

RIKEN-KNU

Partnership Symposium



BK21+



Date: 27 July 2015

Venue: RIKEN Cooperation Center 3F meeting room

Time	Programme	Remarks
9.00 – 9.30 am	Registration	
9.30 – 9.35 am	Opening Speech from KNU, Prof. Inn-Kyu Kang	5 min
9.35 – 9.40 am	Opening Speech from RIKEN, Dr. Yoshihiro Ito	5 min
9.40 – 10.10 am	RIKEN: Dr. Kazuo Takimiya Molecular and Macromolecular Approach to Organic Electronics: New Heteroaromatic Building Blocks for Opto/Electronic Materials	30 min
10.10 – 10.40 am	KNU : Prof. YoungKyo Kim Applications of Organic Field-Effect Transistors and Future Approaches in Flexible Electronics Era	30 min
10.40 – 11.10 am	RIKEN : Dr. Masuki Kawamoto Aqueous Processing for Photoelectric Conversion Materials	30 min
11.10 – 11.25 am	KNU: Mr. Jaehoon Jeong Organic Photodetectors for Sensing UV and Visible Lights: Inverted Device Structures with Metal Oxide Nanolayers	15 min
11.25 – 11.40 am	KNU: Ms. Sunju Hwang Gold Nanofiber Networks for Stretchable Electronics	15 min
11.40 – 1.00 pm	Lunch Break	
1.00 – 1.30 pm	RIKEN : Dr. Hye Ryung Byon Understanding of Lithium-Oxygen Electrochemistry For Lithium-Oxygen Batteries	30 min
1.30 – 2.00 pm	KNU : Prof. In Woo Cheong Preparation of Janus Particles by Droplet Microfluidics	30 min
2.00 – 2.30 pm	RIKEN: Dr. Yousoo Kim Single-Molecule Chemistry and Spectroscopy with STM	30 min
2.30 – 2.45 pm	KNU : Ms. Eunjung Kang Near-Room Temperature Synthesis of Core/Shell Structured Quantum Dots	15 min
2.45 – 3.00 pm	KNU : Ms. Mi-Ri Kim Preparation of Photo and Temperature Responsive Polymeric Vesicles Containing Spiroanthoxazine Via W/O/W Double Emulsion	15 min
3.00 – 3.30 pm	Tea Break	
3.30 – 4.00 pm	RIKEN : Dr. Motoki Ueda Phase-Separated Molecular Assemblies from Amphiphilic Polypeptides Having Helical Hydrophobic Block	30 min
4.00 – 4.15 pm	KNU : Mr. Kyubae Lee Detection of Antigen From Human Plasma Solution by Functionalized Liquid Crystal Droplets	15 min
4.15 – 4.30 pm	RIKEN : Ms. Tran Thoa Thi Thanh Aptamer -based selective electron transfer from photo-excited state of Ru(bpy) ₃ ²⁺	15 min
4.30 – 4.45 pm	KNU : Mr. Sang Hun Lee Application of the Fuoss-Kirkwood Relation to Inferring Relaxation Time Spectrum	15 min
4.45 – 5.00 pm	RIKEN : Ms. Shinhye Park In Vitro Selection of Collagen-Binding Vascular Endothelial Growth Factor	15 min
5.00 – 5.30 pm	KNU : Prof. Inn-Kyu Kang In-Vitro Detection of Cancer Cells Using Ligand-Anchored Liquid Crystal Microdroplets	30 min
5.30 – 5.35 pm	Closing Remarks	5 min

Molecular and Macromolecular Approach to Organic Electronics: New Heteroaromatic Building Blocks for Opto/Electronic Materials

Kazuo Takimiya, Masahiro Nakano, and Itaru Osaka

Emergent Molecular Function Research Group, RIKEN Center for Emergent Matter Science (CEMS),
Wako, Saitama, 351-0198 Japan

ABSTRACT

The field of organic electronics has emerged as a potential technology enabling to realize low cost, ubiquitous, and soft electronics applications. One of the key materials in the technology is organic semiconductors that act as the active material in the electronic devices such as organic field-effect transistors (OFETs) and organic photovoltaic cells (OPVs). Our research group has tried to develop organic semiconductors including small molecular- and conjugated polymer-based materials. In particular, we have focused on fused-heteroarene structures as the key building unit. Such heteroarenes are [1]benzothieno[3,2-*b*][1]benzothiophene (BTBT) [1], dinaphtho[2,3-*b*:2',3'-*f*]thieno[3,2-*b*]thiophene (DNTT) [2], isomeric naphthodithiophenes (NDTs) [3], anthra[2,3-*b*:6,7-*b'*]dichalcogenophenes (ADXs) [4], benzo[1,2-*b*:4,5-*b'*]dichalcogenophenes (BDXs) [5], naphtho[1,2-*c*:5,6-*c'*]bis[1,2,5]thiadiazole (NTz) [6]. These heteroarenes can be efficiently synthesized and modified to afford superior molecular semiconductors, or incorporated into conjugated chains to provide new semiconducting polymers. In this presentation, synthetic chemistry and design strategy of these materials are discussed together with their device characteristics.

References

[1] Ebata, H. *et al. J. Am. Chem. Soc.* **2007**, *129*, 15732. [2] Yamamoto, T.; Takimiya, K. *J. Am. Chem. Soc.* **2007**, *129*, 2224. [3] Shinamura, S. *et al. J. Am. Chem. Soc.* **2011**, *133*, 5024. [4] Nakano, M. *et al. J. Org. Chem.* **2012**, *77*, 8099. [5] Takimiya, K. *et al. J. Am. Chem. Soc.* **2004**, *126*, 5084. [6] Osaka, I. *et al. J. Am. Chem. Soc.* **2012**, *134*, 3498.

Short BIOGRAPHY



E-mail: takimiya@riken.jp Tel: FAX: +81-48-462-1473
Ph.D. Hiroshima University, 1994
JSPS Research Fellow for Young Scientist (1994)
Research Associate, Hiroshima University (1994)
Visiting Researcher at Odense University, Denmark (1997-1998)
Associate Professor, Hiroshima University (2003)
Professor, Hiroshima University (2007)
Group Director at RIKEN CEMS (2013-)

APPLICATIONS OF ORGANIC FIELD-EFFECT TRANSISTORS AND FUTURE APPROACHES IN FLEXIBLE ELECTRONICS ERA

Jooyeok Seo, Hyemi Han, Jaehoon Jeong, Sungho Nam, Hwajeong Kim and Youngkyoo Kim*

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

Organic electronic devices have attracted keen interest because of their huge potentials for next generation electronic device applications. Organic light-emitting devices (OLEDs), which are the first commercialized example of organic electronic devices, are now in market for smart phones and TV sets. Recently, organic solar cells (OSCs) have been intensively studied by various research groups and companies, because the power conversion efficiency of OSCs has reached 9~11% so that their commercialization can be positively anticipated though one condition is left on the stability of OSCs. Organic field-effect transistors (OFETs) have been also widely studied for more than two decades and their performances are being improved to catch conventional FETs. However, the charge carrier mobility of organic semiconducting materials is still far lower than that of inorganic semiconducting materials. This discourages applications of OFETs toward display backplanes and/or memory devices. This presentation will introduce a couple of our efforts for OFETs in terms of applications, such as photodetectors, memory devices, artificial skins etc., in order to find their practical applications through a trade-off between drawbacks in performances and advantages in functions.

Short BIOGRAPHY



E-mail: ykimm@knu.ac.kr, Tel: +82-950-5616, Mobile: 010-3353-0172
B.S. Polymer Science & Engineering, Pusan National University (1991)
M.S. Polymer Science & Engineering, Pusan National University (1993)
Ph.D. Polymer Science & Engineering, Pusan National University (1996)
Ph.D. Physics (Organic Electronics), Imperial College London (2006)
Associate Professor, Department of Chemical Engineering, Kyungpook National University (2007-present)
Principal Researcher, LG R&D Center (2006) / Consultant, Samsung Display (2011-2013)

AQUEOUS PROCESSING FOR PHOTOELECTRIC CONVERSION MATERIALS

Masuki Kawamoto

Emergent Bioengineering Materials Research Team, RIKEN Center for Emergent Matter Science (CEMS) and Nano Medical Engineering Laboratory, RIKEN, 2-1 Hirosawa, Wako, Saitama 351-0198, Japan

ABSTRACT

Single-walled carbon nanotubes (SWCNTs) have been attractive for optoelectronic applications; their extreme electrical properties are of great interest for carbon-based devices. However, SWCNTs form bundles owing to van der Waals interactions and result in poor solubility. When a small amount of the dispersants such as surfactants, polymers, DNA, proteins, or peptides is attached to SWCNTs, well-dispersed solutions are obtained even in water. Unfortunately, most dispersants hinder the transport of electrons, because of their electrically insulating properties.

We developed a novel methodology for solubilizing SWCNTs using semiconducting nanoparticles in water. The aqueous-processed direct assembly of electron-transporting (n) methyl [6,6]-phenyl-C₆₁-butyrate (PCBM) nanoparticles and SWCNTs was essentially unchanged for several months in water without surfactants. The PCBM nanoparticles of 30 nm diameters were attached to the surface of SWCNTs owing to carbon-based π - π interaction. After an aqueous solution of hole-transporting (p) water-soluble polythiophene (WSPT) was added to the PCBM nanoparticle-SWCNT dispersed solution, coassembled p/n heterojunctions of WSPT-PCBM nanoparticles onto SWCNTs was produced. We also demonstrated that exciton generation at p/n heterojunctions and the transfer of electrons were observed in the ternary nanocomposites on picosecond timescales. Furthermore, the ternary nanocomposite films exhibited the photocurrent response upon photoirradiation of an air mass 1.5. The aqueous-processed direct assembly is expected to be applicable to water-processable fabrication for energy conversion devices.

Short BIOGRAPHY



E-mail: mkawamot@riken.jp, Tel: +81-48-467-2752.
B. Sc. Himeji Institute of Technology, 1997
Dr. Eng. Tokyo Institute of Technology, 2003
Postdoctoral Fellow, University of Rochester, (2003-2004)
Research Scientist, RIKEN (2004-2010)
Senior Research Scientist, RIKEN (2010-)
Senior Research Scientist, RIKEN CEMS (2013-)
Visiting Associate Professor, Tokyo University of Science (2013-)

ORGANIC PHOTODETECTORS FOR SENSING UV AND VISIBLE LIGHTS: INVERTED DEVICE STRUCTURES WITH METAL OXIDE NANOLAYERS

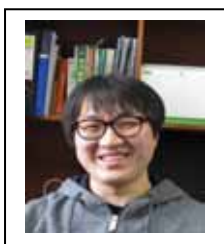
Jaehoon Jeong, Jooyeok Seo, Chulyeon Lee, Myeonghun Song, Sooyong Lee,
Hyemi Han, Eunjoo Kwak, Hwajeong Kim and Youngkyoo Kim*

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

Detectors have been extensively developed for various applications in precision measurements and/or camera applications for our daily life. Most of recent mobile electronic systems, including smart phones and smart pads, have a tendency to employ high-resolution/high-definition cameras that are typically fabricated with inorganic semiconductors. In particular, brand-new flexible/bendable electronic systems need flexible camera systems in order to comply with the trend toward full-flexible electronics era. However, conventional inorganic semiconductors cannot meet such flexibility owing to their intrinsic rigid property even though the minimum bendability can be achieved by sophisticated design/fabrication processes. In this regard, organic photodetectors (OPDs) have been spotlighted because of their benefits to deliver such flexibility when flexible plastic films are accompanied together with organic semiconductors. Of various device types, a diode-type OPD is considered most cost-effective because of its simple structure and fabrication processes that enable large-area OPD production. Recently, we have concentrated on developing an inverted-type device for OPDs and organic solar cells. In particular, our interest has reached sensing of UV light by employing metal oxide buffer layers and conjugated polymer channel layers. In this presentation, we will show the optoelectronic properties of inverted-type OPDs and discuss the mechanism behind the measured performances.

Short BIOGRAPHY



E-mail: jh-jeong@knu.ac.kr, Tel: +82-944-5616, C.P.: 010-8949-7950
B.S. Chemical Engineering, Kyungpook National University (2009)
M.S. School of Applied Chemical Engineering, Kyungpook National University (2013)
Ph.D. Student, School of Applied Chemical Engineering, Kyungpook National University
(2013-present)

Gold Nanofiber Networks for Stretchable Electronics

Sunju Hwang and Soo-Hwan Jeong*

School of Applied Chemical Engineering, Major in Chemical Engineering, Kyungpook National University, 80, Daehak-ro, Buk-gu, Daegu, Korea

ABSTRACT

Flexible, wearable, and stretchable electronics reveal great potential for the next generation electronics due to its promising applications in many areas where devices undergo large deformation. Therefore, many kinds of materials, such as carbon nanotubes, graphene, conductive polymers, and metal, have been extensively studied to endow them with high flexibility and stretchability. Among these materials, metal-based network has provided excellent conductivity and its structure presents relatively good robustness under both bending and stretching situations.

Generally, two methods have been proposed to prepare metal network for these purposes. One is coating dispersed metal nanowires on a stretchable polymeric substrate. In this case, random metal network is formed. Although this approach is very simple, one of the drawbacks is the numerous junctions between individual metal nanowires, resulting in high electrical resistance. The other alternative route is patterning the metal thin films or deposition of a metal film onto a template. Unlike the coating method, one body metal network (mesh) is formed with avoiding wire-to-wire junction problem. As a result, it shows very good electrical conductivity due to junction free structure. However, when tensile strain applies, stress concentrates on their interconnect section of the wires, which shows restricted stretchability.

The aforementioned disadvantages of these processes, such as high junction resistance and limited stretchability, could be solved by using electrospinning the polymeric fibers and subsequent metal deposition on electrospun fibers to form metallized nanofiber network. Electrospinning is considered to be a facile way to obtain continuous and ultralong nanofiber. Extremely long geometries of electrospun nanofiber minimize the number of junctions. Furthermore, nanofiber network accommodates external strain through rearrangement of fibers, thus enhancing more stretchability than that of one body network.

In this seminar, activities of our laboratory regarding the above mentioned topic will be focused. Two structural approaches have been studied to achieve high stretchability of metallized electrospun nanofiber network. First, wavy structure can be obtained by transferring metallized nanofiber network onto prestrained elastomeric substrate and releasing prestrained substrate. Upon stretching, the wavy structure accommodates the strain by straightening. Second approach is patterning the metallized nanofiber network to form double networks. In double networks, lines of large network consist of nanofibers. Structural reorientation of nanofiber network with applied strains transforms shape of small network and then it contributes to shape change of large network. It is expected that these structure changes lead to better stretchability than just metallized nanofiber network.

Short BIOGRAPHY



E-mail: sunju794@knu.ac.kr, Tel: +82-53-950-5615, C.P.: 010-2882-0875

B.S: Department of Chemical Engineering, Faculty of Engineering, Kyungpook National University (2015)

M.S Candidate: School of Applied Chemical Engineering, Kyungpook National University (2015-)

UNDERSTANDING OF LITHIUM-OXYGEN ELECTROCHEMISTRY FOR LITHIUM-OXYGEN BATTERIES

Hye Ryung Byon*

Byon Initiative Research Unit, RIKEN, Wakoshi, Saitama 351-0198, Japan

ABSTRACT

A high demand for the future energy storage applications in electric vehicles (EVs) and grid storage has been driving rapid growth of battery research. In particular, as the current battery technology has almost reached its performance limitation, new battery systems have been extensively investigated to achieve higher energy density. In this context, a lithium-oxygen (Li-O₂) battery has held promise on account for high theoretical energy density (over 3 kWh/kg). However, its development progress has been slow and left the Li-O₂ battery still in the demonstration level due to poor cycling stability and high cathodic polarization. To mitigate these performance degradations, the scientific scrutiny to understand true electrochemical reactions in the Li-O₂ batteries in conjunction with alleviation of parasitic side reactions has been urgently needed.

In this seminar, I present recent research progress of Li-O₂ batteries at Byon IRU. We observe Li-O₂ electrochemical reaction ($2\text{Li}^+ + \text{O}_2(\text{g}) + 2e^- \leftrightarrow \text{Li}_2\text{O}_2(\text{s})$) and evaluate the reaction efficiency using *in situ* analytical tools. These fundamental studies provide the evidence of dynamic Li₂O₂ formation and decomposition, accompanied by parasitic side reactions. Based on the insights obtained from these approaches, we can improve the Li-O₂ cell performance via engineering of Li₂O₂ structure and eliminating of side products. The promising metal oxide catalysts incorporated into carbon nanotube cathode promote smooth decomposition of Li₂O₂ and side products during charge, which greatly lower charge potential and enhance cycling performance, respectively.

Short BIOGRAPHY



Hye Ryung Byon

E-mail: hrbyon@riken.jp, Tel: +81-48-467-9265
B.S. Chemistry, Sookmyung Women's University, 2002
Ph.D. Chemistry, POSTECH, 2008
Initiative Research Scientist, Byon Initiative Research Unit, RIKEN (2011-)
Adjunct Associate Professor, Tokyo Institute of Technology (2014-)

Preparation of Janus Particles by Droplet Microfluidics

In Woo Cheong,* Mi Ri Kim, and Rubal

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

In the recent past, Janus particles of two different surface chemistry or polarity have attracted great attention due to their great potential in applications, such as controlled self-assembly, drug delivery systems, electrical inks, rheological studies, paints and coating. For this, various techniques have been developed, like 2-dimensional direct deposition, phase separation, controlled coalescence of two distinct droplets followed by solidification, hydrodynamics, template-directed self-assembly, etc. Among these, hydrodynamic methods provide a facile and scalable strategy for the preparation of Janus particles. Until now most of microfluidic techniques preparing Janus particles are utilizing two separate streams, which are coflowed through the same channel of the microfluidic device. However, the coflowing streams must remain parallel at all times without perturbations that bring about cross-mixing problem of the fluids. Herein, we present a simple but efficient method of flowing one stream of monomer/polymer solution; therefore, it can avoid the problem of cross-mixing, as in the past cases. In this presentation, I will talk about the Janus particle formation based on photo-sensitive copolymers that have been done for years in my laboratory.

Acknowledgement: This study was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2014R1A1A4A01007436) and Coway Cosmetics (2013/11-2014/10).

Short BIOGRAPHY



E-mail: inwoo@knu.ac.kr, Tel: +82-950-7590, C.P.: 010-4092-8277
B.S. Chemical Engineering, Yonsei University, 1995
Ph.D. Chemical Engineering, Yonsei University, 2001
ARC Postdoc fellowship, KCPC, Univ. of Sydney, 2002-2003
Visiting Scholar, CEMS, Univ. of Minnesota, 2011-2012
Associate Professor, Department of Applied Chemistry, KNU (2005~)

Single-molecule chemistry and spectroscopy with STM

Yousoo Kim*

Surface and Interface Science Laboratory, RIKEN
Hirosawa 2-1, Wako, Saitama 351-0198, Japan

ABSTRACT

The study of single molecules provides deep insights into bonding nature and underlying quantum mechanics concerning about controlling chemical reaction. The scanning tunneling microscope (STM) is a versatile and powerful tool for investigating and controlling chemistry of individual molecules on the solid surfaces. The coupling of tunneling electrons to the electronic and vibrational states of the target molecule allows us to realize mode-selective and state-selective chemistry of the individual molecules as well as to understand how the electron energy can transport leading to various surface processes.

In this talk, I will address two main issues with our experimental and theoretical efforts on investigating interaction of electrons with vibrational and electronic states of a single molecule on the surfaces. The first part is assigned to the excitation of vibrational modes to selectively induce particular dynamic motion and chemical reaction of a single molecule on the metal surfaces. The microscopic mechanism of vibrationally induced molecular motions and the selection rules for the single-molecule vibrational spectroscopy are also discussed. The second part focuses on the selective control of reaction pathways by use of long lifetime of vibrationally and electronically excited states of a molecule on an ultrathin insulating metal oxide surface. The theoretical study revealed that the presence of O vacancies or Mg interstitials at the interface between MgO ultrathin film and Ag(100) substrate result in a substantially lower barrier for the dissociation of water. Finally, I will discuss about our recent works with a photon-STM, where optical properties of a single metal-free phthalocyanine (H_2Pc) molecule on the 2-ML thick NaCl film supported by Ag(111) have been also studied by scanning tunneling luminescence spectroscopy.

Short BIOGRAPHY



E-mail: ykim@riken.jp, Tel: +81-48-467-4073,
B.S. Chemistry, Seoul National University, 1991
Ph.D. Applied Chemistry, The University of Tokyo, 1999
Chief Scientist (2015-)
Director of Surface and Interface Science Laboratory, RIKEN

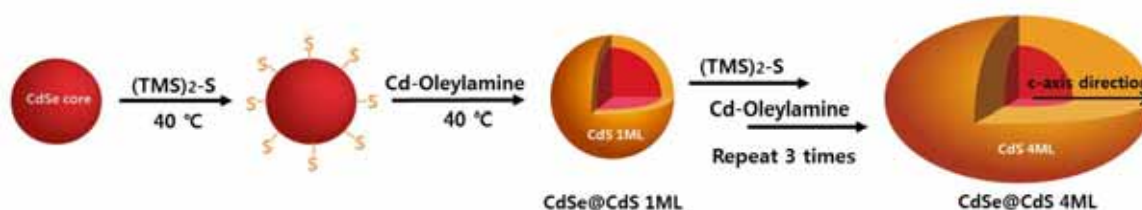
NEAR-ROOM TEMPERATURE SYNTHESIS OF CORE/SHELL-STRUCTURED QUANTUM DOTS

Junhyeong Kim, Eunjung Kang, Jaesung Son, In Woo Cheong, Jin Joo*

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

Core/shell-structured quantum dots (QDs) are considered as important active materials for optoelectronic devices. There have been a lot of synthesis procedures developed so far. Real epitaxial growth of shell layer, however, has not been reported yet. A simple method for the synthesis of CdSe/CdS core/shell QDs is presented. Epitaxial growth of CdS shell on CdSe core is carried out by near room temperature successive ion layer adsorption and reaction (RT-SILAR). Our method for shell formation is conducted at room temperature, which facilitates the separation of resulting products from shell growth solution. After full coverage with one monolayer (ML) of CdS on CdSe QDs surface, photoluminescence (PL) quantum yield (QY) reaches up to 60%. Produced CdSe/CdS QDs have an elongated morphology, implying that CdS layers are formed in an epitaxial manner without etching or deteriorating CdSe QDs surface. This synthesis method for core/shell-structured QDs would be an ideal model for practical implication of QDs as well as fundamental studies.



Short BIOGRAPHY



Email:sweety6min@naver.com C.P.: 01029139534

B.S. Applied Chemistry, Kyungpook National University (2015)

Ph.D. candidate, Kyungpook National University, Daegu, South Korea (2015-)

Preparation of photo and temperature responsive polymeric vesicles containing spironaphthoxazine via W/O/W double emulsion

Mi Ri Kim,* In Woo Cheong

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

Polymers have proven themselves as an ideal candidate in developing stimuli-responsive system because of their versatility through functional substituents. Stimuli-responsive polymers are classified as physical (light, temperature, magnetic), chemical (solvent, ionic strength, pH), or biological stimuli (enzymes, receptors). Among various stimuli, light is the most attractive one because of easy control of intensity, spatial localization, and wavelength changes. Most photo-responsive polymers reported that contain light-sensitive chromophores, such as azobenzene, cinnamoyl, and spiropyran groups.

In the present work, spironaphthoxazine (SPO) methacryloyl was used as a light-stimuli monomer, which undergoes photo-isomerization from closed to open forms resulting the changes in color and hydrophobicity under the UV light of 365 nm. Copolymers containing SPO moiety were prepared from N-isopropylacrylamide (NIPAAm) and styrene monomers through reversible-addition fragmentation chain transfer (RAFT) polymerization, and corresponding vesicles were also prepared using W/O/W double emulsion. Photo-responsive behaviour of these vesicles under UV and visible light will be discussed.

Acknowledgement: This study was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2014R1A1A4A01007436).

Short BIOGRAPHY



E-mail: mile1e1@naver.com, Tel: +82-950-7590, C.P.: 010-5144-8177
B.S. Polymer Engineering, Kumoh National Institute of Technology, 2014

PHASE-SEPARATED MOLECULAR ASSEMBLIES FROM AMPHIPHILIC POLYPEPTIDES HAVING HELICAL HYDROPHOBIC BLOCK

Motoki Ueda, Yoshihiro Ito

**Nano Medical Engineering Laboratory, RIKEN
Hirosawa 2-1, Wako, Saitama 351-0198, Japan**

ABSTRACT

Supramolecules of molecular assemblies are promising nano- or micro-order materials due to the easiness in preparation. The precise control of complex morphology, however, is not easy and thus has been an important challenge in the field of molecular self-assembly. In a cell membrane, an example of the natural molecular assembly, the phase separation enables the control of the unique morphology on cell membrane like caveolae for an effective expression of the cell function. The most phase-separated assemblies reported so far were too unstable to control the size and shape of them.

Here we show that amphiphilic helical peptides can self-assemble into various conjugate morphologies by the phase-separation basis due to selective association of helices including stereocomplex formation of right-handed and left-handed helices. Helical peptides have a good regular packing ability and a high stability in the molecular assembly as shown by frequent observations of helix bundles in proteins. Round-bottom flask assemblies, which are conjugate morphologies of nanotubes and vesicles, can be prepared from amphiphilic helical peptides. The dimensions of the neck part and the spherical part are tunable by changing the combination of the amphiphilic helical peptides. Furthermore, we succeeded to prepare the linear heterojunction by a fusion of different nanotubes with keeping phase-separation.

Short BIOGRAPHY



E-mail: motoki.ueda@riken.jp, Tel: +81-48-467-9303,
B.S. Material Engineering, Kyoto University, 2006
M.S. Engineering, Nara Institute of Science and Technology, 2008
Ph.D. Engineering, Kyoto University, 2011
Researcher, Advanced Scientific Technology and Management Research Institute of Kyoto,
2011-2012
Assistant Professor, Graduate School of Medicine, Kyoto University, 2012-2014
Research Scientist, Nano Medical Engineering Laboratory, RIKEN, 2014-present
Research Scientist, Emergent Bioengineering Materials Research Team,
Center of Emergent Matter Science, 2014-present

Detection of antigen from human plasma solution by functionalized liquid crystal droplets

Kyubae Lee, Inn-Kyu Kang*

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

For more than one decade, liquid crystal(LC) microdroplets have attracted considerable attention not only as chemical targeting but also as biological targeting. Versatile and label free technique based on mono-disperse liquid crystal microdroplets can detect and distinguish antigen from mixed protein solution. The purpose of the study was to find out the interaction between antibody and antigen. 4-Cyano-4'-pentylbiphenyl(5CB, nematic liquid crystal) microdroplets were prepared by using O/W emulsion system. Amphiphilic diblock copolymer of poly (Styrene-b-acrylic acid) (PS-b-PA) was used as a surfactant to prepare the emulsion. Furthermore, anti-IgG(antibody) was introduced on the surface of the LC microdroplets as a hosting platform for protein immunoassays. We also studied the effect of IgG(antigen) concentration on sensing ability of LC droplets as well as selective detection of the LC droplets in mixed protein solution. From the results it was found that the LC microdroplets exhibited configurational change from radial to bipolar by interaction with antigen. Therefore it could be say that functionalized LC microdroplets can play pivotal role in detection of various antigen molecules.

Short BIOGRAPHY



E-mail: power7903@hanmail.net Tel: +82-950-5629, C.P.: 010-4517-6723
B.S. Polymer Science, Kyungpook National University, 2014
M.S. candidate Polymer Science, Kyungpook University, 2015

Aptamer -based selective electron transfer from photo-excited state of $\text{Ru}(\text{bpy})_3^{2+}$

Tran Thi Thanh Thoa **, Toshio Aigaki *, Yoshihiro Ito **, Takanori Uzawa*.

* Nano medical engineering laboratory, RIKEN, 2-1 Hirosawa, Wakoshi, Saitama, Japan .

* Graduate School of Science and Engineering, Tokyo Metropolitan University, 2-1 Minami Osawa, Hachioji, Tokyo, Japan. Email: thoa.tran@riken.jp.

ABSTRACT: $\text{Ru}(\text{bpy})_3^{2+}$ have attracted attention over the past three decades due to their strong reductive and oxidative abilities. However, $\text{Ru}(\text{bpy})_3^{2+}$ can be also strongly quenched by oxygen in solution ($k_q=3.3 \times 10^9$). In particular, there have been many studies of the interaction between Ruthenium complexes with RNA and DNA. Consequently, RNA is more structurally rich than DNA and can work as an enzyme, so an artificial RNA antibody (aptamer) is an interesting target to bind to $\text{Ru}(\text{bpy})_3^{2+}$. With purpose to prevent the electron transfer from $\text{Ru}(\text{bpy})_3^{2+}$ to dioxygen. we should select RNA aptamer binds to $\text{Ru}(\text{bpy})_3^{2+}$. To do so, candidate aptamer sequences were selected and identified from converted-RNA library of 10^{15} DNA molecules using SELEX after 12 rounds of selection. After 12 rounds selection by using SELEX we obtained 8 candidate sequences and identified a minimum functional sequence for binding to $\text{Ru}(\text{bpy})_3^{2+}$. The identified aptamer does not only enantiomer selectively binds to $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ ($K_d=65\text{nM}$) $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ derivatives but also selectively binds to precise 3D structure. The binding of $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ to aptamer elongates its phosphorescence lifetime 4 times. Furthermore, the life time of aptamer-bound $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ does not change under aerobic and anaerobic condition, but the life of free $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ under aerobic condition is longer than its life time under anaerobic condition. Thus life time suggests that the tight packing of the Ru inside of the aptamer reduces quenching efficiency via water dissipation and oxygen-quenching. Interestingly, when we conducted quenching experiment from $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ by using paraquat as an electron acceptor, strong reductive quenching of $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ is held even upon the binding of the aptamer. Thus result points out that our aptamer can blocks dioxygen quenching from $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ without impacting $\Lambda\text{-Ru}(\text{bpy})_3^{2+}$ reductive ability.

Short biography:



B.S. Biology, Hue University, Vietnam, 2004

M.S.C. Biochemistry, Vietnam National University, 2009

Research assistant, Hue University, 2002-2006.

Research assistant, Key lab of Nano medicine, Vietnam national university, 2006-2009.

Research assistant, Chosun University and Kwangju institute of science and technology, 2010-2011

Research associate, Nanomedical engineering Lab., Riken, Japan, 2012-present.

Application of the Fuoss-Kirkwood Relation to Inferring Relaxation Time Spectrum

Sang Hun Lee, Jung-Eun Bae, and Kwang Soo Cho*

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

In the theory of linear viscoelasticity, relaxation time spectrum must be the one of the most important viscoelastic functions because other viscoelastic functions can be calculated from it. However, it should be calculated from other measurable viscoelastic quantities because it cannot be measured directly. The calculation is to solve the Fredholm integral equation of the first kind. Unfortunately, it is well-known that the calculation of relaxation time spectrum is an ill-posed problem. Hence, if the solution of the integral equation is not unique, relaxation spectrum would be meaningless. In 1941, Fuoss and Kirkwood derived the relation between relaxation spectrum and dynamic modulus, called the FK relation which proves the uniqueness of relaxation spectrum. However, most noteworthy algorithms are not based on the least square rather than the FK relation.

In this study, we developed an algorithm for calculation of continuous relaxation spectrum using the FK relation. The core of using the FK relation is how well modulus data can be approximated by an appropriate equation. We suggest double logarithmic power series in terms of Chebyshev polynomial to approximate dynamic modulus data. Our algorithm is to convert the approximate equation for modulus to relaxation spectrum. This approximate approach gives spectrum as accurate as spectra calculated by other previous algorithms based on the least square.

Short BIOGRAPHY



E-mail: gg10star@naver.com, Tel: +82-950-7589, C.P.: +82-10-8541-2336
B.S. Polymer Science and Engineering, Kyungpook National University, Aug. 2014
Graduate Student, Master Course, School of Applied Chemical Engineering, KNU (Aug. 2014-Present)

***In vitro* selection of collagen-binding vascular endothelial growth factor**

Shin-Hye Park, Takanori Uzawa, and Yoshihiro Ito*

**Nano Medical Engineering Laboratory, RIKEN, 2-1 Hirosawa,
Wako, Saitama, 351-0198, Japan**

ABSTRACT

Vascular endothelial growth factor (VEGF) works as important signal protein for angiogenesis during embryonic development or after injury such as myocardial infarction. However after injection of small proteins to a body, it diffuses easily through the extracellular matrix and it is difficult to stay target site for long periods. High concentration of small protein causes undesired side effect such as hemangioma. Therefore it is useful to add some binding affinity to biological components onto VEGF. Since collagen is abundant in cartilage, bones, blood vessels, gut and a dentin in teeth, the surface can be used a target for trap the VEGF.

Here we selected a collagen-binding VEGF by ribosome display which is one of *in vitro* display technology methods. We prepared random sequences of peptide libraries connected to VEGF and selected collagen-binding peptides.

After 8 rounds of *in vitro* selection cycles, 2 kinds of major population of collagen-binding VEGF were obtained. The selected polypeptides were produced by *E. coli*. The biological activity of VEGF was not affected by the addition of binding region peptide. The binding affinity of modified VEGF onto collagen was confirmed by anti-VEGF antibody. As a result they enhanced cell proliferation more significantly than free VEGF on collagen surface.

Short BIOGRAPHY



E-mail: shinhye.park@riken.jp, Tel: +81-48-467-2837

B.S. Department of biotechnology, Chung-Ang University, 2012

Research institute of bio-resource & environment, Chung-Ang University, (2012~)

PhD, Department of life science and medical bioscience, Waseda University, (2013~)

***IN-VITRO* DETECTION OF CANCER CELLS USING LIGAND-ANCHORED LIQUID CRYSTAL MICRODROPLETS**

Yuri Choi, Kyubae Lee, Wang Ding, Inn-Kyu Kang*

School of Applied Chemical Engineering, Graduate School, Kyungpook National University
Daegu 702-701, Korea

ABSTRACT

Liquid crystal microdroplets emulsion for the detection of HepG2 cancer cells has been prepared using 4-cyano-4'-pentyl biphenyl (5CB) liquid crystal molecules in presence of sodium dodecyl sulfate as mediator and ligand anchored poly(styrene-*b*-acrylic acid) (PS-*b*-PA) as modifier of liquid crystal/water interfaces. To induce HepG2 cells interactions with liquid crystal microdroplets, the lactobionic acid (LA) ligand-anchored poly (styrene-*b*-acrylic acid) (PS-*b*-PA-LA) has been synthesized and used to prepare liquid crystal microdroplets emulsion in phosphate buffer saline solution. The interactions of HepG2 cells with liquid crystal microdroplets containing PS-*b*-PA-LA were found to be effective in causing configurational transition from radial to bipolar in liquid crystal molecules during a contact time of 3h in PBS solution (pH 7.4). These studies have clearly indicated that lactobionic acid ligand has strong affinity to interact with HepG2 cells receptor to cause configurational transitions in liquid crystal microdroplets emulsion in comparison to maltotronic acid control. The interactions of liquid crystal microdroplets emulsion containing lactobionic acid-anchored PS-*b*-PA-LA also found to be selective to interact with HepG2 cells in presence of control cells such as KB cancer cells and fibroblast cells at pH 7.4 at 30°C. These studies have clearly indicated that liquid crystal microdroplets emulsion containing lactobionic acid-anchored PS-*b*-PA-LA can be used to develop biosensor for label free optical detection of HepG2 cancer cells in hepatocellular carcinoma using biological fluid.

Short BIOGRAPHY



E-mail: ikkang@knu.ac.kr, Tel: +82-950-5629, C.P.: 010-5287-9629
B.S. Polymer Science, Kyungpook National University, 1980
Ph.D. Polymer Science, Kyoto University, 1987
Professor, Department of Polymer Science, KNU (1988-)
President, Korean Society for Biomaterials, 2009
Dean, School of Applied Chemical Engineering, KNU (2013-)
Director, KNU Center for Scientific Instruments (2012-)