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일시: 2013년 2월 14~15일 장소: 조선대학교 자연과학관 4층 대강당 주최: 한국실리콘학회 주관: 조선대학교 기초과학연구원

제2회 한국실리콘학회 총회 및 학술발표회 2013

The 2nd Annual Meeting of the Korean Silicon Society

제2회 한국실리콘학회 총회 및 학술발표회

- 일시 | 2013년 2월 14~15일(목~금)
- 장소 | 조선대학교 자연과학관 4층 대강당
- **주최** | 한국실리콘학회 (The Korean Silicon Society)
- **주관** | 조선대학교 기초과학연구원

회 고

1.2013 한국실리콘학회 연회비 및 학술발표회 참가비

회원구분	연회비	사전등록 참가비	현장등록 참가비
정회원	50,000원	40,000원	50,000원
학생회원	20,000원	20,000원	40,000원
비회원		90,000원	100,000원
비회원(학생)		40,000원	60,000원
학생회원 비회원 비회원(학생)	20,000원 	10,000원 20,000원 90,000원 40,000원	40,000원 100,000원 60,000원

온라인 납부: 한국실리콘학회 홈페이지 http://www.ksis.re.kr

2. 포스터 발표

포스터 발표시간: 2013년 2월 14일 17:15~18:00 포스터 발표장소: 자연과학관 4층 대강당 로비 발표자는 2월 14일 13:00까지 포스터 게시를 완료하여 주십시오

3. 사용기기

본 발표회에서는 구두 발표자를 위하여 빔프로젝터가 준비되어 있습니다. 발표자료를 PPT 파일로 작성하시어 USB에 저장하여 진행요원에게 제출하여 주십시오.

- 4. 제2회 한국실리콘학회 정기총회 2013년 2월 14일 12:30~13:00 조선대학교 자연과학관 4층 대강당
- 5. 제8회 한국실리콘화학산업연구조합 정기총회 2013년 2월 14일 17:15~17:45 조선대학교 자연과학관 3층 3403호



사단법인 한국실리콘학회 (The Korean Silicon Society) www.ksis.re.kr 사업자등록번호: 224-82-14917 대표자: 이명의 (melgg@yonsei.ac.kr) 220-710 강원도 원주시 흥업면 연세대길 1 연세대학교 창조관 TEL: 033-760-5230



조선대학교 조선대학교 기초과학연구원

제2회 한국실리콘학회 학술발표회 일정표

- 제2회 한국실리콘학회 정기총회: 2월 14일 12:30~13:00 대강당
- 제8회 한국실리콘화학산업연구조합 정기총회: 2월 14일 17:15~17:45 (3403호)

2013.02.	15(목) 조선대학교 자연과학관	2013.02.15	(금) 조선대학교 자연과학관
11:30~13:00	등 록	09:15~10:00	PL-3 하창식 (부산대)
13:10~13:30	개 회	10:00~10:30	IL-5 고영훈 (금호석유화학)
13:30~14:15	PL-1 김정균 (동아대)	10:30~10:45	Coffee Break
14:15~15:00	PL-2 양갑승 (전남대)	10:45~11:15	IL-6 정현담 (전남대)
15:00~15:30	IL-1 정옥상 (부산대)	11:15~11:45	IL-7 조두환 (포스코)
15:30~15:45	Coffee Break	11:45~12:15	IL-8 손홍래 (조선대)
15:45~16:15	IL-2 김우한 (삼성제일모직)	12:15~12:20	폐 회
16:15~16:45	IL-3 정연식 (KAIST)		
16:45~17:15	IL-4 조현모 (연세대)		
17:15~18:00	포스터 발표		
18:10~20:00	환영 리셉션 (솔마루 식당)		

(PL) 기조강연,(IL) 초청강연



조선대학교 자연과학관

학술발표회 일반안내

1. 오시는 길



지하철: 남광주역 하차 도보 10 분

시내버스: 순환 01, 지원 15, 진월 17, 봉선 27, 일곡 28, 운림 35, 금호 36,

금남 55, 문흥 80, 송정 98, 지원 150

- 고속버스: 광주 유스퀘어 광천터미널 하차 (버스: 공항버스 1000, 순환 01, 금호 36)
- **철도:** 광주역 (버스: 금남 55, 송정 98) 송정리역 (버스: 송정 98)

승용차 교내에 주차하시고, 학술발표회 등록대에서 할인주차권을 구입하십시오. (2,000 원/매)

2. 조선대학교 캠퍼스 안내



KSiS 학술발표회장 자연과학관 4층 대강당 교내식당 ①솔마루 교직원 식당, ②입석홀 교직원 식당, ③서석홀 식당, ④본관 지하식당

3. 발표자 공지사항

구두 발표 하시는 회원들은 반드시 빔프로젝터를 사용하여야 하며, 원활한 진행을 위하여 개인 컴퓨터의 사용은 삼가 하여 주십시오.
구두 발표자께서는 파워포인트로 작성하신 파일을 발표 전 준비시간에 진행요원에게 제출하여 주십시오. 본 학회에서는 발표자료를 종료 후 파기 할 것을 약속합니다.
포스터 발표 14 일(목) 17:15~18:00 대강당 로비
포스터 규격은 90 x 120 cm 이내로 준비하여 주십시오.
포스터 게시는 준비된 부착보드에 14 일 오후 1:00 전에 부착하여 주십시오.
발표자는 포스터 발표시간에 대기하시어 질문과 토의에 응하여 주시고 학술발표회 종료 후에 포스터를 철거해 주십시오. 제2회 한국실리콘학회 학술발표회, 2013.02.14~15, 조선대학교 자연과학관

4. 조선대학교 교내 주차안내

학술발표회 참가자는 2,000 원/회의 할인 주차요금을 적용 받습니다. 할인주차권은 학회 등록대에서 구입하여 주십시오.(현금 2,000 원/매, 영수증 발행 안됨) 정산소에서 할인주차권을 제출하고 출차하십시오.(자정을 넘길 경우 2장 필요)

5. 숙박 안내

- 무등파크호텔 약 3km (택시 ~10분/3,000원)
할인가격 부가세포함 99,000원 (Double/Twin, 조식별도)
예약 062-226-0011 (조선대학교로 예약시 할인)
일반모텔: 상무지구 추천 약 9km (택시 ~30분/7,500원, 지하철 10개역)

6. 조직위원 (학회관련 문의: 한준수)

우희권 (전남대학교, hgwoo@chonnam.ac.kr, 062-530-3378) 이규환 (한남대학교, gyuhlee@hannam.ac.kr, 042-629-8816) 손홍래 (조선대학교, hsohn@chosun.ac.kr, 062-230-7372) 한준수 (한국과학기술연구원, jshan@kist.re.kr, 02-958-5097, 010-3691-5097) 최원춘 (한국화학연구원, mrchoi@krict.re.kr, 042-860-7626) 조현모 (연세대학교, hyeonmo@yonsei.ac.kr, 033-760-5230)

7. 주최



사단법인 한국실리콘학회(The Korean Silicon Society) www.ksis.re.kr 사업자등록번호: 224-82-14917 대표자: 이명의 TEL: 033-760-5230 220-710 강원도 원주시 흥업면 연세대길 1 연세대학교 창조관

8. 주관



 조선대학교 기초과학연구원

 광주광역시 동구 서석동 375 번지 조선대학교 자연과학대학 2 층

 062-230-6626
 ricns@shosun.ac.kr

 http://ricns.chosun.ac.kr

9. 후원: 사이플러스, 다미폴리켐, 청산화학, HRS



제2회 한국실리콘학회 학술발표회 초청연사

2013년 2월 14~15일(목~금) 조선대학교 자연과학관 4층 대강당



김정균(Chungkyun Kim) 1985 Ludwig Maximilian Univ. in Munich 박사 2001 대한화학회 학술상 2002 동아대 우수교수상 2007 부산시문화상 2009 유기규소연구회 회장 1986 동아대 화학과 •Carbosilane dendrimer/π electron chemistry



양갑승(Kap Seung Yang) 1988 North Carolina State Univ. 공학박사 1991 일본 큐슈대 방문교수 2007 한국탄소학회 회장 2012 탄소문화상(기술) 1989 전남대학교 고분자섬유시스템 공학과 현재 Alan MacDiarmid 에너지연구소장,

연새 Alan MacDiarmid 에너지연구소상, 크린에너지 국제공동 연구소장



정옥상(Ok-Sang Jung) 1990 KAIST 화학과 박사 1992 Univ. of Colorado Postdoc. 1991 KIST 선임/책임 연구원 2003 부산대 화학과





하창식(Chang-Sik Ha)

 1987
 KAIST 화공과 박사

 1988
 Univ. of Cincinnati 방문연구원

 1997
 Stanford Univ. 방문연구원

 2003
 SUNY Buffalo 방문연구원

 2010
 UCLA 화학과 방문연구원

 현재
 한국접착 및 계면학회 회장, 부산대학교 부총장

고영훈(Young-hoon Ko) 1989 France UPS 화학과 박사 1991 USA USC LHI Research associate 현재 금호석유화학 중앙연구소 상무



정현담(Hyun-Dam Jung) 1996 KAIST 화학과 박사 1996 삼성전자 선임연구원 1999 Georgia Institute of Tech. Postdoc. 2000 삼성종합기술원 수석연구원 2006 전남대 화학과 •나노융합실리콘소재, 실리콘양자점



김우한(Woo Han Kim) 2007 서울대 화학과 박사 2007 Columbia Univ. Postdoc. 2010 삼성제일모직 책임연구원



조두환(Du-Hwan Jo) 1996 경북대학교 화학교육과 박사 1995 KIST 연구원 1998 포항공과대학교 Postdoc. 2000 Univ. of Minnesota Postdoc. 2001 POSCO 기술연구원 표면처리 연구그룹, 전문연구원



정연식(Yeon Sik Jung) 2009 MIT 재료공학과 박사 2001 삼성코닝 연구원 2003 KIST 연구원

2003 KIST 연구원 2009 Lawrence Berkeley National Lab. Postdoc. 2010 KAIST 신소재공학과



조현모(Hyeon Mo Cho) 2002 연세대 화학과 박사 2004 Univ. of Illinois at Urbana-Champaign Postdoc. 2006 삼성제일모직 수석연구원 2009 연세대 실리콘 신소재 센터 •Organosilicon Chemistry •Advanced Silicon Materials



손홍래(Honglae Sohn) 1997 Univ. of Wisconsin-Madison 박사 1998 UC-San Diego Res. Associate 2003 Pico Tech 창업 2003 조선대학교 화학과 •Porous Silicon and Nanoparticles •실리콘 나노센서 소재



2월 14일(목) 학술발표회 프로그램

2013년 2월 14일(목) 조선대학교 자연과학관 4층 대강당

- 11:30~13:00 등록
- 12:30~13:00 제2회 한국실리콘학회 정기총회
- 13:10~13:30 개회

사회: 손홍래 (조선대학교)

초청강연-1	2	좌장: 우 희권	(전남대학교)
13:30~14:15	PL-1 김정균 교수 (동아대 화학과) Big Is Beautiful: Carbosilane Dendrimers Its Preparation and Usability		13
14:15~15:00	PL-2 양갑승 교수 (전남대 고분자·섬유시스템공학과) Supercapacitive Properties of Porous Carbon Nanofibers Containing Si-Si/Si-O Bond via Electrospinning		15
15:00~15:30	IL-1 정옥상 교수 (부산대 화학과) Right-handed-, Left-handed-, and Racemic Helical Coordination Polym Metal Complexes Containing Bis(pyridyl)silane Ligands	ners of	16

15:30~15:45 **COFFEE BREAK**

초청강연-2	좌장: 정현담 (전남대학	·교)
15:45~16:15	IL-2 김우한 박사 (삼성제일모직) Development of the Futuristic Silicone Encapsulant for LED	17
16:15~16:45	IL-3 정연식 교수 (KAIST 신소재공학과) Tunable and Rapid Assembly of Siloxane Block Copolymers for Sub-10 nm Lithography	19
16:45~17:15	IL-4 조현모 교수 (연세대 실리콘 신소재 센터) Silicon-Based Materials for Spin-On Hardmask Process	21

- 17:15~17:45 제8회 한국실리콘화학산업연구조합 정기총회 (자연과학관 3403호)
- 17:15~18:00 **포스터 발표**

18:10~20:00 환영 리셉션 (조선대 솔마루 식당) 시

사회: 손홍래 (조선대학교)

2월 14일(목) 학술발표회 포스터 발표

2013년 2월 14일(목) 17:15~18:00 조선대학교 자연과학관 4층 대강당 로비

[P-01]	Thermal Hydrosilylation of Cyclic Alkadiene with Trichlorosilane <u>정동의</u> , 한준수, 유복렬* (한국과학기술연구원)	29
[P-02]	Thermal Si-C Coupling Reaction of Allyl Chloride with Trichlorosilane and Their Mechanistic Aspects <u>정영애</u> , 한준수, 강윤경,* 유복렬* (한국과학기술연구원, 상명대학교)	30
[P-03]	Synthesis and Characterization of Silicone Resin Precursors and Intermediates <u>박은경</u> , 한준수, 강윤경, 유복렬* (한국과학기술연구원, 상명대학교)	32
[P-04]	New Alkoxycyclosilane Precursors for Polysiloxane-polysilicon Hybrid Materials <u>박성진</u> , 조현모, 이명의* (연세대학교)	33
[P-05]	Supercapacitive Properties of Porous Carbon Nanofibers via the Electorspinning of Metal Alkoxide-Graphene in Polyacrylonitrile <u>김소연</u> , 김보혜,* 양갑승,* 우희권 (전남대학교)	34
[P-06]	고내열성 방열용 실리콘 컴파운드 개발 <u>정희재</u> , 김선택, 이병철, 허준 (한국세라믹기술원, ㈜엘투와이)	36
[P-07]	Reactions of Bromosilylenoid with CN Multiply Bonded Compounds <u>박서연</u> , 조현모, 이명의* (연세대학교)	37
[P-08]	Newly Synthesized Silicon Quantum Dot-Polystyrene Nanocomposite Having Thermally Robust Positive Charge Trapping <u>Mai Xuan Dung</u> , 최진규, 정현담* (전남대)	38
[P-09]	Tuning Optical Properties of Silicon Quantum Dots by π-Conjugated Capping Molecules <u>Mai Xuan Dung</u> , Dao Duy Tung, 정소희, 정현담* (전남대)	39
[P-10]	InP Quantum Dot – Organosilicon Nanocomposites <u>Mai Xuan Dung</u> , Priyaranjan Mohapatra, 최진규, 김진혁, 정소희, 정현담* (전남대)	40

[P-11]	A Study on Electronic Structure of Silicon Quantum Dots using Cyclic Voltammetry	41
	<u>Thu-Huong</u> , 정현담* (전남대)	
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2월 15일(금) 학술발표회 프로그램

2013년 2월 15일(금) 조선대학교 자연과학관 4층 대강당

초청강연-3		좌장: 유복렬 (KIST)
09:15~10:00	PL-3 하창식 교수 (부산대 고분자공학과) Mesostructured Polysilsesquioxane Hollow Spheres	22
10:00~10:30	IL-5 고영훈 박사 (금호석유화학 중앙연구소)	23
	실리콘 화합물의 친환경 타이어 트레드 소재로의 응용	

10:30~10:45 **COFFEE BREAK**

초청강연-4	좌장: 이규환 (한남대학교)
10:45~11:15	IL-6 정현담 교수 (전남대 화학과) 전하 저장 및 수송 제어를 위한 실리콘 나노 융합 재료 분야의 개척	24
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제2회 한국실리콘학회 학술발표회, 2013.02.14~15, 조선대학교 자연과학관

ABSTRACTS

Big Is Beautiful: Carbosilane Dendrimers Its Preparation and Usability

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This is a report on novel carbosilane dendrimers containing branches with Si-C and Si-O-C bonds. Introduction of organic moieties into the dendrimers is performed by hydrosilation of carbon-carbon double/triple bonds. Versatile organic or organometallic moieties are introduced onto the peripheral regions of dendrimers by coupling and complexation reactions, which clearly demonstrates their potential for variation. Dendrimers of unique architecture containing a single kind of multi-functionality have been of increasing interest during the last three decades. Their shapes, sizes, and structures are defined by their preparation and characterization.

Dendrimer purifications are performed by traditional analytical methods such as column chromatography and recrystallization, but they are identified and characterized using newly developed technologies such as AFM (atomic force microscopy), STM (scanning tunneling microscopy) and PL (photoluminescence) etc. Lately, the structures of various dendrimers have been accurately confirmed as having only one class of groups on their peripheries.

The synthesis and characterization of dendrimers with no defects is not easy, especially in the cases of the higher generation ones. The first organic dendrimers were prepared by Vögtle in 1973, which was a macromolecule with a distinct number of functional groups. Since then many diverse dendritic molecules with versatile functional groups on their branches and/or peripheries have been prepared. The first organosilicon dendrimer was prepared by Made (1992) it has been converted into its higher generation versions by using hydrosilation of allylic groups emanating from the central silicon Diverse atom.



dendrimers having silicon-silicon (Si-Si), silicon-carbon (Si-C) and carbon-carbon triple bonds on silicon (Si-C=C-) and siloxane bonds (Si-O), which are versatile products for state of the art material science, have been synthesized. Si-C moieties have been added to the inner skeletons of organosilicon dendrimers as well as their peripheries. Siloxane dendrimers with Si-O moieties were prepared before carbosilane dendrimers with Si-C moieties, although their structures were not confirmed correctly at that time. The Si-O-C skeletons are introduced into siloxane dendritic macromolecules using hydrosilation and alcoholysis, as summarized in various reviews. In this review, carbosilane

dendrimers having ethynyl groups on silicon atoms (Si-C≡C-R moiety) and carbosiloxane dendrimers prepared from cyclic siloxane tetramers as core moieties (Si-O-C moiety) are introduced.

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Supercapacitive Properties of Porous Carbon Nanofibers Containing Si-C/Si-O Bond via Electrospinning

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Supercapacitors have been intensively investigated as primary and/or backup energy storage systems because they can sustain high power levels with long life cycles. Various forms and textures of porous carbons have been examined as possible electrode materials for supercapacitors due to their stable physical and chemical properties, large specific surface area, controlled pore structure, and high conductivity. Electrospinning is a feasible technology for producing composite nanofibers containing function ingredients. In recent studies, electrically conducting carbon nanofiber (CNF) mats were produced by incorporating tetraethoxy orthosilicate (TEOS) and phenylsilane into polyacrylonitrile (PAN) via electrospinning [1-4]. A simple thermal treatment was applied to the electrospun nanofibers to create ultra-micropores with Si-O and Si-C functional groups on the surface that could accommodate a large number of ions of electrolyte, removing the need for a time-consuming activation step. The polar group Si–O–C introduction was made into the carbon nanofibers, and the resulting carbon nanofiber composite (CNFC) electrodes were evaluated as an electrochemical capacitor showing energy densities of 2 and 3 times higher than pristine carbon nano-fiber CNF.

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Right-handed-, Left-handed-, and Racemic Helical Coordination Polymer of Metal Complexes Containing Bis(pyridyl)silane Ligands

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Construction and functionalities of desirable helical structures are important issues in supramolecular materials science owing to potential applications in the fields of asymmetric catalysis, chiral chemistry, nonlinear optical materials, templating precursors, memory devices, biomimetics, DNA, structural biology, specific ion sensors, and molecular reaction vessels.¹⁻⁴ The control of helicity, (that is, of right- (P) and left-handed (M) helices), and of helical pitch is an intriguing challenge for chemists.⁵⁻⁷ The helicity can be intentionally constructed by conformation restrictions of the coordination to metal ions. The infinite square-tubular helices, [CuCl₂(L)(S)] (L = bis(4-pyridyl)methylvinylsilane; S = Me₂SO, HCONMe₂), were constructed via the combined effects of the skewed conformer of L and the angular geometry of the Cu(II) ion. This helical system affords unusual formations of three kinds of P, M crystals in Me₂SO, and racemic crystals in HCONMe₂, in which PFM phase images of racemic crystal and P crystal in out-of-plane and in-plane modes are a significant tool for characterization of their helicity. The cyclic voltammogram (CV) technique using the electrode consisting of *M*-crystals is an effective tool for discerning the chirality of proline.



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Development of the Futuristic Silicone Encapsulant for LED

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Optically transparent polymers have been researched in various applications such as the fabrication of microlenses, optical coatings, and the encapsulation for optoelectronic devices [1]. With the increasing demands for high performance in these applications, a high refractive index and high realiability are important for the optical efficiency and lifetime of the devices [2]. These reliabilities require stable transparency and resistance to external chemical aggression or thermal decomposition for high power devices which need high current and thus high thermal load are involved in [3]. Encapsulation materials for optoelectronic devices such as light emitting diodes (LEDs) are especially sensitive to thermal stability and moisture / gas permeability, because moisture / gas permeation through encapsulation material causes the corrosion of metal lead frame and reflector. Thermal decomposition decreases transparency and reduces the light extraction efficiency from these devices. For example, device reliability and lifetime in high-brightness LEDs can be limited by the capability of the encapsulation materials [4]. Also, a high refractive index in the encapsulation material is required for high efficiency light extraction from an LED, significantly improving its illumination performance. Thus, the key factors of LED encapsulation materials are excellent transparency, high refractive index, and high resistance to heat, moisture, gas, and chemical reactions.

Thermal stability at high temperature and high resistance in moisture / gas permeation are the most desirable combination for use in high power LED encapsulation and would bring the long lifetime and high efficiency of device performance. We confirmed that Cheil's polysiloxane has a sufficient hardness to protect the LED from thermal stress during operation and from external forces. Also, these polysiloxanes has high resistance of oxygen and moisture permeation comparing with commercial polysiloxanes. These properties are the most important advantages for use as LED encapsulation.





Figure 1. Reliability test for Cheil's polysiloxane.

Figure 2. Sulfur corrosion test for Cheil's polysiloxane.

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Tunable and Rapid Assembly of Siloxane Block Copolymers for Sub-10 nm Lithography

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Directed self-assembly (DSA) of block copolymers (BCPs) can generate uniform and periodic patterns within guiding templates, and has been one of the promising nanofabrication methodologies for resolving the resolution limit of optical lithography. BCP self-assembly processing is scalable and of low cost, and is well-suited for integration with existing semiconductor manufacturing techniques. The self-assembly of a BCP, where two mutually incompatible polymer chains are connected via covalent bonding, can create sub-10 nm periodic patterns with different geometries such as dots, lines, holes, and rings, while even more complex features such as bends, T-junctions, and jogs have already been demonstrated. Based on these promising results, our research efforts have focused on resolving remaining challenges for DSA such as control over defects, resolution, and throughput for next-generation lithography with sub-10 nm resolution.

This talk will introduce recent research results on the self-assembly of siloxane block copolymers for the achievement of sub-10 nm resolution, fast pattern generation, transfer-printing capability onto nonplanar substrates, and device applications for nonvolatile memories.¹⁻² An extraordinarily facile nanofabrication approach that enables sub-10 nm resolutions through the synergic combination of nanotransfer printing (nTP) and DSA of block copolymers is also introduced.³ This simple printing method can be applied on oxides, metals, polymers, and non-planar substrates without pretreatments.

We recently reported sub-10 nm scale nanofabrication using poly(styrene-b-dimethylsiloxane) (PS-PDMS) and a poly(2-vinylpyridine-b-dimethylsiloxane) (P2VP-PDMS) BCP with an extremely large χ parameter. A significantly higher degree of tunability of pattern geometry and dimensions can be achieved using P2VP-PDMS BCPs.² We also reported morphological transitions between spheres, cylinders, hexagonally perforated lamellae (HPL) and lamellae, which were induced by choosing different solvent vapors affecting the degree of swelling of the film. The polymer system can achieve a wide variation range in the line width of in-plane cylinders from 6 nm to 31 nm, a change of 417%. This provides a convenient method for obtaining a variety of morphologies from a single block copolymer film.

The oxide nanostructures can practically serve as the active material as well as the localized insulators that can modulate the operation of nonvolatile memories. This talk will report the direct formation of ordered resistive memory nanostructures on metal and graphene electrodes by the self-assembly of Sicontaining BCPs. We found that both silicon oxide memristors of thin films (derived from a lamella-forming BCP) and nanodots (made from a sphere-forming BCP) present unipolar switching behaviors, and especially for the nanodots, the switching current was very low.⁵ This method offers a practical pathway to fabricate high-density resistive memory devices without using high-cost lithography and pattern-transfer processes. Additionally, we will present a novel approach that can relieve the power consumption issue of phase-change memories by incorporating a thin SiO_x layer formed by BCP self-assembly, which locally blocks the contact between a heater electrode and a phase-change material,

effectively reducing the phase-change volume.⁶ The writing current decreases by 5 times (corresponding to a power reduction of 1/20) as the occupying area fraction of SiO_x nanostructures varies. Finally, various functional nanostructures (e.g. graphene nanostructures) that can be prepared using the self-assembled nanostructures as a practical template will be introduced.⁷



Figure 1. Examples of self-assembled morphologies. (Top-Left) 8-nm-wide BCP patterns treated by solvo-thermal treatment at 85°C for 1 min. (Top-right) Uniform hierarchical morphology of blended BCPs. (Bottom) Sequentially transfer-printed BCP patterns using elastomeric molds.

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Silicon-Based Materials for Spin-On Hardmask Process

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In the recent semiconductor manufacturing, as linewidths decrease, *thinner* photoresists (PRs) are adopted to prevent collapse of patterned PR caused by high aspect ratios. But, the thin photoresists could not fully provide deeper etched patterns on substrates in ArF (193 nm) lithography process. To solve this problem trilayer schemes have been designed (Figure 1). The trilayer stack consists of a PR, an oxygen plasma-resistant hardmask (usually Si-HM) which serves as a mask when patterns of Si-HM is transfer to a C-HM, and a halogen plasma-resistant HM (usually C-HM) which serves as a mask when patterns of C-HM is transfer to substrates. The etch rate of silicon-containing material is low for oxygen plasma and is high for halogen plasma, while the etch rate of organic material is low for halogen one and is high for oxygen one. Such etch selectivities of organic and inorganic materials enable to make deep etched pattern.



Figure 1. Etch process using hardmask (trilayer scheme).

Since Si-HM is under-layer of PR in trilayer scheme, Si-HM should absorb 193 nm light for antireflecting at ArF exposure step to make well-established PR pattern. Thus, deep UV (193 nm) absorption as well as oxygen plasma-resistance is required for Si-HM materials. Even though a high silicon or a silica content in Si-HM is necessary to achieve high oxygen plasma-resistance, aryl groups (usually phenyl groups) have been incorporated into Si-HM materials to meet optical property, resulting the increase of an organic content to make oxygen plasma-resistance lower. To resolve this issue, we have investigated to get optimized Si-HM materials which increase a silicon or a silica content of Si-HM along with proper optical property at 193 nm. In this presentation, those results will be presented in detail.

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Mesostructured Polysilsesquioxane Hollow Spheres

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Hollow micro/nanostructured materials have attracted increasing interest for their potential applications as nanoparticle collectors, efficient catalysts, and drug-delivery carriers because of their empty interior. However, very few studies have examined organic-inorganic hybrid materials with hollow structures. Recently, we have been interested in functional hollow polysilsesquioxane (PSO) particles with a general formula of $[RSiO1.5]_n$, where R is an organic group. This type of organicinorganic molecular-level hybrid polymers has many unique properties, which traditional composite materials do not exhibit. In this work, a series of organofunctional PSQ hollow spheres were prepared by an environment-friendly method. The use of this simple and reproducible synthetic approach resulted in highly uniform and monodisperse hollow spheres with high coverage of functional groups, namely, fluoroalkyl, phenyl, vinyl and methyl groups. By adjusting the precursor concentration, the particle size and shell thickness could be precisely controlled. The structure and functionality of these hollow spheres were characterized by field-emission scanning electron microscopy, transmission electron microscopy, Fourier transform infrared spectroscopy, solid-state NMR spectroscopy, X-ray diffraction and nitrogen adsorption-desorption studies. An example of the drug release was demonstrated using fluorinated PSQ (FPSQ) hollow spheres as the drug carrier. The in vitro drug release studies demonstrated that a steady release process was obtained for the fluorinated drug using this carrier. In addition, other functional PSQ materials were used as adsorbents to treat the benzophenone-containing wastewater, and it was found that the hydrophobic contamination could be effectively removed.

Application of Silicon Materials on the Environmentally Benign Tread Rubber for Silica Tire

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Global warming and relating environmental issues that may be caused by the green house gases, such as CO2 from combustion of fossil fuels, urge researchers to develop innovative materials to reduce the emission of CO2 gas. For these reasons, some direct regulations issued lately in the tire industry such as the EU Tire Labeling and CAFÉ rule in USA. These regulations are focused on fuel efficiency, wear resistance and noise reduction of the passenger car tire. The conventional elastomeric materials are experiencing some technical barriers for these new regulations and thus, to fulfill these requirements some innovative ideas should be introduced. The presentation is dealing with the recent technical progress in synthetic rubber materials such as SSBR and wet master batch elastomeric nano-composite.

전하 저장 및 수송 제어를 위한 실리콘 나노 융합 재료 분야의 개척

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실리콘 나소 소재는 플렉셔블 전자, 고성능 반도체, 차세대 에너지 등의 차세대 성장 동력 산업에서 중요한 위치를 차지하고 있어 그 수요가 지속적으로 증가하고 있는 추세이다. 특히 그 원재료인 실리콘 원소는 지구상에 풍부하게 존재하고 친환경적이며 기존의 실리콘 기반 공정 기술을 활용할 수 있고 합성화학을 통하여 다양한 형태의 합성이 가능하여 새로운 기능의 신소재를 창출할 수 있는 장점이 있다. 실리콘 나노 소재의 응용을 가시화하기 위해서는 그 소재 설계 개념이 물리화학 관점에서 확립되고 전자 및 이온의 수송 및 저장의 제어가 가능한 소재 개발이 필요하다. 특히, 플렉서블, 저비용, 대면적의 차세대 전자 소자에 응용이 가능한 구동 소자용 실리콘 나노 소재와 정보 저장용 실리콘 나노 소재가 개발될 경우 국내 IT 산업의 경쟁력 강화 및 실리콘 관련 소재 산업의 획기적 발전이 가능하다. 실리콘 양자점 표면에 기능기를 도입하고 이를 유기계 고분자나 유기-무기 하이브리드 고분자에 분자 수준에서 분산시켜 실리콘 양자점-고분자 나노 복합체를 형성하면 이를 비활성 메모리의 전하 저장 소재로 응용할 수 있다.¹⁻⁷ 이러한 신개넘 분자-실리콘 하리브리드 나노 소재 기술에 분자 전자적 계산,⁸ 물리화학적 특성 평가 방법론을 ^{24,5,9,10} 융합하여 전하 저장 및 수송의 제어가 가능한 나노 융합 재료 분야를 개척하고자 한다.



Figure 1. Silicon quantum dot nanocomposites concept to control charge transport and trapping.

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Functional Coating Technology Containing Organosilane Compound in POSCO

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Both electrogalvanized and hot-dip galvanized steel sheets have been finally produced *via* organicinorganic coating process on the zinc surface to enhance protective corrosion resistance and afford additional functional properties. Recently, POSCO has been developed a variety of chromate-free functional hybrid coated steels that are widely used in household, construction and automotive applications.

During last several years, the functional hybrid coated steels were developed by coating of composite solution on the steel surface *via* roll coating, curing and cooling processes in order. The composite solution comprise of water-bone and solvent-bone type, and those generally consist of polymer resin as a binder, hardener for crosslinking, anti-corrosive pigment such as mironized silica, coupling agent such as organosilnae compound and miscellaneous additives. Especially organosilane compound provides sol-gel hybrid coating that exhibit excellent thermal and abrasive properties as a thin film as well as interesting functionality.

In this presentation, we will describe both new type of hybrid coating as chromate alternatives using organosilane compound and sol-gel hybrid coating with low temperature curable layer. Also, we will present some insights about sol-gel organosilane chemistry to develop new kind of functional coating in industry.



Figure 1. Sol-gel hybrid coated steel sheet produced by roll coating process

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Synthesis and Characterization of Silicon Quantum Dots and Nanoparticles and Their Applications

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Synthesis and characterization of silicon quantum dots, nanoparticles, and nanowires have been developed using solution and chemical etching methods, respectively. Various reaction conditions, such as quantity of reducing agent and reaction time were investigated with the aim of finding a simple, optimized synthetic route. The luminescent silicon quantum dots (SiQDs) and nanoparticles (SiNPs) were synthesized from the reaction of ammonium chloride and magnesium silicide via a low temperature solution route. Optical characterizations of SiQDs and SiNPs were achieved by using ultraviolet-visible (UV-Vis), fourier transform infrared (FTIR), and photoluminescence (PL) spectroscopy. The morphology of SiQDs and SiNPs were characterized by using X-ray diffraction (XRD), high-resolution transmission electron microscopy (HR-TEM), and energy dispersive x-ray (EDX) spectroscopy. The life-time of Si QDs was recorded with PicoQuant Microtime-200 with 375 nm laser (1 W) and 450 nm band-pass filter with 40 nm band width. For the synthesis of SiQDs, silicon nanoparticles grew and their emission wavelength shifted to the longer wavelength as the reaction time longer. The monotonic shift of the photoluminescence as a function of excitation wavelength resulted in the excitation of different sizes of nanocrystals that had different optical transition energies. For the synthesis of SiNPs, the size and shape of SiNPs were varied depending on the reaction conditions. The shape of SiNPs was tetrahedral and rectangle and the range of average size of SiNPs was a couple of decade nanometers to few hundred nanometers.



Figure 1. TEM image and PL Spectrum of Si QDs and NPs

Single-crystalline silicon nanowires (SiNWs) were fabricated by using an electroless metal assisted etching of p-type silicon. The free-standing SiNWs were then obtained using ultra-sono method in

toluene after simple chemical etching of silicon wafers in an aqueous HF solution containing silver nitrate at room temperature. SEM observation shows that well-aligned nanowire arrays perpendicular to the surface of the Si substrate were produced. Optical characteristics of SiNWs were measured by FT-IR spectroscopy and indicated that the surface of SiNWs are terminated with hydrogen. The main structures of SiNWs are wires and rodsand their thicknesses of rods and wire are typically 150–250 and 10–20 nm, respectively.



SiQDs and SiNPs were used for the drug delivery and chemical and bio sensing applications. The release of CPT was measured by UV-vis spectrometer. The intensity of fluorescence of the silicon nanoparticles was measured with a drug release. A new biosensor for the detection of avidin and streptavidin based on biotin-functionalized silicon nanoparticles (BFSi-NPs) with a strong blue emission band has been developed. Quenching of the PL of BFSi-NPs was exploited in the biomolecule-binding studies. Detection limits for detection of streptavidin and avidin based on BFSi-NPs were 20 pM, respectively. For the possible application of SiNWs, Free-standing SiNWs were then obtained using ultra-sono method in toluene. Graphene oxide was prepared by the modified Hummers' process. Activated microwave-exfoliated graphite oxide (MEGO) was prepared and used for the composite materials of silicon nanowires and grapheme oxide via hydrosilylation. The silicon nanowire-graphene composite materials were characterized by EDS, TEM, and FE-SEM. Detailed discussion will be presented.

Thermal Hydrosilylation of Cyclic Alkadiene with Trichlorosilane

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The thermal hydrosilylations¹⁻³ of trichlorosilane (1a) with cyclic alkadienes such as cyclopentadiene (2a), 1,3-cyclohexadiene (2b), and 1,4-cyclohexadiene (2c) were studied at temperatures ranging from 170 °C to 250 °C. In this reaction, the hydrosilylation rate increased as the reaction temperature was raised using an equimolar ratio of 1a to 2a. The reaction of 2a with 1a at 250 °C afforded 2cyclopentenyltrichlorosilane (3a) as the major hydrosilylation product within 1 h in good yield (82%). This reaction also works when dicyclopentadiene (2a') was used as a reactant instead of 2a. In a large scale preparation under the same conditions, **3a** was obtained in 82% isolated yield. It is significant to note that 2a' can be used for the hydrosilylation, with no requirement of a cracking step under our thermal conditions. While the reaction of cyclohexadienes with **1a** under the same conditions gave a mixture of three hydrosilylation products such as 2-cyclohexenyltrichlorosilane (3b), 3- $\frac{1}{2}$ cyclohexenvltrichlorosilane (3c) and cyclohexyltrichlorosilane (5) in moderate yields, along with other unsaturated C6 components, such as benzene and cyclohexene. In the thermal reaction of cycloalkadienes with 1a, the five-membered-ring diene 2a undergoes both a hydrosilylation reaction with 1a as well as a [4+2] cycloaddition reaction, leading to the hydrosilylation product 3a in good yield. While the six-membered ring dienes, 2b and 2c, undergo four different types of reactions, including hydrosilylation, [4+2] cycloaddition, dehydrogenation, and hydrogenation in competition to give the hydrosilylation products, hexane, and benzene, respectively. The reaction rates of cyclic alkadienes under our thermal conditions increase in the following order: $2c \le 2b \le 2a$.



Figure 1. Hydrosilylation of cyclic alkadiene with trichlorosilane

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Thermal Si-C Coupling Reaction of Allyl Chloride with Trichlorosilane and Their Mechanistic Aspects

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알릴실란유도체는 실리콘 산업에서 유용한 출발물질이다.¹ 알릴실란유도체는 수소규소화 반응과 Si-C 결합 형성 반응을 통해 생성된다. 비록 유기규소 화합물의 합성에 대한 Si-C 결합형성반응이 기초적이고 간단할 지라도 우리가 알고 있듯이 촉매 없이 유기규소 분자 를 만드는 열을 이용한 수소규소화 반응은 드물다.² Ru(II) complex, Platinum(0)등과 같은 촉매를 사용한 불포화 화합물들의 수소규소화 반응은 이미 계산을 통해 메커니즘이 밝혀 져 있지만³⁻⁵ 열을 이용한 반응의 메커니즘은 아직 연구가 이루어지지 않았기 때문에 알 릴 화합물의 Si-C 결합 형성 반응에 대하여 연구를 진행하였다.

Allyl chloride(1)와 trichlorosilane(2)의 150-250도 범위에서 열 반응에 의한 Si-C 결합 형성 반응은 수소규소화 반응과 탈염화수소 반응으로 Si-C 결합이 형성된 다양한 화합물이 얻 어졌다. 특히, 수소규소화 반응의 생성물인 3-chloropropyltrichlorosilane(3)과 탈염화수소 반응의 생성물인 allyltrichlorosilane(4)이 주로 얻어졌다. 이 두 물질 이외에도 1,3bis(trichlorosilyl)propane(5)이 얻어졌다. 이 화합물은 4의 수소규소화 반응을 통해 생성되 었다. 위 두 종류의 반응은 서로 경쟁적으로 반응이 일어나며 온도가 낮을 때에는 3이 주로 생성되며 온도가 높을 때에는 4가 주로 생성되었고 연속적인 수소규소화 반응을 통 해서 5가 생성되었다. 화합물들은 GC, GC/MSD, ¹H NMR, ¹³C NMR, DEPT-135 NMR, ²⁹Si NMR, FT-IR 를 사용하여 분석하였다. 이 열 반응은 앞에 언급된 두 반응이 경쟁적으로 일어나서 비교적 복잡한 생성물이 얻어졌다.

반응 메커니즘을 규명하기 위해서 Gaussian 프로그램을 이용하여 불안정한 중간체의 에 너지를 계산하였다. 2의 Si-H 결합이 이온 혹은 라디칼 중간체로 분해되어 반응에 참여 할 것이라고 예상하여 298.2K 에서 2의 해리 에너지를 계산해 보았다. 이온으로 해리 될 때 필요한 Gibbs 자유 에너지는 273.77kcal/mol 이고 라디칼로 해리 될 때 필요한 Gibbs 자유 에너지는 143.21kcal/mol 이다. 라디칼과 이온으로 분해되는데 드는 에너지는 100kcal/mol 이상으로 너무 높아서 반응 조건에서는 일어나기 힘들다는 결론을 내렸다. 그리고 3을 생성하는 반응에서 전이 상태의 Gibbs 자유 에너지는 64.28kcal/mol 이었고 생 성된 3의 Gibbs 자유 에너지는 -18.87kcal/mol 이었다. 4를 생성하는 반응에서 전이 상태 의 Gibbs 자유 에너지는 59.75kcal/mol 이었고 생성된 4의 Gibbs 자유 에너지는 -13.73kcal/mol 이었다. 3과 4를 생성하는 전이 상태의 Gibbs 자유 에너지는 50-60kcal/mol 로 상당히 높다. 그러므로 200℃ 이상의 높은 열을 주어야 반응이 일어날 수 있는 것을 확인하였다. 본 계산으로부터 Gibbs 자유 에너지가 상대적으로 더 낮은 **3**이 더 안정하다 는 것을 확인하였다. 결론적으로 본 열 반응에서는 탈염화수소 반응보다 수소규소화 반 응이 더 잘 일어난다는 것을 계산을 통해 확인하였다.



Figure 1. 1과 2의 열 반응의 Gibbs 자유 에너지에 의한 반응 경로

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Synthesis and Characterization of Silicone Resin Precursors and Intermediates

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This presentation relates the synthesis and characterization of cyclopentylsilanepolyol derivatives such as cyclopentylsilanetriol (1), 1,3-bis(cyclopentyl)-1,1,3,3-disiloxanetetraol (2), and silicone resin. Cyclopentylsilanepolyol derivatives having cyclopentyl and more than two silanol groups were synthesized by hydrolysis of cyclopentyltrimethoxysilane (3)¹ in the presence of acid catalyst, and characterized by ¹H, ¹³C NMR data. 1 and 2 were synthesized in 71% and 64% yields by hydrolysis of 3 under acidic conditions, respectively.

Cyclopentylsilanepolyol was reacted with R_3SiCl (R = Me, Vi) to give completely silylated cyclopentylsiloxane derivatives as colorless and stable liquids. 1 and 2 were reacted with R_3SiCl (R = Me, Vi) and triethylamine which acts as a base catalyst, respectively. The use of a catalyst was able to shorten the reaction time and to get a better yield. In order to separate the unreacted silanol compounds, the completely silylated compounds were separated through a column chromatography with a hexane eluent.

1,3,5,7-Tetrahydroxy-1,3,5,7-tetracyclopentylcyclotetrasiloxane (4), a precursor of silsesquioxane, was synthesized in 39% yield by hydrolysis of cyclopentyltrichlorosilane (5), and analyzed by ¹H NMR. As the reaction proceeding, the number of Si–OH peaks was increased. **5** was obtained as a mixture of isomers which was confirmed by multiple silanol peaks in ¹H NMR.²⁻³

To prevent the rapid molecular weight growing, silicone resins $[(C_5H_9SiO_{3/2})_x(RMe_2SiO_{1/2})_y, /R = Me$, Ph, Vi] were synthesized by the hydrolysis and co-condensation of **5** with monochlorosilanes, thus we could obtained organic solvent soluble silicone resins. By increasing the molar ratio of the monochlorosilane to **5**, viscosity was decreased, however, there was little change in the molecular weight. For addition curable functionality, vinyl terminated silicone resin was prepared with vinlydimethylchlorosilane. Due to the high refractive index of the phenyl group itself, high-refractiveindex resin (1.4885) was obtained by reacting with phenyldimethylchlorosilane. The average molecular weights of the synthesized resins were in the range of M_n 600~700 by GPC.

Cyclopentylsilanepolyol derivatives and silicone resins applicable in silicone industry were prepared and their properties will be discussed in detail.

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New Alkoxycyclosilane Precursors for Polysiloxane-polysilicon Hybrid Materials

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Cyclosilane is a silicon analogue of hydrocarbon ring compound. In contrast with cyclohydrocarbon compounds, general properties of cyclosilanes are similar with aromatic compounds, which come from delocalization of σ (Si-Si) electron.¹ These compounds are attracting attention in application fields such as electronic materials.² The cyclosilanes have been generally prepared by reductive coupling reactions of diorganodihalosilanes (R₂SiCl₂). The synthetic yields of cyclic silanes depend on the choice of reducing metals and substituent groups of diorganohalosilanes.³ We synthesized four, five and six membered ring silanes from the reactions of dichlorodiorganosilanes with reducing metals (Li and Mg) and then halogenated cyclosilanes were obtained by dephenylative chlorination. And nucleophilic substitution reactions of halogenated cyclosilanes with alcohols gave alkoxycyclosilanes (Figure 1) which can be used as new precursors for polysiloxane-polysilicon hybrid materials.



Figure 1. New Alkoxycyclosilanes

Using the new alkoxycyclosilanes with trimethoxymethylsilane, hybrids of polysiloxane and cyclosilane were prepared via hydrolysis and condensation. The materials which were soluble in organic solvent showed a high silicon content and optical property of deep UV absorption (193 nm). Thin films prepared with them via spin-coating and baking of the hybrids can be applied to etch selective process in semiconductor manufacturing since high silicon content materials show a high oxygen plasma resistance and a low CF_x plasma resistance. And the deep UV absorption of thin films is key property to avoid unwanted reflections during patterning photoresists in ArF lithography process. We successfully prepared hybrid films and investigated their optical properties at 193 nm and etch selectivity toward O_2 and CF_x plasmas. In this presentation, syntheses of cyclosilanes and its prospect of application will be presented in detail.

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Supercapacitive Properties of Porous Carbon Nanofibers via the Electorspinning of Metal Alkoxide-Graphene in Polyacrylonitrile

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1. Introduction

Supercapacitors have been intensively investigated as primary and/or backup energy storage systems because they can sustain high power levels with long life cycles.¹⁻² Researchers have explored graphene-based composite materials to improve the capacitance performance, due to superior electrical conductivities of graphene.³ Electrospinning is a unique method capable of producing nanoscale fibers from both synthetic as well as natural polymers for numerous applications.⁴ In this work, the highly spinnable polyacrylonitrile (PAN), graphene, and tetraethyl orthosilicate (TEOS) as pore generator were combined to prepare electrospun fiber webs. The resulting Si–O–C based carbon nanofiber composites (CNFCs) were evaluated for electrode performances of a supercapacitor on the basis of pore characteristics and unique microstructural features.

2. Experimental

Solution for electrospinning were prepared by dispersing the appropriate amount of graphene (3 and 5 wt% relative to PAN and TEOS) in TEOS/PAN with weight ratio of 1/9 in dimethylformamide (DMF). This solution was fed into a positively charged spinneret attached to an electrospinning apparatus. The electrospun fiber web was stabilized in air and then carbonized in N_2 atmosphere at 800 °C. The samples were identified as TGP-3 and TGP-5, indicating concentrations of 3 and 5 wt% graphene. For the pristine samples, TG, GP-3 and CNF, without either graphene or TEOS, were prepared.

3. Results and discussion

SEM images obtained at low and high magnification of the various CNFC webs are presented in Fig. 1. All of the samples exhibited long and continuous cylindrical morphologies with 100~300 nm of average diameter.



Figure 1. FE-SEM images showing (a) GP-3, (b) TP, (c) TGP-3, and (d) TGP-5

Nitrogen adsorption–desorption isotherms and the corresponding pore size distribution curves by the DFT method of the samples are shown in Fig. 2. The adsorption isotherms of TGP-3 and CNF show typical type I behavior indicating high microporosity. According to the pore size distributions, 60~80%



of the micropores in TGP-3 were ultramicropores with diameters less than 0.6 nm.

Figure 2. (a) N₂ adsorption-desorption isotherms and (b) pore size distributions determined of TGP-3 and CNF.

The porous CNFC electrodes were cut into rectangles and were attached to nickel foam to evaluate the capacitance of the material in a two-electrode system and 6 M KOH(aq) electrolyte. Cyclic voltammograms (CVs) obtained at a scan rate of 25 mVs⁻¹ are presented in Fig. 3(a). The TGP-3 electrode shows a much larger quasi-rectangular shape than the other samples, whereas the GP-3 electrode shows a rectangular and symmetric shape. The TGP-3 web electrode had a greater specific capacitance at all current densities than the other electrodes, which was attributed to the higher electrical conductivity and the larger specific surface area of TGP-3. This same trend of power and energy performance, which indicates a good behavior in specific capacitance, was also evaluated with a Ragone plot.



Figure 3. Electrochemical test of Si–O–C based CNFCs in KOH (aq) electrolyte; (a) CVs at a scan rate of 25 mVs⁻¹, (b) specific capacitances as a function of a various current densities, (c) Ragone plots.

4. Conclusion

The polar group Si-O-C introduction was made into the carbon nanofibers, and the resulting CNFC electrodes were evaluated as an electrochemical capacitor. The electrodes of the EDLC improved not only in the specific capacitance but also in the energy density; from the specific capacitance of 60.0 Fg^{-1} , energy density of 6.0 Whkg⁻¹ of the CNF, to 144.80 Fg^{-1} and 18.49 Whkg⁻¹, respectively, at the composite fibers of 3 wt% of graphene. The introduction of TEOS and graphene into the PAN solution modified the morphological structure, resulting in increases in specific surface area electrical conductivity leading to the enhancement of the electrochemical performances of CNFCs.

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고내열성 방열용 실리콘 컴파운드 개발

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전기.전자 및 반도체 산업에서 각종 전자제품의 프레임 샤시 또는 열 분산의 다른 형태 를 통하여 열전달을 필요로 하는 부분, 전기통신분야, CD ROM과 열분산 장치 사이, 반 도체와 열 발산판 사이, RDRAM, DDRRAM Memory Modules 등에 사용되어 전자 부품 및 조립제품의 열 손실을 낮추면서도 전자제품의 열 방출량에 따라 다양한 두께로 공급할 수 있는 실리콘계 Thermal Interface Material 의 합성에 목적을 두고 있다.

열전도성 재료로 내열성 및 전기절연성이 뛰어난 phenylsilsesquioxanes을 phenyltrichlorosilane과 phenylenediamine으로 preamination, hydrolysis, condensation reaction 시켜 용해성이 우수한 ladder형의 polyphenylsilsesquioxane (PPSQ)을 합성한 후 PPSQ의 방열효과를 증가시키기 위해, 현재 많이 상용되고 있는 열전도성 필러들 중, Al2O3, Tin coated copper, Silver Coated copper 및 BN을 각각 혼합하여 pellet형태로 제 조한 뒤, 열적 특성과 표면특성을 위해 TGA, 광학현미경 및 SEM을 통해 실리콘 컴파운 드의 특성을 관찰하였으며 그에 따른 열전도도를 측정한 결과 PPSQ+BN의 경우가 열적 특성이 우수함을 확인하였다.

Reactions of Bromosilylenoid with CN Multiply Bonded Compounds

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Silylenoids are species containing an alkali metal (M) and a leaving group (X, usually halogen) bound to the same silicon atom, which make them display amphiphilic properties. Reaction of a silylenoid with a compound containing CN multiple bonds has not been studied, whereas experimental studies of CN multiple bonds with silylenes have been reported by several groups, which can be shared with reaction characteristics of silylenoids.¹⁻² Herein, we report reactions of bromosilylenoid with imines and isocyanides.

Bromosilylenoid, 2 was prepared from the reaction of tribromo[tris(trimethylsilyl)methyl]silane, 1 with two equivalents of lithium naphthalenide in THF at -78 °C. Then, compounds having CN multiple bonds, such as imines and isocyanides were added to resulting solution at same temperature. Interestingly, there were quite different results of reactions depending on imines. Silaaziridine, 3 was synthesized from the reaction of 2 with N,1-di(phenyl)methanimine, whereas with N-butylphenylimine, azaindane, 4 was formed. On the other hand, reactions of 2 with isocyanides such as 1-adamantane isocyanide and *tert*-butyl isocyanide afforded silacyanides 5 and 6 in good yields, respectively. In this presentation, we will discuss reactivities of bromosilylenoid with imines and isocyanides in detail.



Figure 1. Reactions of bromosilylenoid with imines and isocyanides.

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Newly Synthesized Silicon Quantum Dot-Polystyrene Nanocomposite Having Thermally Robust Positive Charge Trapping

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A silicon quantum dot-polystyrene nanocomposite (SiQD-PS NC) was synthesized and its charge trapping has been examined due to its applicability to large-scale OTFT based nonvolatile memory devices. The NC contains two miscible components: homopolystyrene (PS) and Si QDs capped with polystyrene chains (SiQD@PS). Metal-insulator-semiconductor (MIS) devices and thin film field effect transistors (TFTs) having a structure p-Si⁺⁺/SiO₂/NC/pentacene/Au source-drain were constructed by using spin-coated films of the NC on p-Si⁺ wafer or thermally-oxidized p-Si⁺⁺ wafer. Capacitance-voltage (C-V) curves obtained from the MIS devices exhibit a well-defined counterclockwise hysteresis with negative fat band shifts, which was stable over a wide range of curing temperature (50-250 °C). The positive charge trapping capability of the NC originates from the spherical potential well structure of the SiQD@PS component while the strong chemical bonding between SiQDs and polystyrene chains accounts for the thermal stability of the charge trapping property. The transfer curve of the transistor was controllably shifted to the negative direction by varying applied gate voltage. Thereby, this newly synthesized and solution processable SiQD-PS nanocomposite is applicable as charge trapping materials for TFT based memory devices.



Figure 1. An illustration of the synthesis and charge trapping behavior of the newly synthesized SiQD-PS nanocomposite.

Tuning Optical Properties of Silicon Quantum Dots by π-Conjugated Capping Molecules

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The absorption and photoluminescence (PL) properties of silicon quantum dots (QDs) are greatly influenced by their size and surface chemistry. Herein, we examined the optical properties of three Si QD samples with increasing σ - π conjugation length: octy-, trimethylsilyl)vinyl-, and 2-phenylvinyl-capped SiQDs. The PL photon energy obtained from as-prepared samples decreased by 0.1-0.3 eV, while the photoluminescent excitation (PLE) extended from 360 nm observed in the octyl-capped Si QDs to 400 nm in the case of 2-phenylvinyl-capped Si QDs. The σ - π conjugation induced an increase in the UV absorption cross-section near the band gap transitions. After soft oxidation through drying the samples in open air, all samples showed blue PL with maxima at approximately 410 nm. A similar high-energy peak was observed with a bare Si sample. The changes in optical properties of Si QDs originate from additional states that are created due to the quantum dot oxidation or the σ - π conjugation. Numerical calculations showed that charges are extracted more at the organic capping layer by lengthening the σ - π conjugation, thus implying a faster charge transfer across the QD's surface for fostering silicon nanocrystals based photovoltaics.



Figure 1. Illustration of the effect of σ - π conjugation on the optical properties of Si QDs. The σ - π conjugation creates surface states, which mediates the relaxation of exciton giving rise to more light in the visible range.

InP Quantum Dot – Organosilicon Nanocomposites

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InP quantum dot (QD) – organosilicon nanocomposites (NCs) were synthesized and their photoluminescence quenching was mainly investigated because of their applicability to white LEDs (light emitting diodes). We have introduced a new ligand, 3-aminopropyldimethylsilane (APDMS), which enables embedding the QDs into vinyl-functionalized silicones through direct chemical bonding. The exchange of ligand from MA to APDMS quenches the PL to about 10% of its original value with the relative increase in surface related emission intensities, which is explained by stronger coordination of the APDMS ligands to the surface indium atoms. InP QD-organosilicon NCs were synthesized by connecting the QDs using 1,4-divinyltetramethylsilylethane (DVMSE). The formation and changes in the optical properties of the InP QD-organosilicon NC were monitored by UV and PL spectroscopies. As the hydrosilylation reaction proceeds, the QD-organosilicon NC is formed and grows in size as indicated by an increase in the UV-vis absorbance. At the same time, the PL spectrum is red-shifted and quenched gradually. Three PL quenching mechanisms are regarded as strong candidates for the PL quenching of the QD nanocomposites, namely the scattering effect, Förster resonance energy transfer (FRET) and cross-linker tension preventing the QD's surface relaxation.



Figure 1. An illustration of the synthesis and the changes in optical properties of InP-organosilicon nanocomposites.

A Study on Electronic Structure of Silicon Quantum Dots using Cyclic Voltammetry

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Silicon quantum dots (Si QDs) were prepared by etching of silicon powder with aqueous hydrofluoric acid (HF) and nitric acid (HNO₃). By only controlling the etching time, the size of hydride-terminated silicon quantum dots (H-Si QDs) was tuned. Then, the H-Si QDs were functionalized by 1-octene (Oct). The electronic structure of various sized H-Si QDs and Oct-Si QDs, such as conduction band edge, valence band edge, inter-band trap, and quasi-particle gap, were investigated by cyclic voltammetry (C-V) and compared to the spectroscopic results such as UV-vis absorption and photoluminescence (PL), in order to study the effects of surface chemistry and oxidation on the electronic structure of QDs.



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Solution-Processed High–k ZrO₂-SiO₂ Hybrid Gate Insulator for Organic Thin-Film Transistors

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Solution-processed high- $k \operatorname{ZrO}_2$ -SiO₂ hybrid gate insulator was prepared by sol-gel method from metal alkoxide monomers, followed by spin-coating onto Si-wafers. The properties of ZrO_2 -SiO₂ hybrid thin films according to the Zr-Si ratio and curing temperatures were investigated. The dielectric constant (k) and leakage current of the hybrid thin films were measured from capacitance-voltage (C-V) and current-voltage (I-V) curves in metal-insulator-semiconductor (MIS) and metal-insulator-metal (MIM) structures, respectively. Pentacene semiconductor layers and Au electrodes (source and drain) were deposited by conventional vacuum deposition technique at low pressure of 10⁻⁶ torr on the hybrid gate insulator thin films to fabricate organic thin-film transistors (OTFTs) then the transfer and output characteristics were obtained using a semiconductor parameter analyzer, HP4145B, in which highly-doped p-type Si-wafers were used as substrate and gate electrode as well. In addition, the effect of polystyrene layer, which was synthesized from styrene monomer via thermally-initiated radical chain reaction, inserted between the ZrO₂-SiO₂ hybrid and pentacene layers on the OTFT properties was investigated.



Figure 1. Synthesis of high-k SiO₂-ZrO₂ hybrid gate insulator for OTFTs

Synthesis and Characterization of C₆₀-Organosilicon-Xylene Hybrid Nanocomposites and Thin Films

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Buckminsterfullerene (C₆₀) has attracted much attention due to unique optical and electrical properties from its well-defined symmetrical structure.¹ However, its poor solubility and processability pose difficulties in utilizing the C₆₀ for practical applications.² Not only chemical modification on the surface of C₆₀ but also incorporation with polymers have been intensively attempted to overcome the low solubility and processability as well as to give additional functionality.³ In this study, it was originally attempted to synthesize C₆₀-organosilicon hybrid nanocomposites from C₆₀ and 1,1,3,3,5,5hexamethyltrisiloxane (HMTS) in o-xylene solvent by platinum (Pt)-catalyzed hydrosilylation reaction at a high temperature of 130 °C. Interestingly, it was found that, under this condition, the HMTS is incorporated not only with the C_{60} by the hydrosilylation but also with the *o*-xylene solvent molecule via Pt-catalyzed dehydrogenative coupling reaction (poly xylene-organosilicon, PXS),⁴ resulting in complex C₆₀-HMTS (organosilicon)-xylene (CSX) hybrid nanocomposites. The CSX hybrid nanocomposite (with C₆₀) and PXS (without C₆₀) thin films were prepared by a conventional spincoating method onto quartz and Si-water substrates, respectively. Then, their structures and optical properties were characterized by NMR (¹H and ¹³C), FT-IR, gel permeation chromatography (GPC), UV-vis absorption spectroscopy, and spectroscopic ellipsometry (SE). The CSX hybrid nanocomposite (with C₆₀) thin films show much higher refractive index values of 1.64, 1.63, 1.66, and 1.75 according to the film curing temperatures of 80°, 150°, 250°, and 350°C, respectively, than those of 1.50, 1.44, 1.44, and 1.43 for the PXS thin films, which is owing to the C_{60} in the nanocomposite films of high refractive index.





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Theoretical Study on Electron Transport in Conjugated Molecular Junction with Silicon Electrode

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Research attention on the transport behavior of electrons through a single molecule has recently been much encouraged due to its fundamental scientific importance as well as being accompanied with recent prototype-advances on molecular electronics, at which individual molecule can act as a functional building unit.¹⁻³ The electron transport properties through a molecule are not only dependent on the molecule itself but also interaction with electrode.⁴⁻⁶ To date, gold (Au) electrode has been mostly used as the metal electrode due to its conducting characteristics and good adhesion property with sulfur atom of a molecule.^{5,7,8} In this study, electron transport properties through simple conjugated molecules; dithiolbenzene (DTB) and dithioldiphenylethyne (DDE), with metallic Au as well as semiconducting silicon (Si) electrodes, in which the molecules would have interestingly unique interaction with the Si electrode, were theoretically investigated using nonequilibrium Green's function/density functional theory (NEGF-DFT) formalism in Atomistix ToolKit (ATK) package.⁹⁻¹¹



Figure 1. Theoretical calculation of electron transport properties in molecular junctions using NEGF formalism.

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N-Methylaniline Promoted Si-Si Bonds Cleavage Reaction of Perchlorosilanes

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Si-Si bond cleavage reaction can be occurred using alkali metal or UV radiation. For example, 1,5dilithiodecaphenylpentasilane was prepared from decaphenylcyclopentasilane through a reductive Si– Si cleavage reaction with lithium.¹ And a few examples of amine supported Si-Si bond cleavage were reported. For instance, neopentasilane was synthesized from Si-Si bonds cleavage of hexachlorodisilane through amine-induced disproportionation.² Now, we wish to report Si-Si bonds cleavage of decachlorocyclopentasilane to give amino-substituted monosilanes in the presence of N-methylaniline. The reaction of decachlorocyclopentasilane with an excess amount of N-methylaniline gave (NMePh)SiHCl₂, (NMePh)₂SiHCl, (NMePh)₃SiH and trace of (NMePh)₂SiCl₂. We obtained (NMePh)₃SiH as a crystal by recrystallization in hexane. This reaction occurred through Si-Si bonds cleavage and nucleophilic substitution of N-methylaniline (scheme 1). The products were identified by GC/MS, ¹H NMR, ²⁹Si NMR spectroscopy and X-ray crystallography. Octachlorocyclotetrasilane and neopentasilane in the presence of N-methylaniline also afforded Si-Si bonds cleavage product in similar condition. Detailed results will be described in poster.



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Facile Synthesis and Characterization of Antimicrobial Silver Nanoparticle/Bis(o-phenolpropyl)silicone Composites by Gold Catalyst

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The easy preparation and characterization of silver nanoparticle/bis(o-phenolpropyl)silicone composites catalyzed by a gold complex have been carried out. The one-pot reduction of Ag(+) salts to stable Ag(0) nanoparticles is mediated by bis(o-phenolpropyl)silicone [(o-phenolpropyl)₂(SiMe₂O)_n, n = 2, 3, 8, 236], polysiloxanes possessing reductive phenolic O-H bonds as end group. The transformation was facilitated by HAuCl₄. XRD, TEM, FE-SEM, and solid-state UV-vis analytical tools were used to characterize the hybrid nanocomposites. TEM and FE-SEM data show the formation of hybrid composites in which large numbers of spherical silver nanoparticles are dispersed throughout the silicone matrix. The size of silver nanoparticles is found to be less than 20 nm. XRD patterns are consistent with that for multicrystalline silver. However, in the absence of the bis(o-phenolpropyl)silicone, most of the silver particles undergo macroscopic precipitation, implying that the silicone moieties are essential for stabilizing the metal nanoparticles.

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Preparation and Stabilization of Trimetallosilanes

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The syntheses and structure of organosilicon lithium compounds have been the subject of much interest. Recently a few dilithiosilyl compounds including their synthetic applications and ab initio calculation, etc. were reported. However, trilithiosilane has not been reported yet. Last ten years we have synthesized stable halosilylenoids and dilithiohalosilanes formed from the reduction of trihalosilanes with strong reducing agents. These results prompted us to investigate a synthesis of trilithiosilanes.

The reaction of trihalo[tris(trimethylsilyl)methyl]silane (TsiSiX₃, Tsi=C(SiMe₃)₃, X=Br, Cl) with more than 6 equivalents of lithium naphthalenide (LiNp) in THF at -78 °C gave trilithiosilane together with halodilithiosilane and halolithiosilane which are indirectly monitored by GC/MS after adding excess MeOH into reaction mixture. Transmetalation of lithiosilanes with MgBr₂, ¹BuMgCl, ¹PrMgBr and their thermal stability were also investigated. In this presentation, synthesis of trilithiosilane and its transmetalation will be discussed in detail.



Synthesis of Silicon Quantum Dots and Nanoparticles showing High Quantum Efficiency

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Silicon quantum dots (Si QDs) and nanoparticles (Si NPS) was successfully synthesized from the reaction of ammonium chloride and magnesium silicide. Pholuminescnece (PL) and quantum yields of Si QDs have been measured. The change of quantum yield and optical characterization of Si QDs are measured depending on the reaction time. Highly luminescent Si QDs were obtained as the reaction time increased. TEM topograph of a typical nanoparticle reveals the tetrahedral geometry of the nanoparticle. The size of the nanocrystal is 250 nm. The SAED pattern is from several of the particles shown in the TEM image and thus single zone axis patterns are observed. The [111] zone axis pattern for diamond cubic is observed. Absorption measurement indicated that the Si QDs consisted of only silicon and hydrogen atom. Optical characterizations of Si QDs were measured by UV-Vis and PL spectroscopy. The size distribution and orientation of Si QDs were measured by TEM and XRD. TEM image displays the spherical Si QDs with the size of 2-4 nm. The monotonic shift of the PL as a function of excitation wavelength resulted in the excitation of different sizes of QDs that had different optical transition energies.

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Figure 1 . High-resolution transmission electron microscopy (HRTEM) image of Si-NPs

Synthesis of 1,1-Difunctional Germafluorene for OLED Applications

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Various functionalized germaflourene derivatives have been synthesized and their optical and electronic properties were investigated. The germafluorene compounds were synthesized by a stepwise reactions from 1,2,4,5-tetrabromobenzene to 2,2'-dibromobisfluorene with germanium tetrachloride in THF at row temperature. The germafluorene compounds were characterized by ¹H-NMR, UV-Vis absorption, and photoluminescence spectroscopy. The optical absorption spectra showed an absorption edge at 285 nm, while a strong UV-vis photoluminescence at 350 nm is observed. These germafluorene compounds are served as light emissive layers. They possess relatively low LUMO energy levels while maintaining high HOMO-LUMO optical gaps. Differential scanning calorimetry measurements reveal that these germafluorene compounds exhibited very good thermal stability at extremely high temperature ca. above 350 °C. Organic light-emitting diodes have been fabricated using thermal evaporation technique which emit blue light with an excellent diode behavior under the forward bias.

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HOMO



B3LYP/6-31G(d)

Figure 1. . Molecular Orbital of 1,1-dimethyl-4,5,8,9-germafluorene

Photocurable Effect of Methacryl Siloxane Materials in the Presence of both Photocurable Catalyst and Hydrosilylable Catalyst

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The synthesis of methacrylate oligosiloxane resins were reported by a sol-gel condensation process between 3-(trimethoxysilyl) propyl methacrylate (MPTS) and diphenylsilanediol (DPSD) with different compositions of precursor molar ratios from 33 to 55 mol% DPSD over MPTS.[1] For this reaction, barium hydroxide monohydrate, Ba(OH₂) H₂O was typically added as a catalyst to promote the direct condensation reaction of the methoxy radical of MPTS and the diol radical of DPSD to form siloxane bonds. This synthesis proceeded without the addition of water for hydrolysis, but the materials to obtain reasonable hardness took 2 hours. Here we report the synthesis of methacrylate oligosiloxane resins in the presence of phenyltris(dimethylsiloxy)silane with platinum catalyst to investigate the fast curing effect. Methacryl siloxane polymer was prepared by curing and heat-treatment of methacryl oligosiloxane resin and phenyltris(dimethylsiloxy)silane for the light emitting diode encapsulation. The photophysical properties such as an optical transmittance, refractive index of fabricated hybrimer, and harness will be reported depending on curing time and precursor composition.

This research was financially supported by the Ministry of Education, Science Technology (MEST) and National Research Foundation of Korea (NRF) through the Human Resource Training Project for Regional Innovation. (2012H1B8A2026282)

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Synthesis and Characterization of Microwave-Exfoliated Graphene Oxide/Silicon Quantum Dot and Microparticle Hybrimers

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Microwave-exfoliated graphene oxide(MEGO)/silicon quantum dot or silicon microparticle hybrimers have been successfully synthesized and characterized for the possible application of supercapacitor. Graphene oxide was synthesized by using modified Hummer's method. Obtained grapheme oxide was exfoliated by microwave to give Microwave-exfoliated graphene oxide. Hyride-terminated silicon quantum dots were synthesized from the reaction of ammoniumchloride and magnesium silicide. The ball milling of silicon wafer (<100> wafers (p-type, boron-doped, 500 m thick) was carried out in a planetary ball-mill machine at 500 rpm to give silicon micro particles. To start with, 5 g of the silicon wafer were placed into a stainless steel capsule containing stainless steel balls of 5 mm in diameter. The container was then sealed and fixed in the planetary ball-mill machine, and agitated with 500 rpm for 48h. The ball-milled silicon microparticles were electrochemically reacted in the presence of HF solution to obtain hyride-terminated silicon microparticles. Activated MEGO was reacted with H-terminated silicon quantum dots or silicon microparticles via hydrosilylation in the presence of platinum catalyst. The slicon qantum dot or silicon microparticle hybrimers of grapheme oxides were characterized by XRD, TEM and FE-SEM. A specific surface area was measured by the Brunauer-Emmett-Teller (BET) method. Detailed information for the composite materials will be discussed.

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Figure 1. FE-SEM images for microwave-exfonated graphene oxide

VOC's Sensors based on Luminescent Porous Silicon having Reflectivity

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Novel porous silicon chip exhibiting dual optical properties, both Fabry-Perot fringe (optical reflectivity) and photoluminescence had been developed and used as chemical sensors. Porous silicon samples were prepared by an electrochemical etch of p-type silicon wafer (boron-doped, <100>orientation, resistivity $1 \sim 10\Omega$). The etching solution was prepared by adding an equal volume of pure ethanol to an aqueous solution of HF (48% by weight). The porous silicon was illuminated with a 300 W tungsten lamp for the duration of etch. Etching was carried out as a two-electrode galvanostatic procedure at an anodic current. The surface of porous silicon was characterized by FT-IR instrument. The porosity of samples was about 80%. Three different types of porous silicon having different surface properties, fresh porous silicon (Si-H terminated, hydrophobic), oxidized porous silicon (Si-OH terminated, hydrophilic), and surface-derivatized porous silicon (Si-R terminated, hydrophobic) were prepared by the thermal oxidation and hydrosilylation. Then the samples were exposed to the vapor of various organics, such as chloroform, hexane, methanol, benzene, isopropanol, and toluene. Both reflectivity and photoluminescence were simultaneously measured under the exposure of organic vapors. These surface-modified samples showed unique respond in both reflectivity and photoluminescence with various organic vapors. While polar molecules exhibit greater quenching photoluminescence, molecules having higher vapor pressure show greater red shift for reflectivity. This research was financially supported by the Ministry of Education, Science Technology (MEST) and National Research Foundation of Korea (NRF) through the Human Resource Training Project for Regional Innovation. (2012H1B8A2026282)



Figure 1. . 2-D map resulting from the change quenching photoluminescence and change of optical thickness under the exposure of various organic analytes.

One-Pot Synthesis of Camptothecin-Derivatized Silicon Quantum Dots for Drug Delivery Applications

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Camptothecin(CPT)-derivatized silicon quantum dots (SiQDs) were successfully synthesized from the reaction of ammonium chloride, magnesium silicide and camptothecinyltrichlorosilane. Optical characterizations of SiQDs were achieved by using ultraviolet-visible (UV-Vis) and photoluminescence (PL) spectroscopy. The morphologies of SiQDs were achieved by scanning electron micrograph (SEM) and transmission electron micrograph (TEM). CPT-derivatized SiQDs were characterized by nuclear magnetic resonance (NMR) and infra-red (IR) spectroscopy. SiQDs synthesized without camptothecinyltrichlorosilane were emitted the light at 450 nm with an excitation wavelength of 400 nm. CPT itself was emitted the light at 425 nm with an excitation wavelength of 370 nm. After the one-pot synthesis, CPT-derivatized SiQDs were emitted the light at 570 nm with an excitation wavelength of 480 nm.Optical characteristic of drug-derivatized silicon particles were investigated in PSB buffer solution. The release of CPT was measured by UV-vis spectrometer. The intensity of fluorescence of the SiQDs was measured with a drug release. The concentration of released drug exhibited non-linear relationship with a release time. Quantum yields for SiQDs, CPT, and CPT-derivatized SiQDs were measured. Detailed information about the photoluminescence will be discussed.

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Figure 1.Synthesis of CPT-Si NPs.

Synthesis and Characterization of Graphene Oxide/Silicon Nanowire Hybrimer

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Single-crystalline silicon nanowires (SiNWs) were fabricated by using an electroless metal assisted etching of bulk silicon wafers with silver nanoparticles that are deposited by wet electroless deposition. The etching of SiNWs is based on subsequent treatments in aqueous solutions of silver nitrate followed by hydrofluoric acid and hydrogen peroxide. Free-standing SiNWs were then obtained using ultrasono-method in chloroform. Graphene oxide (GO) was prepared by the modified Hummer's method and used for the synthesis of GO/SiNW hybrimers through hydrosilylation in the presence of Pt catalyst. The morphology of GO/SiNW hybrimesr were characterized by EDS,TEM, and FE-SEM. Covalent bond between GO and SiNW was confirmed by using XPS and FTIR spectroscopy. BET measurement showed that GO/SiNW hybrimesr had a microporous. Detailed information about the characterization of GO/SiNW hybrimesr will be discussed.

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Figure 1. FE-SEM images for Silicon Nanowires

Development of New Cross-Linking Agents for the Synthesis of Phenyl-Vinyl-Based Polysiloxane Resins

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Development of new cross-linking agents for the synthesis of phenyl-vinyl-based polysiloxane resins has been achieved through the hydrosilylation reaction. Here, we discovered new cross-linking agents for the synthesis of polysiloxane resins. Phenyl-vinyl-based polysiloxane resins was obtained from the reaction of phenyl-vinyl-based oligosiloxanes and hydrogen-terminated oligosiloxane through a nonhydrolytic sol-gel condensation in the present of Pt catalyst. Structural analysis of phenyl-vinyl-based oligosiloxanes and hydrogen-terminated oligosiloxane were determined by using ¹H-NMR. By using new curing agent such as a hydrogen-terminated oligosiloxane, the prepared phenyl-vinyl-based polysiloxane resins exhibited a good refractive index, high hardness, and great transmittance. The comparison with phenyltris(dimethylsiloxy)silane as a cross-linking agent has been reported. Hardness and refractive index, transmittance was measured using a coating with a thickness of 2mm. Durometer(GS-702N), Refractometer(NAR-1T SOLID), and UV-vis spectrometer(UV-2401 PC, Shimazu) were used.

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Effect of Phenyl Derivatives on Phenylvinyl Oligosiloxanes for OLED Encapsulants

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The synthesis of thermally stable transparent phenylvinyl oligosiloxane resins with high refravtive index were well known procedure and reported by a sol–gel condensation process between vinyltrimethoxysilane (VTMS) and diphenylsilanediol (DPSD).[1] We have invastigated the effect of phenyl derivatives on phenylvinyl oligosiloxane resins. Instead of using DPSD, dimestylsilanediol (DMSD) was synthesized from the reaction of 2 equivalent of mesityllithium and silicon tetrachloride, Mesityllithium was obtained from the reaction of bromomesitylene with buthyllithium. The prepared mesityl poly-siloxane resins showed a refracive index of 1.55 after 4 hours of reaction time. For the comparision with mesityl poly-siloxane resins, bis(triphenylphenyl)silane diole (TPPSD) was synthesized from the reaction of bis(triphenylphenyl)silyl lithium with silicon tetra chloride. The optical properties such as an optical transmittance, refractive index, and harness will be reported depending on curing time and precursor composition.

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Development of Ultra-Fast Curing Agent for High Refractive and Great Transparent Polysiloxane Resins for the Application of LED Encapsulant

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The epoxy-based oligosiloxanes were synthesized by a sol–gel condensation process between 3glycidoxypropyltrimethoxysilane and diphenylsilanediol (DPSD) in the present of Ba(OH)₂H₂O and reported somewhere.[1] The prepared epoxy-based oligosiloxanes was cured with methyl hexahydrophthalic anhydride (MHHPA) as a cross-linking agent in the present of amine catalyst to give epoxy-based polysiloxane resins. However, the curing time to obtain for suitable hardness of polysiloxane resins took 12 hours to complete the reaction. Here, we discovered ultra-fast curing agents for the synthesis of epoxy-based polysiloxane resins. Curing time was about 30 min. to give suitable hardness. Structural analysis of epoxy-based oligosiloxane was determined by using ¹H-NMR. By using new curing agent, the prepared epoxy-based polysiloxane resins exhibited an ultra-fast curing time, good refractive index, and high hardness and transmittance. Over time by measuring the hardness could see the progress of curing. Hardness and refractive index, transmittance was measured using a coating with a thickness of 2mm. Durometer(GS-702N), Refractometer(NAR-1T SOLID), and UV-vis spectrometer(UV-2401 PC, Shimazu) were used.

This research was financially supported by the Ministry of Education, Science Technology (MEST) and National Research Foundation of Korea (NRF) through the Human Resource Training Project for Regional Innovation. (2012H1B8A2026282)



Figure 1. Synthesis of epoxy and Epoxy resin.

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Synthesis of Phenyl-Vinyl-Based Polysiloxane Resin Containing Silicon Quantum Dots and Silicon Microparticles

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Silicon quantum dots (Si QDs) and microparticles (Si MPs) were used as cross-linking agents for the synthesis of organic-inorganic polysiloxane hybrimer. Si QDs were synthesized from the reaction of ammonium chloride and magnesium silicide to give hydride-terminated surface of Si QDs. Optical characterizations of silicon nanoparticles were achieved by using ultraviolet-visible (UV-Vis) and photoluminescence (PL). To obtain the hydride-terminated Si MPs, the ball milling of silicon wafer (<100> wafers (p-type, boron-doped, 500 m thick) was carried out in a planetary ball-mill machine at 500 rpm to give silicon micro particles. To start with, 5 g of the silicon wafer were placed into a stainless steel capsule containing stainless steel balls of 5 mm in diameter. The container was then sealed and fixed in the planetary ball-mill machine, and agitated with 500 rpm for 48h. The ball-milled silicon microparticles. Nonhydrolytic sol-gel condensation was achieved with H-terminated silicon quantum dots or silicon microparticles via hydrosilylation in the presence of platinum catalyst to give organic-inorganic polysiloxane hybrimers. The optical properties such as an optical transmittance, refractive index, and harness will be presented.

This research was financially supported by the Ministry of Education, Science Technology (MEST) and National Research Foundation of Korea (NRF) through the Human Resource Training Project for Regional Innovation. (2012H1B8A2026282)

One-Pot Synthesis of Silicon Quantum Dots/Silole Core/ Shell Nanoparticles Showing High Quantum Efficiency by FRET

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Silicon Quantum Dots (SiQDs) derivatized with organic fluorophore such as siloles were successfully synthesized from the reaction of ammonium chloride, magnesium silicide. and dichlorotetraphenylsiloles in DMF. Optical characterizations of SiQDs were achieved by using ultraviolet-visible (UV-Vis) and photoluminescence (PL) spectroscopy. The morphologies of SiQDs were achieved by scanning electron micrograph (SEM) and transmission electron micrograph (TEM). Silole-derivatized SiQDs were characterized by nuclear magnetic resonance (NMR) and infra-red (IR) spectroscopy. SiQDs synthesized without silole were emitted the light at 450 nm with an excitation wavelength of 400 nm. The emission wavelength of tetraphenylsilole is 520 nm with an excitation wavelength of 360 nm. After the synthesis of Si QD/silole core/shell nanoparticles, core/shell nanoparticles were subjected to measure the PL. Si QD/silole core/shell nanoparticles exhibited an absence of PL for Si QDs and an enhancement of PL for silole by few hundred times. This result can be interpreted by the efficient forter resonance energy transfer (FRET) from Si Qd having large band gap to silole having small band gap. Detailed information about the photoluminescence will be discussed.

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Fig. 1 . Photographs of (A) as-prepared Si QDs, (B) Si QD/silole core/shell nanoparticles, and (C) Siloles

Physical Properties of Hydrogel Contact lens with Type and Amount of Silicon-containing Monomers

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The aim of this research is to examine the physical properties of hydrogel contact lens with type and additional ratio of silicon-containing monomers such as 3-(trimethoxysilyl)propyl methacrylate (TRIS), 2-(trimethylsilyloxy)ethyl methacrylate (TEMA), (trimethylsilyl)methacrylate (TMMA). Silicon hydrogel contact lens were prepared by copolymerization (at 100 °C, 5 hrs) of a silicon-containing monomer, 2-hydroxyethyl methacrylate (HEMA), a cross-linker ethylene glycol dimethacrylate (EGDMA), N-vinyl-2-pyrrolidone (NVP), and a radical initiator, 2,2'-azobis isobutyronitrile (AIBN) in a cast mold.

The water contents of transparent silicon hydrogel contact lens in good shape were found to be 39.2%, 38.3%, and 35.1%, respectively, when the content of TRIS was 20%, 30%, and 40% in the copolymers.



Figure 1. Silicon hydrogel contact lens prepared with 20%, 30%, and 40% of TRIS

The water contents of translucent silicon hydrogel contact lens were found to be 42.4%, 39.6%, and 37.0%, respectively, when the content of TEMA was 20%, 30%, and 40% in the copolymers.



Figure 2. Silicon hydrogel contact lens prepared with 20%, 30%, and 40% of TEMA

The water contents of opaque silicon hydrogel contact lens were found to be 42.3%, 37.0%, and 34.9%, respectively, when the content of TMMA was 20%, 30%, and 40% in the copolymers.



Figure 3. Silicon hydrogel contact lens prepared with 20%, 30%, and 40% of TMMA

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