Programme – Shandong University

山东大学化学与化工学院
School of Chemistry and Chemical Engineering, Shandong University

2nd WACKER-RSC International Symposium on
Smart Materials for Smart Applications – Emulsion Polymers and Silicones
4 November 2014, The Hall of Run Run Shaw Building, Shandong University

Chair: Prof Shengyu Feng, Shandong University

Time	Event	Session chair
08:30	**Introduction and welcome**	**Prof Shengyu Feng** Shandong University
08:40	**Dr Fridolin Stary, Senior Vice President R&D, WACKER Chemie AG** Innovation fuelling WACKER since 100 years to the future	
09:30	**Prof Michael Cunningham, Queen's University, Canada** Nitroxide-mediated copolymerization of 2-(diethylamino)ethyl methacrylate and styrene in water and one-pot synthesis of stimuli-responsive amphiphilic block copolymer nanoparticles	
10:10	**Coffee break**	
10:30	**Prof Caihong Xu, Institute of Chemistry, Chinese Academy of Sciences, China** Fabrication of functional coatings from silicon-based polymers	**Dr Timo Hagemeister** WACKER Chemicals China
11:10	**Prof Qingzeng Zhu, Shandong University** Functionalized polysilsesquioxane materials	
11:50	**Lunch**	
12:50	**Poster session**	
13:50	**Prof Peter Jutzi, University of Bielefeld, Germany** The π-complex chemistry of low-valent silicon	**Dr Fridolin Stary** WACKER Chemie AG
14:30	**Prof Zaijun Lu, Shandong University, China** Drug carrier, porous foam, and functional film based on polymer emulsion	
15:10	**Prof Weibo Lv, New Materials Research Institute of Shandong Academy of Sciences, China** Study on preparation and properties of methylphenyl silicone materials for LED packaging	
15:50	**Group photo & coffee break**	
16:20	**Panel discussion** Your career preparation and development in multinational companies... how?	**Dr Timo Hagemeister** WACKER Chemicals China
17:20	**Poster presentation prize and closing remarks**	
17:30	**Close**	

School of Chemistry and Chemical Engineering, Shandong University

The School of Chemistry and Chemical Engineering at Shandong University has two primary disciplines (chemistry and chemical engineering), eleven affiliated research institutes, and one experiment centre. Its laboratory of colloid and interface chemistry is a key open laboratory of the Ministry of Education of China. The School has two outstanding disciplines at the provincial level, physical chemistry and polymer materials. Besides a postdoctoral station in chemistry, the School offers doctoral and master programmes in inorganic chemistry, organic chemistry, analytical chemistry, physical chemistry, and polymer chemistry and physics, as well as master programmes in applied chemistry and chemical process.

Presently, the school has 4 adjunct academicians, 58 full professors, and 58 associate professors. Among them there are more than 30 doctoral advisors. Till now, the School has lead hundreds of research projects from the “863 program”, the “973 program”, the National Natural Science Foundation of China, and various other national, provincial, or ministerial programmes. The School’s annual research funding has reached more than 6 million RMB. Numerous faculty members have received the National Natural Science Award, the National Science Conference Award, the National Invention Award, the National Science and Technology Progress Award, etc.

Host: Professor Shengyu Feng
Shandong University, China

Education

D.Sc. Quantum Chemistry, Shandong University, 1992; MS Polymer Chemistry, Shandong University, 1984; BS Organic Chemistry, Shandong University, 1982

Professional carrier

1984-1991	Lecturer, Shandong University
1991-1994	Associate Professor, Institute of New Materials, Shandong University
1994-2002	Professor, Institute of New Materials, Shandong University
1998	Fellow 1998 of Japan Society for the Promotion Science (JSPS), Kyoto University (Tamao’s group)
2001-2002	Visiting Scholar (Stobart’s group), University of Victoria, Canada
2002-2008	Professor, Director of Institute of Polymer Chemistry and Physics, School of Chemistry and Chemical Engineering, Shandong University
2008-Present	Professor, Director of Institute of Polymer Chemistry and Physics, Director of Key Laboratory of Special Functional Aggregated Materials, Ministry of Education; School of Chemistry and Chemical Engineering, Shandong University

Research interests

Organosilicon Chemistry; Polymer Chemistry; Polymer Materials;
Applied Quantum Chemistry

Speaker biographies and abstracts

Dr Fridolin Stary
Senior Vice President R&D, WACKER Chemie AG
Email: Fridolin.stary@wacker.com

Born 1952 in Austria (Europe)

Education

Master in Chemistry and Chemical Engineering, Technical University Graz, Austria; PhD, Technical University Graz, Austria (Thesis: Electrochemical studies for the zinc electrolysis process).

Professional career

1976 – 1980	Application chemist for PVC additives at BBU in Austria
1980 - 1984	Klöckner Humbold Deutz, Cologne (Germany) Technical project manager for chemical engineering and start-up of petrochemical projects worldwide
since 1984	WACKER Chemie AG
• 1984 - 1986	Process developments and technical marketing for Silicones
• 1986 - 1990	Technical Director WACKER Brazil (technical support of local business and expansion of local manufacturing)
• 1990 - 1996	Head of GB-S Supply Chain
• 1996 - 2007	Vice President of the global Silicone Elastomers business
• since 2008	Senior Vice President Research & Development

Innovation Fuelling WACKER since 100 Years to the Future

Fridolin Stary
Senior Vice President R&D, WACKER Chemie AG

WACKER is a technology leader in the chemical, solar and semiconductor industry. All businesses are technology and innovation driven and business success strongly depends on the R&D capabilities and the resulting innovation power.

Strong future and innovation orientated entrepreneurship has driven WACKER since its beginning 100 years ago. A short view back into the company's history will show the major inventions and developments during the last century.

The presentation shows the importance and the efforts of R&D at WACKER.

It is demonstrated how innovative product developments together with production process optimization sustain and improve the market position even in highly competitive markets.

The following case studies will be addressed:

- Developments of monocrystalline Si-Wafers for the next generation of electronic devices with design rules of 11nm
- Process optimizations and new process developments for lowest cost and best quality production of hyperpure polycrystalline Silicon for the photovoltaic industry
- Silicones, its vast variety of properties with examples of novel developments
- C2-Polymers – solutions for many different markets and recent developments
- Silicon based anode active materials for the next generation of Lithium-Ion Batteries

Prof Michael F. Cunningham
Queen's University, Canada
Email: Michael.cunningham@chee.queensu.ca

Professor Cunningham obtained his Ph.D. in Chemical Engineering from the University of Waterloo in the field of polymer science. He then spent six years in the Xerox Corporate Research Group developing new processes for composite nanoparticles. In 1996 he accepted a faculty position at Queen's University. The primary focus of his current research is the design of water-based polymer dispersions using novel polymerization chemistry, the preparation of stimuli-responsive polymer colloids, and modifying natural polymers such as nanocrystalline cellulose and alginate. He is a recipient of the Syncrude Canada Innovation Award, presented by Canadian Society for Chemical Engineering (awarded to a resident of Canada who has made a distinguished contribution in the field of chemical engineering before the age of 40). He holds an Ontario Research Chair in Green Chemistry and Engineering.

Nitroxide-mediated copolymerization of 2-(Diethylamino)ethyl methacrylate and styrene in water and one-pot synthesis of stimuli-responsive amphiphilic block copolymer nanoparticles

Ali Darabi, Abbas Rezaee Shirin-Abadi, Philip G. Jessop, Michael F. Cunningham*

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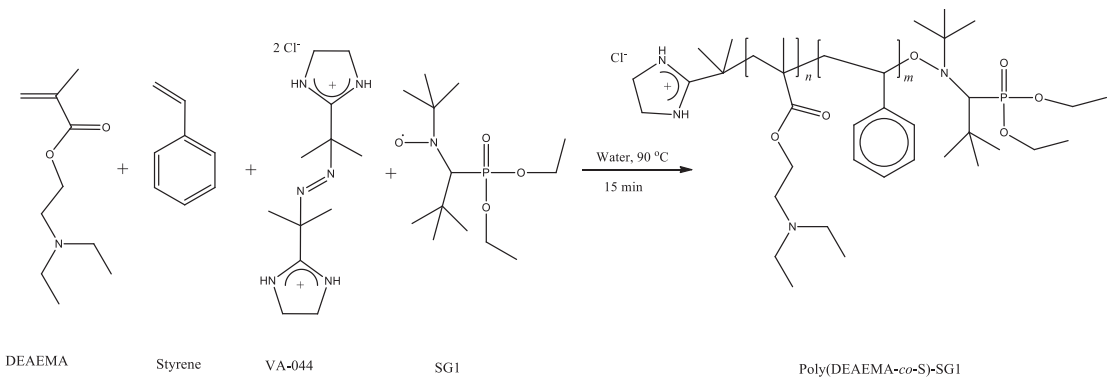
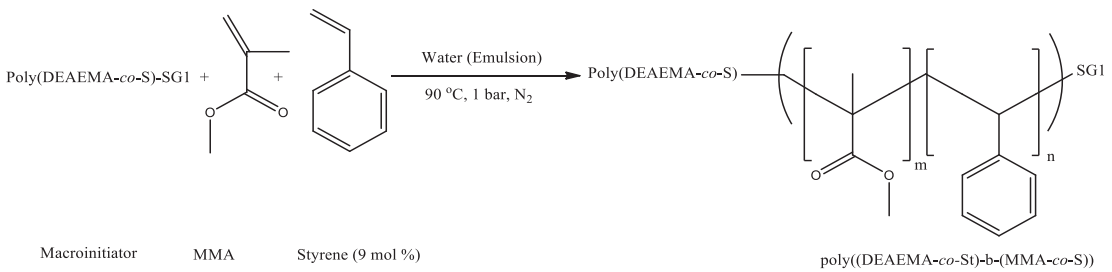
The SG1-mediated copolymerization of 2-(diethylamino)ethyl methacrylate (DEAEMA), a pH-sensitive monomer, and a small percentage of styrene (S) was performed in water using 2,2'-azobis[2-(2-imidazolin-2-yl) propane]dihydrochloride, (VA-044) as a positively charged stabilizer and initiator (Scheme 1). The resultant macroalkoxyamine was then employed in the protonated form as both macroinitiator and stabiliser in the same pot for the surfactant-free emulsion copolymerization of methyl methacrylate (MMA) and styrene which proceeded via polymerization-induced self-assembly (PISA) (Scheme 2). The polymerization reaction exhibited all the features of a well-controlled living radical polymerization (LRP). Latex particles had monomodal size distribution, narrow size polydispersity and small average size. The final latexes were pH-sensitive and coagulated easily by neutralization with sodium hydroxide (NaOH).



Scheme 1. Schematic representation of the polymerization of DEAEMA with 9 mol% styrene in water initiated by VA-044 at 90°C.



Scheme 2. Schematic representation of surfactant-free batch emulsion of methyl methacrylate with 9 mol% styrene at 90°C initiated by poly(DEAEMA-*co*-S) macroalkoxyamine.

Prof. Dr. Peter Jutzi
University of Bielefeld, 33613 Bielefeld, Germany
Email: peter.jutzi@uni-bielefeld.de

1963 Diploma in Chemistry at TU München
1965 PhD in Organometallic Chemistry, University of Marburg
1971 Habilitation at University of Würzburg
1979 Full Professor of Inorganic Chemistry at the University of Bielefeld

Research Interests:

Synthetic Organosilicon Chemistry, Dynamic Covalent Chemistry with Organometallic Compounds, Nanoparticle Synthesis and Mechanistic Studies.

Awards:

1987 Wacker Silicon Award
1992 Max-Planck Research Award
2000 Frederic-Stanley-Kipping Award
2002 Alfred-Stock Award

The π-complex chemistry of low-valent silicon

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Faculty of Chemistry, University of Bielefeld, D 33613 Bielefeld, FRG
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The first stable molecules of the type R_2Si and $RSi^+ X^-$ containing divalent silicon have been realized by π-complexation of the silicon atom. The sandwich-complex $(Me_5C_5)_2Si$ was reported already in 1986, and the half-sandwich complex $[Me_5C_5Si]^+ [B(C_6F_5)_4]^-$ was reported only in 2004. Synthesis, structure, bonding, and chemistry of these compounds are described. Their reactivity is characterized by the divalent state of silicon, by the flexibility of the bonding modes and the leaving-group ability of the Me_5C_5 ligand. A survey of other classes of stable compounds containing low-valent silicon (Si^{II}, Si^{I}, Si^{0}) accessible only for a short while is presented.

References

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2. P. Jutzi , The Pentamethylcyclopentadienylsilicon(II) Cation: Synthesis, Characterization, and Reactivity, *Chem. Eur. J.* 2014, **20**, 9192-9207.

Prof Zaijun Lu
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Work and Education

2011	Case Western Reserve University (US), Visiting scholar
2009	The Chinese University of Hong Kong, Visiting scholar
2003-now	Shandong University, Professor
2000-2002	Durham University (UK), Research associate
1999-2000	Kyoto University (Japan), Postdoctoral fellow
1995-1998	Fudan University, PhD
1988-1995	Sichuan University, MS & BS

Research Interests

Molecular design and heat-resistant polymer; Chain design and liquid rubber; Material design and polymer composites.

Prof Lu has published about 60 academic papers in various international journals, such as *Macromolecules*, *Langmuir*, *J. Polym. Sci.*, *Polymer*, *Macro. Rapid Commun.*, *J. Appl. Polym. Sci.*, and 13 authorized patents. Among them, benzoxazine resins and composites have been applied in three gorge generating units and J-10 fighter jets. The HTPB liquid rubber synthesized by anionic polymerization technique has been used in solid missile / rocket propellant.

Drug carrier, porous foam, and functional film based on polymer emulsion

Yanzhe Wei, Runcan Cao, and Zaijun Lu**
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Using living anionic polymerization technique, the biocompatible and amphiphilic block copolymer, H2N-PEG-b-PLA, was designed and synthesized. The amino end groups provided active sites to connect all kinds of functional compounds. Those special block copolymers self-assembled into micelles in water. Their application in drug carriers was discussed.

Using soap-free emulsion polymerization technique, monodisperse and functional polymer nanoparticles were designed and synthesized. When those particles used as emulsifier and styrene used as oil phase, Pickering emulsion was formed. After polymerization and drying, polystyrene porous foam was obtained. When those particles used as functional component and blended with polyacrylate emulsion, the homogeneous emulsion was prepared. After casting and drying, the functional film was obtained. The advantage of this method was that the functionality was achieved only a small amount of addition of functional particles.

Prof Weibo Lv
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Professor Lv is the deputy director and research professor of the Institute of New Materials at Shandong Academy of Sciences. He is also the director at the Shandong Province Key Laboratory of Adhesive Materials. Professor Lv's major research areas include adhesive polymers, coating materials, polyurethane resins, and silicones materials.

Professor Lv has taken more than 20 research programmes at the national and provincial level. Among them, there are 3 national research projects and 2 key independent innovation projects of Shandong Province. 7 of his research results have won the Science and Technology Progress Awards of Shandong Province. Professor Lv has been granted 11 Chinese invention patents.

Study on preparation and properties of methylphenyl silicone materials for LED packaging

Weibo Lv
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A series of linear and body methylphenyl silicon polymer with different viscosities and phenyl contents, vinyl or hydrogen group were synthesized. With these polymers, 3 kinds of LED packaging silicone gum with a refractive index of 1.54 and transmittance (450 nm, 4 mm) > 88% were prepared. Test results showed that the above gums showed good performance and transmittance. After 150 °C thermal aging for 500 h ~ 1000 h or 350 nm UV aging for 100 h ~ 300 h, the transmittance had little change within the range of 400 ~ 800 nm wavelength. The packaging gums showed excellent UV aging and thermal aging properties.

Prof Caihong Xu
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Professor Xu received her M.S. degree from Shandong University in 1998 and her Ph.D. from Institute of Chemistry, Chinese Academy of Sciences (ICCAS) in 2001. She conducted postdoctoral research at Kyoto University and Nagoya University in Japan from 2001 to 2004. She was supported by 100 Talents Project of Chinese Academy of Sciences and joined ICCAS as a full professor in 2005.

Her research interests include silicon-containing functional materials and polymer precursors for silicon-based advanced ceramics. The research has generated over 100 publications, 20 patents and patent applications.

Fabrication of functional coatings from silicon-based polymers

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In this presentation, we will demonstrate fabrication of functional coatings from new polysilazane and polysiloxane, the ceramicizable silicon-based polymers synthesized in our laboratory. Thus, heat resistant ceramic coatings were successfully prepared with polysilazane (PSN1) as a precursor and aluminium (Al) powder as active filler. The effect of Al content on chemical composition, microstructure, and mechanical properties of the coatings was investigated. Chemical composition analysis revealed that Al powder was completely converted into Al_2OC and AlN phases during the ceramization process, accompanied by volume expansion. Ceramic coatings derived from less Al powder containing PSN1/Al showed more compacted surface morphology and continuous microstructure. The surface hardness and elastic modulus of ceramic coatings decreased with the increase of the volume fraction of Al from 10% to 40% (Al/PSN1, v/v).

Highly transparent and durable superhydrophobic organic–inorganic hybrid nanoporous coatings with different surface roughnesses were fabricated via a simple solidification-induced phase-separation method using a liquid polysiloxane (PSO) as the precursor and polydimethylsiloxanes (PDMS) as porogens. Owing to the existence of $Si–CH_n$ units, the hybrid material is intrinsically hydrophobic. The roughness of the coating can be easily controlled at the nanometer scale by changing the viscosity of PDMS to achieve both superhydrophobicity and high transparency. The influence of surface roughness on the transparency and hydrophobicity of the coatings was investigated. The optimum performance coating has an average transmittance higher than 85% in the visible light range (400–780 nm), a water contact angle of 155°, and a slide angle lower than 1°. The coatings also exhibit good thermal and mechanical stability, and durable superhydrophobicity.

Prof Qingzeng Zhu
Shandong University, China
Email: qzzhu@sdu.edu.cn

Qingzeng Zhu is Professor of Chemistry at School of Chemistry and Chemical Engineering. He received his master's degree in Polymer Chemistry and Physics, and Ph.D. degree in Materials from Shandong University. Then he spends two years as a postdoctoral fellow at State Key Laboratory of Polymer Physics and Chemistry, Institute of Chemistry, Chinese Academy of Sciences. In 2007, he worked at Max-Planck-Institute for Polymer Research in Germany as a visiting scholar in Prof. Hans-Jürgen Butt's group.

His research interests include synthesis and investigation of organosilicon materials, polyester and polyurethane, and biomedical polymer materials. He also solves the problems and optimizes the conditions during the processing and manufacturing of these materials for their final applications.

Functionalized polysilsesquioxane materials

Qingzeng Zhu*, Ruofei Hu, Hui Liu, Jiaojie Cao, Chunxiao Li, Weikai Chen and Shengyu Feng

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Polysilsesquioxane (PSQ) refers to an organosilicon polymer with formula $RSiO_{3/2}$, where R is a hydrogen atom or a carbon moiety. This kind of materials is usually prepared from tri-functional silanes by sol-gel polymerization. The silicon-oxygen framework offers the materials stability and the organic functional groups offer the materials functional site for versatile applications. PSQs possess moldability, heat resistance, thermosetting property, and characteristic electrical and optical properties. PSQs can be used in the areas of photoresists, interlayer dielectrics, and coating films nowadays.

In this topic, chelating polysilsesquioxane, molecularly imprinted polysilsesquioxane, various morphologies polysilsesquioxane particles, fluorescent sensors based on polysilsesquioxane, ordered bridged silsesquioxanes and cubic *n*-propylsilsesquioxanes will be discussed.

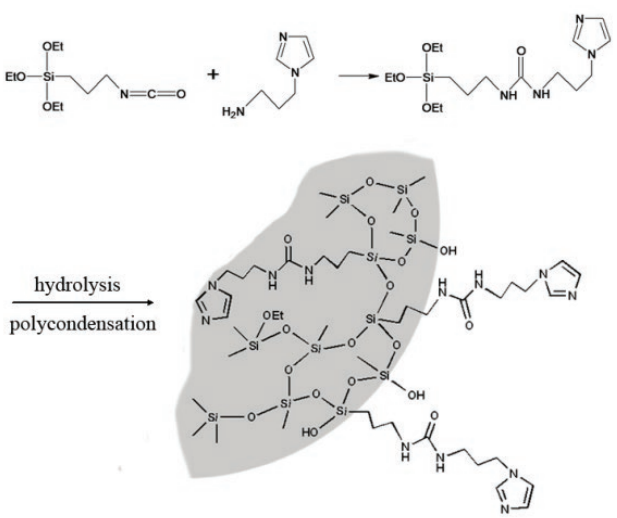

Fig.1 Chelating polysilsesquioxane

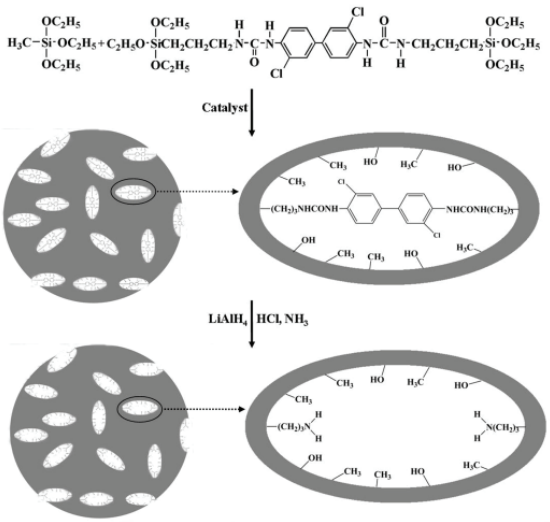

Fig.2 Molecularly Imprinted Polysilsesquioxane

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