 microwave 가열 시스템				
발명자	이철수				
특허지역	국내	특허유형	출원	출원번호	10-2011-0044453
발명 참여 대학원생					

특허명	무선통신기반 복수 대상물 위치 인식 시스템				
발명자	이철수, 김명식, 김광수				
특허지역	국내	특허유형	출원	출원번호	10-2011-0044454
발명 참여 대학원생					

특허명	방사성의약품 합성 프로세스 검증을 위한 네트워크 모델링				
발명자	이철수, 허은영				
특허지역	국내	특허유형	출원	출원번호	10-2011-0043673
발명 참여 대학원생					

특허명	HPLC 및 방사선센서를 이용한 방사성의약품 정제 자동 CUT 시스템				
발명자	이철수, 허은영, 김동수				
특허지역	국내	특허유형	출원	출원번호	10-2011-0043671
발명 참여 대학원생					

◆ 최근 대표논문

High speed pocket milling planning by feature-based machining area partitioning	
Eun-Young Heo , Dong-Won Kim ,Jong-Young Lee , Cheol-Soo Lee , F. FrankChen	책임
ROBOTICS AND COMPUTER-INTEGRATED MANUFACTURING	27, 706-713 (2011)

Pocket milling operations are involved in two and a half-dimensional(2.5D) machining. The machining area of a pocket has to be divided into several submachining regions(SMRs) to effectively select the machining parameters for ordinary or high speed milling. ASMR of a pocket has its own characteristic geometry, which implicitly provides machining features used for the generation of strategies for high speed machining. This paper presents a methodology to partition a pocket machining area, as well as to identify machining features used for planning of high speed pocket machining. To generate the machining strategy, the attributes of machining features are defined, and evaluated through a machining volume slicing method. SMR-based partitioning rules are developed based on the geometric features of a pocket. The proposed partitioning algorithm is applied to both simple and complex shaped pockets. A case pocket volume is divided into several SMRs, represented by a tree structure containing associated information for pocket milling planning.

Geometric modeling and tool path generation of model propellers with a single setup change	
Cheol-Soo Lee , Jae-Hyun Lee	책임
INTERNATIONAL JOURNAL OF ADVANCED MANUFACTURING TECHNOLOGY	50, 253-263 (2010)

Abstract A model propeller plays important roles in the design of the marine vehicles. The cavitations, the erosion, the pressure fluctuation, and the flow are measured by the model propeller. These measurements help to create the actual marine propeller. In this paper, geometry modeling and tool path generation for a model propeller are proposed, and the hub surface and lateral surface of the wing surfaces are generated by the proposed method. Considering the characteristics of the model propeller, efficient Cutter Location (CL) data are proposed: (1) the finish machining is completed with one setup posture. (2) A four-axis machining algorithm is proposed that makes it possible to the propeller with one setup and that minimizes machining error. (3) To minimize the maximum machining load, zigzag machining and an outside-to-inside tool path are introduced. A tilting guide curve is proposed to determine the tool axis vector. A smoothly changing tool axis vector is obtained through this curve, and the calculation is simple and fast. The results demonstrate that the proposed method is useful for the manufacturing of model propellers.

Generation of Velocity Profiles with Speed Limit of Each Axis for High-Speed Machining using Look-Ahead Buffer	
Cheol-Soo Lee	책임
INTERNATIONAL JOURNAL OF PRECISION ENGINEERING AND MANUFACTURING	11, 201-208(2010)

An efficient look-ahead algorithm to generate velocity profiles is presented in this paper. Algorithm allows for a nonzero starting point velocity and end point velocity of every line segment to increase machining productivity. The paper considers the intelligence of look-ahead to achieve faster machining speed, along with required accuracy. Speed limitation of a specific axis and the direction change of an axis are newly added to the constraints of the velocity profile problem. This paper solves graphically the problem of generating velocity profiles and derives the equations for representing the velocity profile. A method to manage the look-ahead buffer is also proposed. To generate velocity profiles using the look-ahead buffer, three phases are proposed. Phase 1 determines the velocity conditions such as the maximum velocity, starting point velocity and end point velocity. In phase 2, velocity profiles are generated independently. Phase 3 handles the change of the start or end point velocity. This phase 3 is repeated until all adjacent point velocities are the same. The proposed method was utilized in the manufacturing field to engrave aluminum tire molds. It was demonstrated that this method contributes to an increase of the machining accuracy and a reduction of the production time.



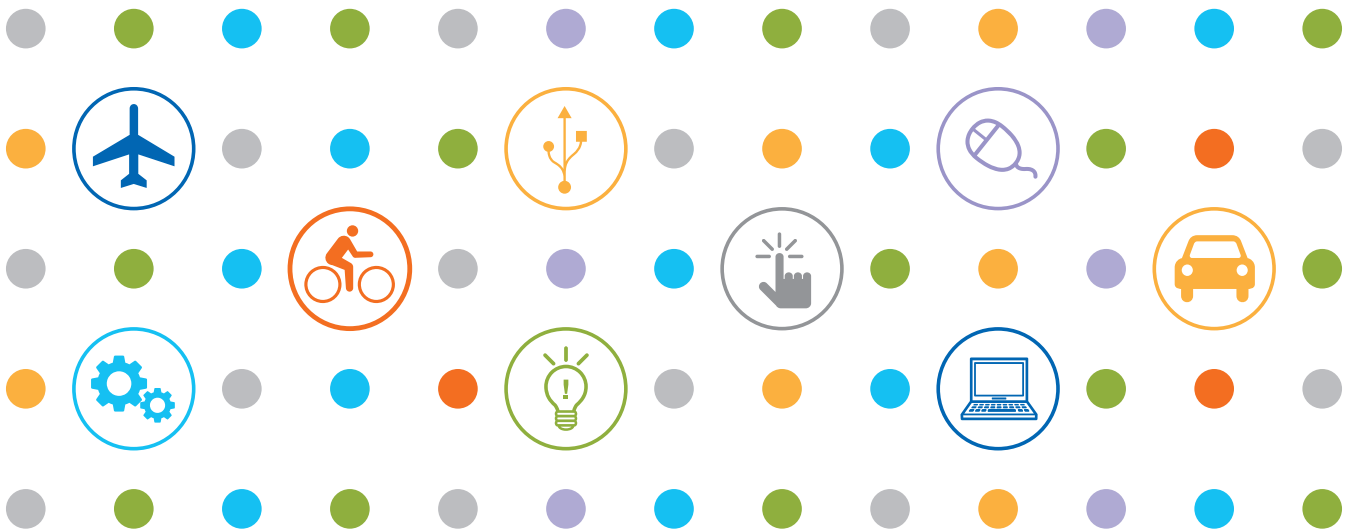
engineering



industry



technology



The Department of Mechanical Engineering

IV. 연구실 소개(7)

Research Laboratories

7. 자동차공학 연구그룹

Research on Automotive Engineering

- 1) 정형가공 연구실 _ 116
Net Shape Manufacturing Laboratory
- 2) 자동차 메카트로닉스 및 바이오 역학 연구실 _ 128
Automotive Mechatronics & Bio Mechanics Lab
- 3) 다중물리 & 다중스케일 시스템 연구실 _ 70
Multiphysics & Multiscale Systems Laboratory

Automotive Mechatronics & Bio Mechanics Lab



Professor Hyun-Yong Jeong
Mechanical Engineering, Sogang University
R619, <http://ambmlab.sogang.ac.kr>



• The Prediction of Dynamic Load of TBR Tire in Cornering

■ Objectives

- Develop an FE truck-tires model
- Develop an input and post-processing program
- Predict dynamic load at each axle



Fig. 1-1 Truck Trailer Model



Fig. 1-2 FE Tire Model

■ The Process

- Simplify a tire model in ABAQUS
- Compare to the results from a commercial code

• The Development of Forward Collision Decision Algorithm based on Crash Probability

■ Objectives

- Set up the warning time differently depending on driver's driving propensity
- Calculate the crash probability using stochastic analysis
- Suggest optimum avoidance path

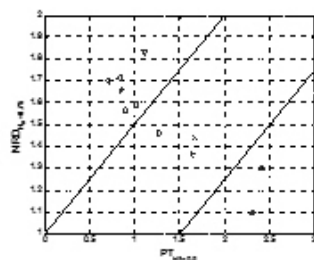


Fig. 2 Driver characteristics

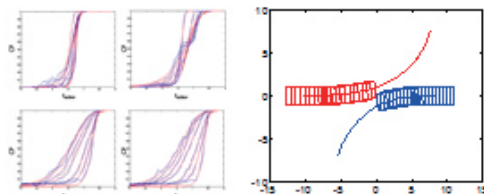


Fig. 3 Crash Probability and collision avoidance

■ The Process

- Signal processing of deceleration pulse at testing ground and public road
- Develop the new metrics for crash severity
- Make a look-up table based on crash condition
- Automatically regulate the warning time according to driver's tendency.
- Generate vehicle path for collision avoidance.

• Development of Analysis Technique for Tire Model

■ Objectives

- Create a method of driving experience
- Make a Magic-formula tire model of wheel-loader
- Analysis ADAMS model with results of experience



Fig. 4 Locations of sensors in wheel-loader



Fig. 4-2 Accelerometer



Fig. 4-3 Inertia sensor

■ The Process

- Make a Magic-formula of wheel tire
- Make an ADAMS tire model

• Development of a Simulation Methodology to Predict the Fatigue Life of Solders in the BMS Module

■ Objectives

- Develop the technique to predict solder Fatigue life in BMS Module
- Develop the program to calculate CED(Cracking Energy Density) and SERR(Strain Energy Release Rate)

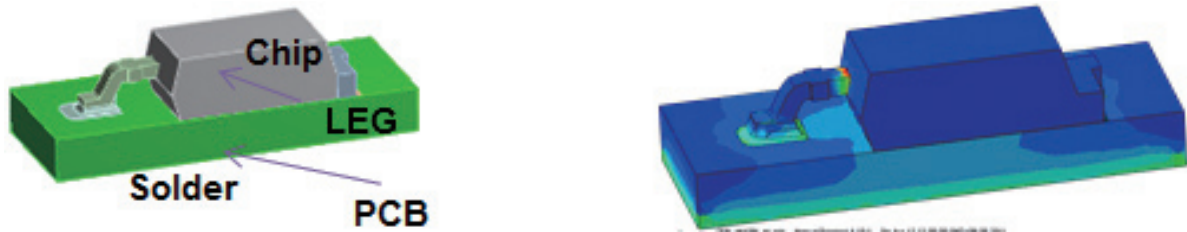


Fig. 5 Geometry of Chip Section & Analysis Result

■ The Process

- Collect BMS Materials Properties of PCB
- Analyze BMS Module design by FE simulations
- Calculate CED and SERR

• The Human Body FE Model

■ Objectives

- Construct an FE human body model

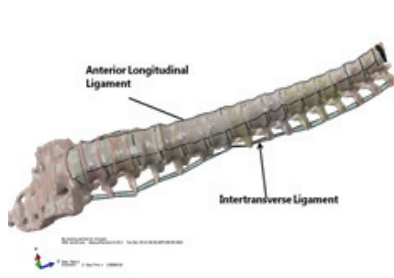


Fig. 6 The FE model of Vertebral Column

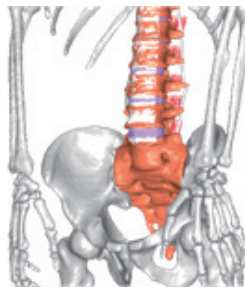


Fig. 7 The FE model of whole human body

■ The Process

- Construct an FE model of the vertebra column
- Develop a muscle force estimation algorithm
- Validate the developed model

• Development of Guidelines for Evaluation of Vascular Stent

■ Objectives

- Research for variants of performance tests of cardiovascular stents
- Specify the guidelines for performance tests of cardiovascular stents

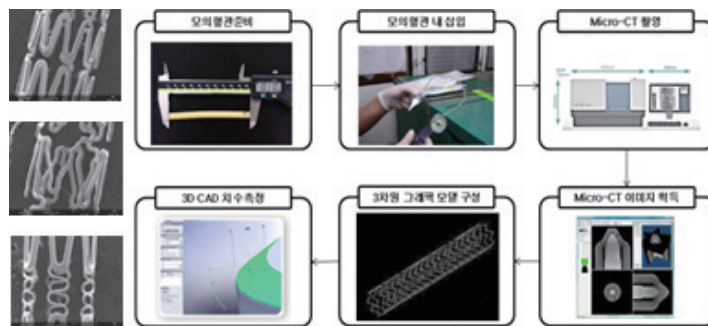


Fig. 8 Stent designs and the process of measuring dimensions

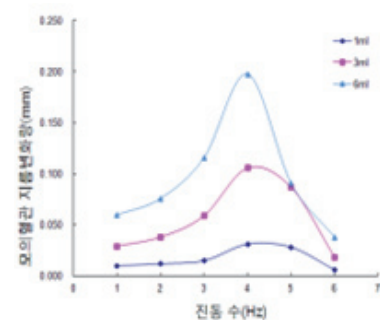


Fig. 9 Deformations of mock vessels

■ The Process

- Collect the data in the market and study the development trends
- Design the devices for measuring dimensions
- Establish the method to measure the radial force
- Establish the test method and the test settings for durability

• 자동차 메카트로닉스 및 바이오 역학 연구실 Automotive Mechatronics & Bio Mechanics Laboratory

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■ 기본연구방향

본 연구실은 역학과 유한요소법 등의 기계공학 지식을 바탕으로 자동차 안전, 바이오 역학, 타이어 역학 등에 관하여 연구하는 곳입니다. 이와 같은 연구를 수행함에 있어서 이론적 접근과 실험적 접근을 모두 시도하고 있으며, ABAQUS, LS-DYNA, MADYMO 등의 상용 코드를 사용하기도 합니다. 무엇보다도 철저한 연구활동, 투명하고 합리적인 실험실 운영을 기치로 프로젝트를 성실히 수행하고 있습니다.

■ 최근 수행된 연구과제

1. BMS 모듈 Solder의 피로 수명 예측 해석 기술 개발, LG innotek
2. 타이어 내구성 평가, 트랙 타이어 동적 하중 연구, 한국타이어
3. 확률 기반 전방추돌판단 알고리즘개발, 현대기아자동차
4. 자동차안전 ECU 개발, 에어백설계 및 해석, 만도
5. 도로 포장면 특성에 따른 수막현상 시뮬레이션 및 미끄럼 저항성 예측에 관한 연구, 건설기술연구원
6. 심혈관용 스텐트의 특성 평가 가이드라인 개발 연구, 식품의약품안전평가원

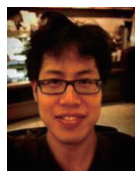
■ 최근 대표 발표논문 목록

1. D.-W. Cha, H.-Y. Jeong, Development of a Mode III fatigue test method and a peel test method for tire specimens, International journal of fatigue 2011: pp. 912-920.
2. T.-W. KIM and H.-Y. JEONG, HYDROPLANING SIMULATIONS FOR TIRES USING FEM, FVM AND AN ASYMPTOTIC METHOD, International Journal of Automotive Technology, Vol. 11, No. 6, pp. 901-908 (2010).
3. Taewung Kim and Hyun-Yong Jeong, Crash Probability and Error Rates for Head-On Collisions Based on Stochastic Analyses, IEEE TRANSACTIONS ON INTELLIGENT TRANSPORTATION SYSTEMS 2010: pp. 896-904.
4. Jaehoon Kim, H.-Y. Jeong, A study on the hysteresis, surface temperature change and fatigue life of SM490A, SM490A-weld and FC250 metal materials, International Journal of Fatigue 32 (2010) 1159 - 1166.
5. T.-W. KIM and H.-Y. JEONG, STOCHASTIC ANALYSIS OF THE VARIATION IN INJURY NUMBERS OF AUTOMOBILE FRONTAL CRASH TESTS, International Journal of Automotive Technology, Vol. 11, No. 4, pp. 481-488 (2010).
6. J. H. KIM, H. Y. JEONG and J. S. PARK, DEVELOPMENT OF THE FMECA PROCESS AND ANALYSIS METHODOLOGY FOR RAILROAD SYSTEMS, International Journal of Automotive Technology, Vol. 10, No. 6, pp. 753-759 (2009).

■ 연구실 구성원



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Lee Jong Hyuk
(Master program)



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(Master program)



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(Undergraduate program)



곽인용
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(Undergraduate program)



문형주
(학부연구생)
Moon Hyung Joo
(Undergraduate program)

◆ 최근 수행 연구과제

연구과제명	어드밴스드 에어백 제어장치용 충돌 정도 알고리즘과 전개 로직 개발		
주무기관	(주) 만도기흥중앙연구소	연구자역할	책임
연구비	80,000,000원	연구기간	2010.06.01~2011.05.31
주요 참여 대학원생	이민성, 최원민, 이충령		

연구과제명	Screw 및 Plate 개발에 관한 연구		
주무기관	(주) 덴티움 수원공장	연구자역할	책임
연구비	60,000,000원	연구기간	2010.07.01~2011.06.30
주요 참여 대학원생	배종수, 이민성, 이충령		

연구과제명	MADYMO 해석과 시험 결과 분석 및 설계에 관한 연구		
주무기관	(주) 만도기흥중앙연구소	연구자역할	책임
연구비	45,000,000원	연구기간	2010.11.25~2011.06.30
주요 참여 대학원생	정재용, 최원민		

연구과제명	확률 기반 전방추돌판단 알고리즘 개발		
주무기관	(주) 현대엔진비	연구자역할	책임
연구비	72,250,000원	연구기간	2010.12.27~2011.11.26
주요 참여 대학원생	이민성, 정재용, 최원민, 이충령		

연구과제명	심혈관용 스텐트의 특성 평가 가이드라인		
주무기관	식품의약품안전평가원	연구자역할	참여
연구비	80,000,000원	연구기간	2011.01.15~2011.11.30
주요 참여 대학원생	배종수, 이민성, 정재용, 주상민, 이충령		

연구과제명	트럭 종류, 취부위치와 운행조건을 고려한 타이어 해석기법 개발 및 Bel		
주무기관	(주) 한국타이어 중앙연구소	연구자역할	책임
연구비	70,000,000원	연구기간	2011.03.01~2012.02.28
주요 참여 대학원생	배종수, 이민성, 정재용, 주상민, 이충령		

연구과제명	BMS 모듈 Solder의 피로 수명 예측 해석 기술 개발		
주무기관	(주) 엘지이노텍	연구자역할	책임
연구비	70,000,000원	연구기간	2011.07.01~2012.06.30
주요 참여 대학원생	배종수, 이민성, 정재용, 주상민, 이충령		

◆ 최근 대표논문

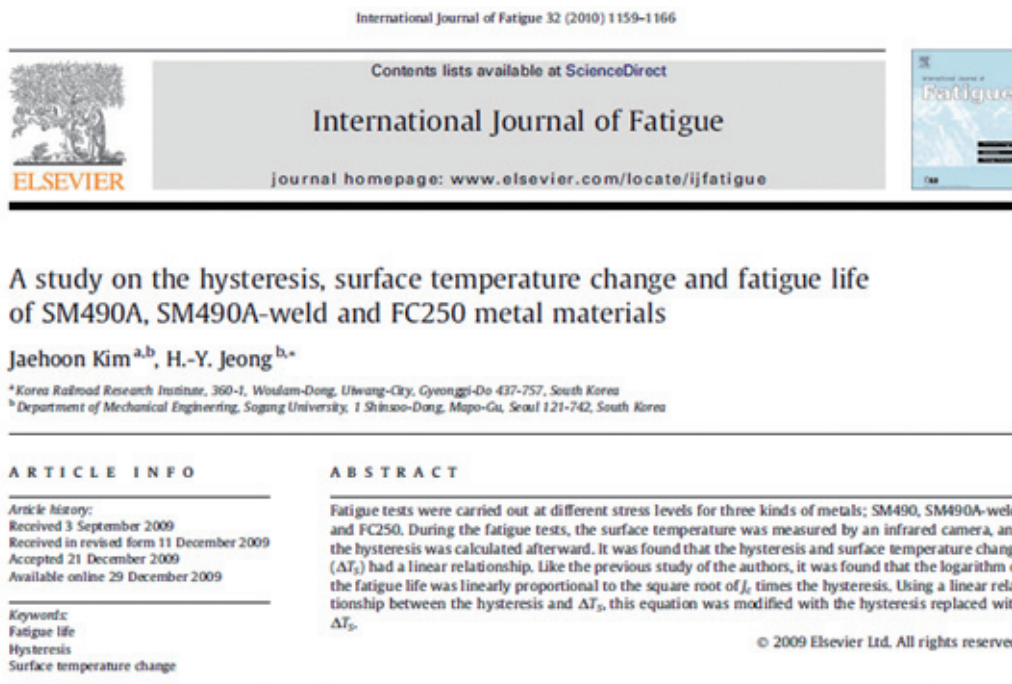
A study on the hysteresis, surface temperature change and fatigue life of SM490A, SM490A-weld and FC250 metal materials

Jaehoon Kim^a, H.-Y. Jeong

책임

International Journal of Fatigue

32 (7), 1159 (2010)



HYDROPLANING SIMULATIONS FOR TIRES USING FEM, FVM AND AN ASYMPTOTIC METHOD

T.-W. KIM and H.-Y. JEONG*

책임

International Journal of Automotive Technology

11 (6), 901 (2010)

International Journal of Automotive Technology, Vol. 11, No. 6, pp. 901-908 (2010)
DOI 10.1007/s12239-010-0107-0

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1229-9138/2010/055-17

HYDROPLANING SIMULATIONS FOR TIRES USING FEM, FVM AND AN ASYMPTOTIC METHOD

T.-W. KIM and H.-Y. JEONG*

Department of Mechanical Engineering, Sogang University, Seoul 121-742, Korea

(Received 6 October 2008; Accepted 30 September 2009)

ABSTRACT—Hydroplaning tires have been frequently simulated using commercial explicit FEM (Finite Element Method) codes. However, these simulations are slow, and the result of the lift force is so oscillatory that the hydroplaning speed cannot be accurately determined. Thus, in the author's previous study, a new methodology using FDM (Finite Difference Method) code and an FE tire model iteratively was proposed. However, this full iteration method still required a long computation time, especially for patterned tires. Thus, in this study, the full iteration methodology was modified such that no iteration or only one additional iteration was needed at each speed. Then, by applying the full iteration method, no iteration method and one iteration method, the hydroplaning speeds of a straight-grooved tire were determined, and it was noted that the hydroplaning speed obtained from the one iteration method was almost the same as that obtained from the full iteration method. Moreover, the hydroplaning speeds of two patterned tires were determined using the one iteration method, and they were compared with the hydroplaning speeds obtained experimentally.

KEY WORDS: Hydroplaning, Tire, Finite Difference Method, Finite Element Method, Iteration Method, Navier-Stokes Equation, Continuity Equation

STOCHASTIC ANALYSIS OF THE VARIATION IN INJURY NUMBERS OF AUTOMOBILE FRONTAL CRASH TESTS

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책임

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STOCHASTIC ANALYSIS OF THE VARIATION IN INJURY NUMBERS
OF AUTOMOBILE FRONTAL CRASH TESTS

T.-W. KIM and H.-Y. JEONG*

Department of Mechanical Engineering, Sogang University, Seoul 121-742, Korea

(Received 17 February 2009; Revised 16 September 2009)

ABSTRACT—Although automobile crash test data have a comparatively large variation because of the complexity of the tests, only a limited number of crash tests are usually conducted due to monetary and time limitations. Thus, it is necessary to control input variables that cause the variation in test data to obtain consistent crash test results and to correctly assess the safety performance of an automobile under development. In this study, a MADYMO model was validated deterministically to yield the head, chest, pelvis deceleration pulses of anthropomorphic test devices and the belt load pulses similar to those from actual tests, and it was also validated stochastically to yield means and standard deviations of the head and chest injury numbers, i.e., HIC_{15} and 3 msec clip similar to those from actual tests. A stochastic analysis was conducted using the validated MADYMO model to calculate the sensitivity of the standard deviations of the injury numbers to the standard deviations of influential input variables to determine the most influential input variable that makes the largest contribution to the variation in the injury numbers. Moreover, the Taguchi approach was used to determine the optimal values of the influential input variables to improve safety performance.

KEY WORDS : Stochastic analysis, Frontal crash test, HIC_{15} , 3 msec clip, Taguchi approach



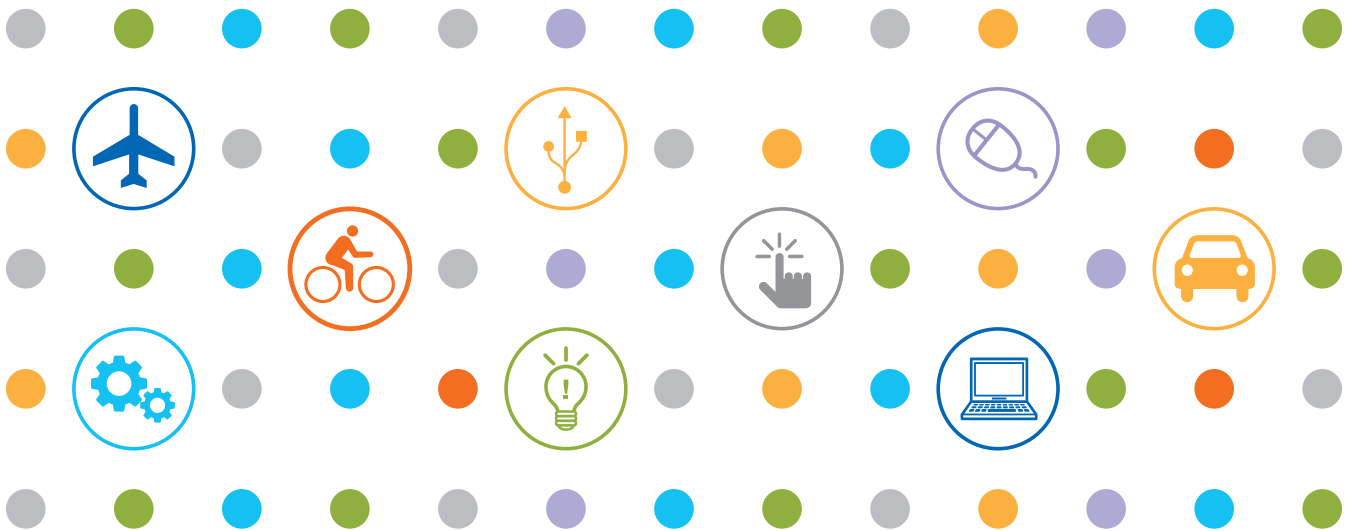
engineering



industry



technology



The Department of Mechanical Engineering

V. 대형과제

Large-scale Projects

1. Multi-phenomena CFD ERC
2. PET용 방사성의약품 고수율 자동 합성 시스템 융합 기술 개발
3. 중증 장애인을 위한 휠체어 결합형 하지 운동/
재활훈련 시스템 개발
4. 비뇨기 질환 모니터링 및 치료기기 시스템 개발

Multi-phenomena CFD ERC

(Multi-phenomena Computational Fluid Dynamics Engineering Research Center)

Tel. : 82-2-705-8637 / e-mail : m3cfd@sogang.ac.kr



M³ : Multi-dynamics · Multi-physics · Multi-scale

CFD : Computational fluid Dynamics

ERC : Engineering Research Center

Research Director

: Nahmkeon Hur (Sogang University)

Support from NRF

: September, 2009 ~ February, 2016
7,700 Million Won

• Natural phenomena & industrial flow system

: Complex interaction of various dynamics, physics and scales

• Need for advanced technique to analyze multiple flow phenomena

: Emerging technologies, like bio-, nano-, space-, energy and environment

• Current CFD

- Mostly focused on analysis of a single flow phenomena
- Limits concurrent simulation for multiple flow phenomena

• Multi-phenomena CFD

- **Multi-dynamics** : fluid flow phenomena related to solid objects
- **Multi-physics** : interfacial flow, complex heat transfer, electrohydrodynamics, chemical reaction and rheology
- **Multi-scales** : top-down and bottom-up methodology for combining between nano, micro, macro scales

• Research Goal of Multi-phenomena CFD ERC

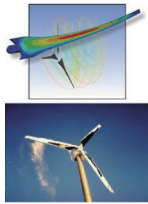
: Development of hybrid CFD framework for flow analysis and design of multiple flow phenomena

• Object of Multi-phenomena CFD ERC

- Development of basic techniques for multi-phenomena flow analysis
- Applications of hybrid CFD framework to multi-phenomena flow analysis and design

• Wind Power/Environment

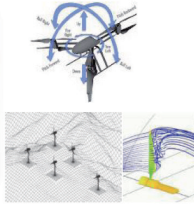
Wind Power/Environment



Turbine blade icing

- Blade design for highly efficient wind power generation
- Optimal placing of wind farms

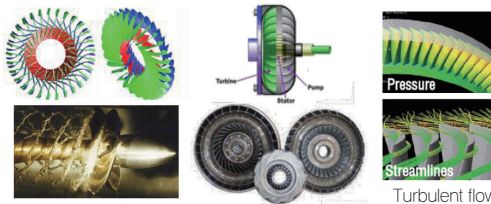
6 degrees of freedom



Multi-scale analysis

• Turbo-machinery

Fluid-structure interaction



Cavitation flow

- Blade design for higher performance and efficiency
- Design to prevent cavitation and back flow

• Heat Exchanger

Conjugate heat transfer

Two-phase flow with phase change

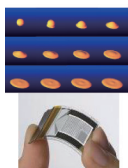


Turbulent flow

- Optimal design of heat exchangers
- Analysis for induced turbulence and phase change

• Jet Printing/LOC

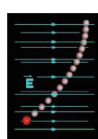
Interfacial flow



Micro-scale analysis

- Optimal design of micro/nano jets
- Techniques for control of electrohydrodynamics droplets

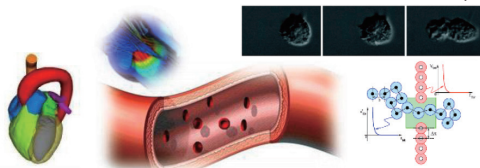
Electrical mechanism



• Bio-fluids/Bio-materials

Fluid-structure interaction

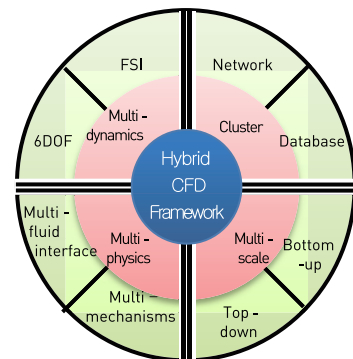
Micro-scale analysis



Macro-scale analysis

Nano-scale analysis

- Development of remedy with prediction of blood flows
- Development of DNA sequencing techniques



PET용 방사성의약품 고수율 자동 합성 시스템 융합 기술 개발

연구책임자: 서강대학교 기계공학과 이철수

· 개요

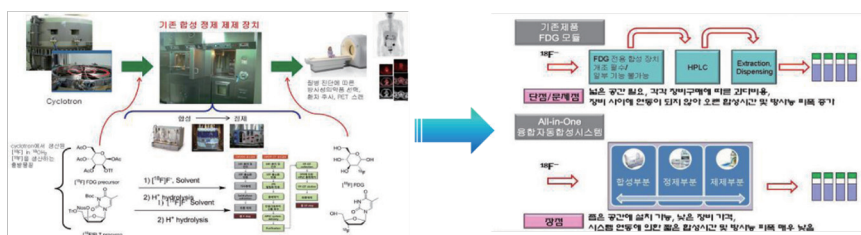
신기술융합형 성장동력사업의 일환으로 수행되고 있는 본 과제는 향후 5년 이내에 기존 기술의 한계를 극복할 수 있는 첨단 의료기기 분야로 교육과학기술부의 지원받아 수행되고 있다. 본 연구가 속해 있는 첨단의료기기 사업단(www.cf.re.kr) PET 방사성의약품, 고성능 의료영상, 질량분석 의료기술 융합 연구단으로 구성되어 있으며, 이 중 PET 방사성의약품 융합 연구단의 2세부 과제로서 연구단의 핵심 기술을 개발하고 있다. 전자방출단층촬영술(PET; Positron Emission Tomography)은 인체영상 분야의 가장 중요한 영상기술 중의 하나로서 각 종 종양 및 질병을 진단기술이다. 이미 확보한 F-18 표지 고수율 합성 원천 기술을 바탕으로, 다양한 질병을 진단할 수 있는 방사성의약품 합성 장비 개발을 목표로 하고 있다. 본 연구에서 개발하고자 하는 장비는 one-button push type 및 one-box 형태로 PET용 방사성의약품의 자동합성-정제-제제화까지 생산 전 과정이 완전 자동화된 신개념 융합 시스템으로서 PET 진단의 필수적인 장치라 할 수 있다. 본 연구를 위해 기계공학과 이철수 연구책임교수를 필두로 20여명의 연구원들이 개발에 참여하고 있으며, 질병의 초기단계의 진단을 통한 삶의 질 향상 및 맞춤의학 실현을 통한 질병 치료성적 향상 실현을 위해 노력하고 있다.

연구 목표	연구 내용
본 과제의 최종 연구목표는 "PET용 방사성의약품 다약제 생산 수율이 50% 이상의 고수율로 자동합성-정제-제제의 전 과정 자동화가 가능한 자동합성 시스템 융합 기술 개발"이며, 이러한 최종 목표를 위한 세부연구 목표는 다음과 같다. • one-button push type, one-box 형태 및 PLC 내장 PET용 방사성의약품의 자동합성-정제-제제화까지 생산 전 과정이 완전 자동화된 신개념 융합 시스템 설계 및 개발 • 자동 합성 parameter 및 process가 적용된 자동합성 공정 운영 software의 개발 및 보안 기술 개발 • 1회용 카세트 적용을 위한 원천기술 개발 및 생산 수율 최적화 기술 개발 및 시스템 최적화 기술 개발	- 고수율 PET 방사성의약품 생산을 위한 합성-정제-제제의 전 과정 자동화가 가능한 융합 시스템은 CAD/CAM 작업을 통한 시스템의 설계, 3차원 시뮬레이션을 통한 가상 제작 및 시험 - 자동합성시스템의 mock test를 실시를 통한 설계 최적화 연구 - 자동합성시스템의 합성, 정제, 제제의 3개 부분의 운영 소프트웨어의 개발 및 상호간의 인터페이스 기술 개발과 동시에 시스템 main control screen의 구성 및 구성요소 개발, 각종 센서로부터 획득한 자료의 추적 그래프 구현, 저장 및 database화 연구 - 시스템 보안 및 운영 소프트웨어 보안 기술이 개발 및 적용 - GMP 기준에 적합하도록 생산 보고서 작성 및 audit 기능을 내장한 소프트웨어 기술 개발 - 자동 합성 시스템에 적합한 1회용 카세트 설계, 디자인 및 원료물질 함량 최적화 기술 개발 - 자동합성 시스템 및 1회용 카세트 시제품 제작 및 cold reaction test를 통한 시스템 운영 기술 개발 - 전체 시스템 및 카세트의 filed test를 통하여 전체 시스템 최적화 연구 및 방사 화학적 수율 안정성, 생산 실패율 및 여러 발생률 시험 결과 획득 및 결과분석 및 feedback

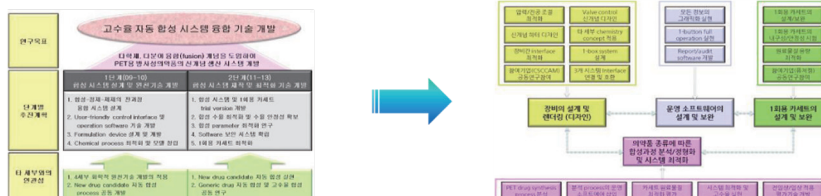
◆ 연구현황

총 사업비	참여 연구원	연구 실적
1억 1600만원/년 (총 5년 5억 5700만원)	26명/년	시제품 3기 제작(18F)FDG 수율 50% 확보, 논문 2편 작성, 특허 4편 출원, 국내외학술대회발표 5편

◆ PET CYCLE 분석



◆ 추진 체계 구성 및 업무 분장



◆ 시제품 개발



중증 장애인을 위한 휠체어 결합형 하지 운동/재활훈련 시스템 개발

개발목표

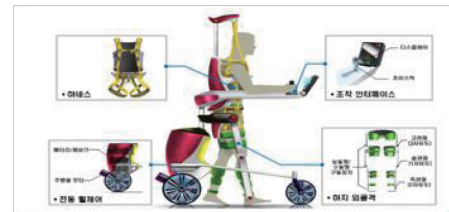
- 중증 장애인용 12자유도 하지 외골격 개발
- 전동 휠체어와 연계된 하지 운동 시스템 구현
- 지능형 하지 운동/재활훈련 알고리즘 개발
- 신체 모니터링 기술 개발



과제 소개



개발대상 시스템



사용 대상 : 중증 장애인



- 척추손상 장애인(C5~L2 수준)
- 뇌졸중 편마비 장애인
- 하지 운동장애를 가진 기타 중증 장애인

운동 및 재활 기대효과

- 혈액순환 및 소화기순환 도움
- 운동기능 회복
- 근력증강 훈련
- 실제보행 연습

척추손상		뇌졸중 (편마비)
ASIA A, B 등급	ASIA C, D 등급	
운동, 건강유지	재활/운동	재활/운동

12자유도 메커니즘 구현

사용 대상 : 중증 장애인



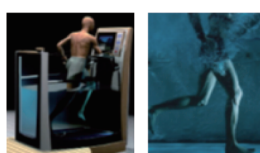
- 중증 장애인의 운동특성 결과로부터 12자유도 시스템의 능동 및 수동 메커니즘 구현
- 장애 정도에 따른 각 관절의 가동범위 설정 가능
- 스프링 메커니즘을 이용한 모터의 출력 토크 최소화 방안 연구

휠체어 시스템 설계 및 제작



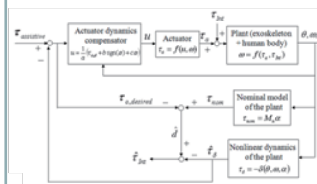
- 안전성, 효율성을 고려한 기립 보조 메커니즘 설계
- 전복에 대한 안전성을 가지는 휠체어 프레임 구조 설계
- 각 관절 통합 휠체어 결합형 시스템 제작

지능형 알고리즘 개발



- 외골격 로봇에 수중동작을 구현하는 지능형 알고리즘 개발
- 재활 전문가의 자문을 통한 지식 데이터베이스 구축 및 이를 통한 각 관절의 가동 범위 및 속도를 제시하는 알고리즘 개발

모니터링 기술개발



- 외골격 로봇과 사람 사이의 상호작용과 관련된 수학적 모델을 예측하고, 실제 움직임과 비교하여 운동 부하 값을 추정
- 특별한 센서 없이 운동부하 모니터링 시스템을 이용하여 장애인의 근경직 발생감지 알고리즘 개발

Bladder Pressure Monitoring and Therapeutic System for Urologic Diseases

(비뇨기 질환 모니터링 및 치료기기 시스템 개발)

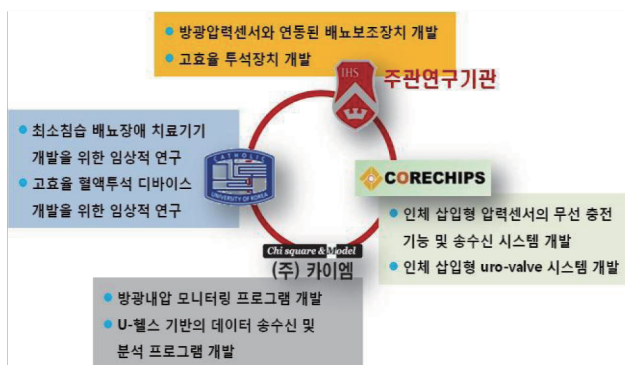
세부 주관 기관: 서강대학교 (책임자: 최범규 교수)
 위탁 기관: 가톨릭대학교 (책임자: 김세웅 교수)
 참여 기업: (주)코아칩스 (대표: 오재근), (주)카이엠 (대표: 정운찬)

과제개요

과제 목표

세부 과제	(세부) 과제명	성명	기관명
1	• 방광압력센서와 연동된 배뇨보조장치 개발 및 • 고효율 투석장치 개발	최범규	서강대학교
2	• 최소침습 배뇨장애 치료기기 개발을 위한 • 임상적 연구	김세웅	서울 성모병원 (비뇨기과)
3	• 고효율 혈액투석 디바이스 개발을 • 위한 임상적 연구	박철휘	서울 성모병원 (신장내과)

- 개발기간: 2011.04 ~ 2016.02 (4년11월)
- 연구개발비: 총 32억 8천만원
- 참여기관: 서강대학교(주관), 가톨릭대학교, 코아칩스(주), 카이엠



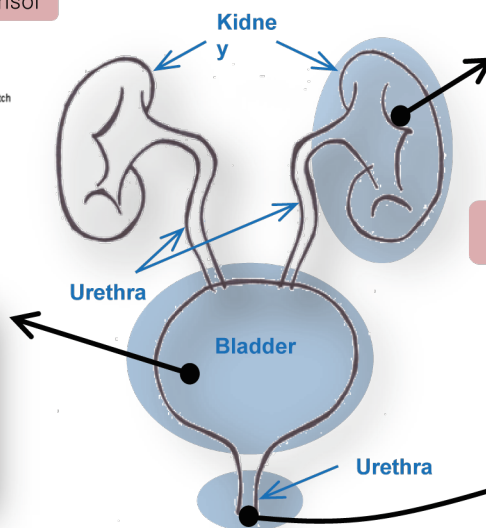
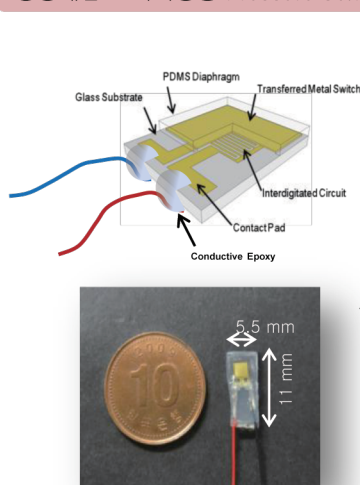
연구내용

- 인체 삽입형 방광압력센서의 무선 충전/송수신 모니터링 시스템 개발
- 요도삽입형 Micro uro-valve의 개발
- 유비쿼터스 의료 적용을 위한 센서와 Micro uro-valve의 연동시스템 기술 개발
- 혈액투석장치 개발을 위한 기초 인공 신단위(artificial nephron) 기술 개발

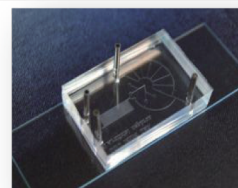
기대성과

- 배뇨 장애 치료를 위한 최소침습적(minimal invasive) 자동 배뇨관리 시스템 개발 및 임상 토대 마련
- Membrane 비 적용 인공 신장 개발의 기초 토대 마련

방광내압 모니터링용 Pressure Sensor



PDMS Artificial Nephron



Micro uro-valve system concept (with pressure monitoring system)

