8th RSC-CSJ Joint Symposium 2017
—Recent Developments in Plasmonics—

March 18th (Sat), 2017
Hiyoshi Campus, Keio University; Yokohama, Kanagawa, Japan

The Chemical Society of Japan & The Royal Society of Chemistry
The 8th RSC-CSJ Joint Symposium
―Recent Developments in Plasmonics―
The Chemical Society of Japan  The 97th Annual Meeting

Date March 18th (Sat), 2017  9:00-17:20
Venue S3; Room J29,  Room J29, House B, Bldg., 4
Hiyoshi Campus, Keio University; Yokohama, Kanagawa, Japan
Hosted by
The Chemical Society of Japan (CSJ) & The Royal Society of Chemistry (RSC)

9:00  Opening Remarks  Robert Parker
CEO; RSC

9:10  Recent Developments in Plasmonics: Introduction  Hiromi Okamoto
Institute for Molecular Science

9:20  Site-selective Nanoscale-polymerization via Plasmon
Induced Charge Separation  Yukina Takahashi
Kyushu University

10:00  Investigating Functional Materials using Surface
Plasmon Resonance Spectroscopy  Petra J Cameron, et al.
University of Bath

10:40  Break

10:50  Spectral Properties of Plasmon-Molecule Hybrid
States and Coupled Plasmonic Systems  Kosei Ueno, et al.
Hokkaido University

11:30  Metamaterials for Reactive Plasmonic Applications  Wayne Dickson, et al.
King’s College London

12:10  Lunch Break

13:30  Space and Temporal Properties of Plasmons in a
Single Metal Nanoplate Revealed by Scanning
Near-field Optical Microscopy  Kohei Imura
Waseda University

14:10  Photonics at the Biomedical Interface:
Intracellular Surface-enhanced Raman Spectroscopy  Sumeet Mahajan
University of Southampton

14:50  Break

15:10  Alloy Plasmonic Materials for Sensor Applications  Yoshiaki Nishijima
Yokohama National University

15:50  Chemical Applications of Nanophotonic: Probing the
Structure of Soft Matter with Chiral Nanostructures  Malcolm Kadodwala
University of Glasgow

15:50  Plasmonic Optical Tweezer toward Molecular
Manipulation  Yasuyuki Tsuboi
Osaka City University

17:10  Closing Remarks  Hisashi Yamamoto,
President, CSJ
Welcome to Japan!

Dear Colleagues

Globalization is the process of international integration arising from the interchange of world views, products, ideas, and other aspects of culture.

Particularly, collaborations between chemists of various countries often transcend borders and cultural differences. The fundamental nature of chemical science allows chemists to communicate using knowledge of their field. Its focus is on chemistry students and chemists interested in developing a global approach to open new science and technology, by participating in an international symposium. Overall, multidisciplinary is the password for the successful globalization of chemistry.

The Chemical Society of Japan (CSJ) is delighted to be co-organizing with the Royal Society of Chemistry (RSC) at the occasion of 97th Annual Meeting of Chemical Society of Japan at Yokohama. I am confident that multidisciplinary research can be developed through these international symposia.

I would like to thank Dr. Robert Parker, Chief Executive Officer, Dr. Kathleen Too, International Development Manager-Asia and Dr. Hiromitsu Urakami, Representative of Japan office of RSC, and Prof Hiromi Okamoto and Prof. Yasuyuki Tsuboi, representing CSJ as Chairs, for their great effort to make RSC-CSJ joint symposium possible.

Mutual exchange and collaboration among chemists between two countries have continued ever after, even when the flow of knowledge became no longer one-sided, as it was in early days, and have led to tremendous contributions to the development of new chemistry.

It is our great pleasure and honor to add new pages to the history of mutual exchange between global countries.

Professor Hisashi Yamamoto
President;
The Chemical Society of Japan
Welcome Address

Dear Colleagues

It is my pleasure to welcome you to the 8th UK-Japan Symposium, one of a series of joint events held by the Royal Society of Chemistry and our long-standing partner the Chemical Society of Japan.

We have worked closely with the Chemical Society of Japan for a number of years to support scientific collaboration and exchange between our two countries. In 2010 we formalised our relationship by signing an international cooperation agreement, which we renewed in 2015.

The theme for this year’s symposium is Fundamentals and Chemical Applications of Plasmonics and it brings together leading Japanese and UK scientists to discuss their latest research. We hope that the presentations will stimulate the exchange of ideas and experiences between all participants and we thank each of the speakers and all the participants for their contributions to this symposium.

We are very grateful to the Chemical Society of Japan, Professor Hiromi Okamoto and Professor Yasuyuki Tsuboi for their organisation of this symposium and we look forward to continuing to work even more closely together in the future.

Once again a very warm welcome to what promises to be an exciting scientific event. I hope that today offers an opportunity to build relationships and find new opportunities for researchers from the UK and Japan to collaborate on this important topic.

I wish you all an informative, productive and enjoyable day.

Dr Robert Parker
Chief Executive Officer
Royal Society of Chemistry
Hiromi Okamoto

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- **Educational Background**
  1983  B.Sc., The University of Tokyo
  1985  M.Sc., School of Science, The University of Tokyo
  1993  Doctor of Science, The University of Tokyo

- **Professional Career**
  1985  Research Associate, Institute for Molecular Science
  1990  Research Associate, The University of Tokyo
  1993  Associate Professor, The University of Tokyo
  2000  Professor, Institute for Molecular Science

- **Research Interests**
  1) Near-field microscopy and nano-optics, plasmons
  2) Chiral spectroscopy/microscopy

- **Awards**
  2012  The Chemical Society of Japan Award for Creative Work

- **Recent Publications**
Recent Developments in Plasmonics: Introduction

Hiromi Okamoto

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Collective oscillation modes of conduction electrons in metallic materials, known as plasmons, generate huge polarisations on the materials. Plasmons couple with electromagnetic waves and localises in the vicinities of the metal surfaces, to form resonance states (surface plasmon resonance) that depend on the materials, shapes and sizes of the substances. Surface plasmon resonance is the origin of unique optical properties of metal nanostructures, that is, localisation of the optical field into nano-spaces and huge local field enhancement, and in conjunction with them, reduction of the light velocity in the vicinity of the metal surface, resulting in an increase in wave number (i.e., spatial frequency). In the field of chemistry, a variety of surface enhanced spectroscopies have been developed on the basis of plasmon resonances for nearly 40 years, which provide fundamental techniques of chemical sensors. In addition, it has been recently reported that plasmon resonances accelerate photochemical reaction processes. In the fields of applied physics and optics, the unique optical characteristics of plasmons are exploited as the bases for metamaterials with negative refractive index and various novel optical elements including light sources. Studies pursuing the fundamental characteristics of plasmon resonances and studies on fabrication of metal nanoparticles that yield various unique characteristics are also being made continuously.

In this symposium, we have invited 9 researchers from Japan and UK who are active at the forefront of these fields. The lectures cover research fields from fundamental to application studies, that is, plasmon-assisted chemical reactions (Takahashi), characterization of materials with plasmon resonance spectroscopy (Cameron), strong coupling between plasmons and molecules (Ueno), optical characteristics of plasmon-based metamaterials (Dickson), near-field imaging of plasmons (Imura), biomedical application of surface enhanced Raman spectroscopy (Mahajan), application of plasmons to sensors (Nishijima), chiral plasmonics (Kadodwala) and optical manipulation with plasmons (Tsuboi). With this series of lectures, we intend to overview the current status of researches on plasmons in chemistry and new developments in the future.

I am grateful to Prof. Y. Tsuboi and Prof. M. Kadodwala who co-organised this symposium.
Yukina Takahashi

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➤ Educational Background
2002  B.Eng., The University of Tokyo (supervisor: Prof. Noritaka Mizuno)
2004  M.Eng., Graduate School of Engineering, The University of Tokyo (supervisor: Prof. Tetsu Tatsuma)
2007  Doctor of Engineering, Graduate School of Engineering, The University of Tokyo (supervisor: Prof. Tetsu Tatsuma)

➤ Professional Career
2007  Project research associate, Institute of Industrial Science, The University of Tokyo
2010  Assistant professor, Faculty of Engineering, Kyushu University

➤ Research Interests
1) Photocatalyst
2) Energy conversion
3) Plasmonic metal nanoparticles

➤ Awards
2006  The Predoctoral Fellowship, Hayashi Memorial Foundation for Female Natural Scientists
2011  Excellent Oral Presentation Award for Young Scientist, The 30th meeting of Solid Surface Photochemistry
2012  MMS Award, Precious Metals Research Grants of TANAKA Holdings
2013  Hot Article Award Analytical Sciences (Vol.29, No.1), "Gold Nanorods Embedded in Titanium Oxide Film for Sensing Applications", The Japan Society for Analytical Chemistry
2014  Yang Researcher Award of The Electrochemical Society of Japan (Sano Award), The Electrochemical Society of Japan

➤ Recent Publications
Site-selective Nanoscale-polymerization via Plasmon Induced Charge Separation

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Metal nanostructures, such as gold and silver nanoparticles, can generate strong enhanced electromagnetic fields in nanospaces around the surfaces by coupling with incident light in the wavelength region of visible to near-IR on the basis of localized surface plasmon resonance (LSPR). They can be applied to enhancement of both absorption and emission processes of the light-absorbing molecules and/or semiconductors placed in the nanospaces. It is also known that noble metal nanoparticles combined with an n-type semiconductor, such as TiO$_2$ and ZnO, exhibit plasmon induced charge separation (PICS).$^{1,2}$ When the resonant light irradiates plasmonic metal nanoparticles on an n-type semiconductor, electrons of the metal nanoparticles transfer to the semiconductor resulting in reductive and oxidative reactions on the surfaces of the semiconductor and the metal nanoparticles, respectively. This phenomenon can be utilized to various applications, such as visible-light responsive photocatalysts, photovoltaic cells, and sensing devices.

Control of space arrangement between dye molecules and metal nanostructures is very important for effective utilization of LSPR, because optical properties of dye molecules which only exist at strong enhanced electric fields can be enhanced. In addition, oxidative reactions based on PICS are expected to proceed site-selectively at strong enhanced electromagnetic fields on the surface of metal nanoparticles. Therefore, in this symposium, site-selective nanoscale-polymerization of monomeric dye molecules, such as pyrrole, based on PICS using gold nanoparticle (AuNP)-loaded TiO$_2$ system (Figure 1)$^3$ is demonstrated. Detailed mechanisms of polymerization reactions will be discussed.

**Figure 1.** A schematic illustration and a scanning electron microscopic image of the site-selective nanoscale-polymerization based on PICS.

**References**

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➢ Educational Background
2001 –2004 PhD, University of Bath (Supervisor Prof. L. M. Peter)

➢ Professional Career
2005 –2007, Alexander Von Humboldt Research Fellow, Max Plank Institute for Polymer Research, Mainz, Germany.
2007-2011 RCUK Research Fellow, University of Bath, UK
2012-2014 Assistant Professor, University of Bath, UK
2014-present Associate Professor, University of Bath, UK

➢ Research Interests
1) Energy Materials
2) Functional Materials
3) Solar Cells and Fuel Cells

➢ Awards
Harrison-Meldola Memorial Prize and Medal (Royal Society of Chemistry, 2009)

➢ Selected Publications
2. ‘Cs+ incorporation into CH3NH3PbI3 perovskite: substitution limit and stability enhancement’, Niemann, Ralf G; Gouda, Laxman; Hu, Jiangang; Tirosh, Shay; Gottesman, Ronen; Cameron, Petra J; Zaban, Arie; J. Mater. Chem. A, 2016, 4, 17819.
3. ‘Polymerization of low molecular weight hydrogelators to form electrochromic polymers’,

*A full list of my publications can be found at http://people.bath.ac.uk/chppjpc/publications.html
Investigating Functional Materials using Surface Plasmon Resonance Spectroscopy

Petra J Cameron, Surendra Yadav, Ralf Niemann, and Dave Adams

Department of Chemistry, University of Bath, Bath BA2 7AY, U.K.
Department of Electronic Engineering, University of Rome, Tor Vergata, Rome, Italy
Department of Chemistry, University of Glasgow, Glasgow, G12 8QQ, U.K.

In our research we use surface plasmon resonance spectroscopy (SPR) and optical waveguide spectroscopy (OWS) to investigate the formation and function of a range of soft and hard materials. We combine electrochemistry with SPR to allow the in-situ surface triggered self-assembly of dipeptides into hierarchically structured hydrogels. Using SPR allows us to probe the kinetics of gel formation and the layer-by-layer deposition of ultrathin gel layers with different functionality. We have shown that we can electropolymerise hydrogels in situ to make electrochromic polymers. Polymers prepared from pre-formed gels have quite different micro-structures to polymers formed from monomers dissolved in solution. In the group we also have a strong focus on energy materials. We have used OWS to measure dye uptake in dye sensitized solar cells; more recently we have also been using OWS to look at degradation in perovskite films for perovskite solar cells.
Kosei Ueno

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- **Educational Background**
  1999 B.Sc., Faculty of Science, Hokkaido University
  2001 M.Sc., Graduate School of Science, Hokkaido University
  2004 Doctor of Science, Graduate School of Science, Hokkaido University

- **Professional Career**
  2004-2006: JSPS Research Fellow, Hokkaido University
  2006 -2007: Research Assoc., Hokkaido University
  2007-2008: Assist. Prof., Hokkaido University
  2007-2014: PRESTO Researcher, Japan Science and Technology Agency
  2008-2009: Specially-Appointed Assoc. Prof., Hokkaido University
  2009-present: Assoc. Prof., Hokkaido University
  2010-2012: Visiting Associate Professor, Institute for Molecular Science

- **Research Interests**
  1) Photochemistry on Nanostructured Surface
  2) Plasmon-Based Physics and Chemistry

- **Awards**
  2011 The Japan Chemical Society Award for Young Chemist, The Chemical Society of Japan
  2010 The Japanese Photochemistry Association Prize for Young Scientist, Japan Photochemistry Association
  2007 Yong Scientist Prize, Japan Soc. Analytical Chemistry

- **Recent Publications**
Spectral Properties of Plasmon-Molecule Hybrid States and Coupled Plasmonic Systems

Kosei Ueno, a Sho Nozawa, a Han Yu, a Jie Li, a Quan Sun, a Tomoya Oshikiri, a and Hiroaki Misawa a,b

a Research Institute for Electronic Science, Hokkaido University
b Department of Applied Chemistry, National Chiao Tung University, Taiwan

We are studying plasmon-based chemistry through utilizing well-defined metallic nanostructures fabricated by advanced nanofabrication technologies. To construct metallic nanostructures array with a strong enhancement of electromagnetic field for the photochemical reaction fields, the near field coupling between adjacent metallic nanostructures is often employed for localizing electromagnetic field at the nanogap and inducing dark states of quadrupole mode which shows longer plasmon dephasing. In addition, the strong coupling between plasmon and exciton is also utilized for the modulation of electronic states and the enhancement of light matter coupling. So far, the spectral properties based on the couplings have been mainly studied through far field extinction or reflection spectroscopy. However, it is still unclear that hybrid states are really formed due to the couplings only by measuring the far field spectrum because the spectrum modulation is also induced by the interference of their spectra. Here, we report on the spectral properties of plasmon-molecule hybrid states and coupled plasmonic systems by measuring excitation spectrum or near field spectrum to confirm the formation of hybrid states.

References
Wayne Dickson

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➢ Educational Background
1998  B.Eng., Mechanical Engineering, Queen’s University Belfast
2001  B.Sc., Department of Physics, Queen’s University Belfast
2005  Doctor of Physics, Department of Physics, Queen’s University Belfast
       (supervisor: Prof. A. Zayats)

➢ Professional Career
2005  Queen’s University Belfast (PD)
2010  King’s College London (PD)
2012  Lecturer, King’s College London

➢ Research Interests
1) Nanophotonics, metamaterials.
2) Nanofabrication, self-assembly.

➢ Recent Publications
Metamaterials for Reactive Plasmonic Applications

Wayne Dickson, a Mazhar Nasir, a Pan Wang, a Emiliano Cortes, b William Wardley, a Margoth Cordova-Castro, a Stefan Maier, b Anatoly Zayats a

a Department of Physics, Nano-optics and plasmonics, King’s College London, U.K.
b Department of Physics, Centre for Plasmonics and Metamaterials, Imperial College London, U.K.

Plasmonic metamaterials have long been viewed as excellent candidates as optical sensors due to their strong light matter interaction1 and high sensitivity to variations in the local refractive index2. Self-assembled metamaterials based on arrays of quasi-ordered metallic nanorods possess the necessary sensitivity combined with a scalable fabrication approach.2 These materials have already demonstrated the ability to detect bio-chemical events,2 ultrasound3 and more recently, hydrogen4 with high sensitivity making them excellent candidates for modern sensors. Furthermore, the flexibility of this metamaterial platform make it an excellent candidate for the development of electro-optical sensors based on functionalised quantum tunnelling junctions. In this paper I will review these developments and present the prospects for future sensors and devices.

Figure 1. (a) Schematic of hydrogen sensor comprised of core(Au)/shell(Pd) nanorods. (b) Change in reflectivity of an Au/Pd metamaterial on exposure to 2% H2 in N2. (c) Light emission from a tunneling-electron-driven metamaterial (the size of the emission area is approximately 2mm2).

References
Kohei Imura

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- Educational Background
  1995  B.Sc., Osaka University (supervisor: Prof. Toshio Kasai)
  1997  M.Sc., Graduate School of Science, Osaka University (supervisor: Prof. Toshio Kasai)
  2000  Doctor of Science, Graduate School of Science, Osaka University (supervisor: Prof. Toshio Kasai)

- Professional Career
  2000  JSPS research fellow (PD), Tohoku University
  2001  Assistant professor, Institute for Molecular Science
  2009  Associate professor, Waseda University
  2015  Professor, Waseda University

- Research Interests
  1)  Plasmonics
  2)  Nanomaterials
  3)  Near-field optics

- Awards
  2005  Japan Society for Molecular Science Award for Young Scientists
  2007  The Spectroscopical Society of Japan Award for Young Scientists
  2007  The Chemical Society of Japan Award for Young Chemists
  2012  The Young Scientists’ Prize, The Commendation for Science and Technology by the Minister of Education, Culture, Sports and Technology

- Recent Publications
Space and Temporal Properties of Plasmons in a Single Metal Nanoplate Revealed by Scanning Near-field Optical Microscopy

Kohei Imura

Department of Chemistry and Biochemistry, School of Advanced Science and Engineering, Waseda University, Okubo, Shinjuku, Tokyo 169-8555, Japan

Plasmon excited in metal nanoparticle confines optical fields spatially as well as temporally, and generates enhanced fields in the vicinity of the particle. The enhanced fields have attracted much attention due to their potential use in metamaterials, chemical sensing, and photochemical reactions. To design plasmonic optical fields for the practical applications, spatio-temporal properties of the plasmon should be revealed. Since the spatial scale of the plasmon is smaller than the diffraction limit of light, the microscope with a nanometer spatial resolution is indispensable for visualization. We developed various types of near-field imaging methods to study static and dynamical properties of the plasmons in the metal nanoparticles. In this symposium, we present spatio-temporal properties of plasmons excited in a single metal nanoplate.

Figure 1(a) and 1(b) shows spatial distributions of optical fields on a single gold nanoplate visualized by detecting two-photon photoluminescence from gold. In Fig.1(a), the optical field is enhanced at the apex of the plate due to the lightning rod effect and/or a dipolar mode excitation. In Fig. 1(b), on the other hand, the optical field is enhanced not only at the apex but also at the internal sites of the plate. The spatial features in Fig. 1(b) originate from dipolar and quadrupolar plasmon mode excitations. We examined temporal properties of the plasmons, and found that dynamics on the plate in Fig. 1(a) is almost identical regardless of the internal position of the sample, whereas that in Fig. 1(b) is position dependent. Plasmons provide novel photochemical processes at the nanometer scale, and thus the knowledge obtained from the near-field imaging techniques are indispensable for the applications of the plasmonic optical fields.

References
Sumeet Mahajan

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- **Educational Background**
  2005  M. Tech., School of Bioscience & Bioengineering, Indian Institute of Technology Bombay (supervisor: Prof. A. Q. Contract, Prof. S. Mukherji)
  2008  Doctor of Philosophy, School of Chemistry, University of Southampton (supervisor: Prof. Phillip N. Bartlett)

- **Professional Career**
  1999  Scientist, Defence R & D organisation
  2008  Post-Doctoral Research Fellow, Cavendish Laboratory, University of Cambridge
  2010  EPSRC Fellow, Department of Genetics, University of Cambridge
  2012  Senior Lecturer/Associate Professor, University of Southampton

- **Research Interests**
  1) Surface-enhanced spectroscopies
  2) Label-free chemical imaging
  3) Spectroscopic and imaging applications in biomedicine

- **Awards**
  1998  Proficiency Prize, Indian Institute of Technology Kanpur
  2008  Ronald Belcher Memorial Award by the RSC
  2011  Raymond & Beverly Sackler Fellowship, Magdalene College, University of Cambridge

- **Recent Publications**
Photonics at the Biomedical Interface: Intracellular Surface-enhanced Raman Spectroscopy

Sumeet Mahajan

Department of Chemistry and Institute for Life Sciences, University of Southampton, Highfield, Southampton SO17 1BJ, U.K.

Our research is at the interface of photonics, nanomaterials and biomedicine. I will give an overview of the interdisciplinary work in my group but focus the talk on the applications involving plasmonics for biomedical spectroscopy. Here the research aim is to gain an understanding of biochemical phenomena inside cells and especially obtain information that cannot be provided by prevalent biological techniques. We use the highly sensitive molecular ‘finger-printing’ technique of surface-enhanced Raman spectroscopy (SERS) which relies on the plasmonic enhancement of signals from nanoscale metallic materials. In the case of biological cells we have used gold nanoparticle probes that are voluntarily taken up by them. We use the reporter-free SERS approach. Thus, the SERS nanoprobes report the immediate chemical environment around them. This SERS nanoparticle probe approach is made even more powerful by the functionalization of nanoparticles making them biocompatible as well as allowing the targeting of different organelles. We have shown that such biochemical information provided by SERS allows distinction between closely related cell types and between diseased and healthy cells. Additionally the rich molecular information, available through the reporter-free SERS approach, harvested by multivariate methods allows distinction of organelles such as vesicles in the endolysosomal pathway inside cells. We have further utilized this extremely sensitive methodology for monitoring uptake of small molecules (such as therapeutic drugs) inside organelles in live cells. This paves the way for measuring the bioavailability of drug molecules inside cells, which will improve cell-based assays and the drug discovery process. Although this highly sensitive, real-time chemical sensing capability is unparalleled by any other technique further developments in nanomaterials for SERS are expected to further strengthen this strategy and its adoption in biomedical research and drug discovery.

Figure 1. The Reporter-free SERS approach for obtaining chemical information inside cells.

References
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- Educational Background
2004 B.Sc., Hokkaido University (supervisor: Prof. Noboru Kitamura)
2006 M.Sc., Graduate School of Science, Hokkaido University (supervisor: Prof. Noboru Kitamura)
2009 Graduate school of information science and engineering, Hokkaido University.
(supervisor: Prof. Hiroaki Misawa)

- Professional Career
2008 – 2010 JSPS research fellowship for young scientist.
2011 – 2013 Assistant Professor in Graduate school of Engineering, Yokohama National University. Principle investigator for Plasmonics lab.
2013 – present Associate Professor in Graduate school of Engineering, Yokohama National University. Principle investigator for Plasmonics lab.

- Research Interests
YN is currently interested in the field of plasmonics and nano-photonics. Especially he is interested in the fabricating new optical materials for chemical sensor using surface enhanced Raman and infrared absorption (SERS/SEIRA), photo-thermal photo-electric conversion applications. Recently YN and his group succeeded to reveal experimentally and theoretically that artificially random arrangement of gold nano-disc structures have quieted strong electro-magnetic field enhancement due to the scattering light in the plane. One of the random plasmonic work has published in the ACS photonics. This strong EM field enhancement is useful for the SERS sensors. YN’s group also succeeded to constructing the mid infrared plasmon structures for SEIRA materials. And these materials were applied to the SEIRA gas sensor. These plasmonic materials are effective to reducing the optical pass and total sensor system size with increasing the sensitivity.

- Awards
2009 CSJ Hokkaido winter meeting, best presentation award

- Recent Publications
Alloy Plasmonic Materials for Sensor Applications

Yoshiaki Nishijima
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Precious metal alloys enables new possibilities to tailor materials for specific optical functions. Here we present a systematic study of the effects of a nanoscale alloying on the permittivity of Au-Ag-Cu metals at 38 different atomic mixing ratios. The permittivity was measured and analyzed numerically by applying the Drude model described below equation.

\[ \varepsilon(\omega) = \varepsilon(\infty) - \frac{\omega_p^2}{\omega^2 + i\omega\Gamma} \]  

where \( \varepsilon(\infty) \) represents permittivity at the high frequency limit (infinity), \( \omega_p \) is the plasma frequency, \( \Gamma \) is the damping constant, respectively. Both, optical spectra and XRD results point towards an equivalent composition-dependent electron scattering behavior. Correlation between the fundamental structural parameters of alloys and the resulting optical properties is elucidated.

Plasmonic properties of the Au-Ag-Cu alloy thin film (SPR) and nanoparticles (LSPR) were investigated by numerical calculations. Sensing ability to the refractive index sensing, electromagnetic field enhancement for the surface enhanced Raman spectroscopic application (Au-Ag system) and hydrogen storage alloy sensing (Au-Pd system) will be discussed in the presentation.

Guidelines for designing plasmonic response of nano-structures and their patterns are presented from the material science perspective.

Figure 1. Interpolated ternary plots of experimentally obtained Drude parameters (a) plasma frequency \( \omega_p \) and (b) relaxation constant \( \tau \). Middle inset indicates the atomic ratios at which experimental measurements were performed.
Malcolm Kadodwala

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➢ Educational Background
1990 1st Class B.Sc. (Hons) Chemical Physics, University of Nottingham

➢ Professional Career
2016-Present Professor of Nanoscience and Nanotechnology, School of Chemistry, Joseph Black Building, University of Glasgow, Glasgow, G12 8QQ, UK
2013-2016 Reader, School of Chemistry, Joseph Black Building, University of Glasgow, Glasgow, G12 8QQ, UK
2007-2013 Senior Lecturer, School of Chemistry, Joseph Black Building, University of Glasgow, Glasgow, G12 8QQ, UK
1996-2007 Lecturer, School of Chemistry, Joseph Black Building, University of Glasgow, Glasgow, G12 8QQ, UK
1994-1995 Post-doctoral Fellow, FOM Institute

➢ Research Interests
1) Nanophotonics for Chemical Applications
2) Chirality

➢ Recent Publications
Chemical Applications of Nanophotonic: Probing the Structure of Soft Matter with Chiral Nanostructures

Malcolm Kadodwala
School of Chemistry University of Glasgow,
Joseph Black Building, Glasgow G12 8QQ, U.K.

Chirality, the property of an object to lack mirror symmetry and thus be able to exist in two non-superimposable mirror image forms, is a ubiquitous property in nature. Indeed, the building blocks of life, amino acids and sugars are chiral, and this sense of handedness propagates into the complex structures of life. In this talk I will discuss how near fields with chiral asymmetries, generated by light scattering from chiral nanostructures, can uniquely characterise higher order biological structure which is invisible to conventional spectroscopy. I will demonstrate how the interaction of chiral nanostructures and biomaterials can be understood using concepts from physical chemistry and atomic and molecular physics; orbital hybridisation and quantum interference phenomenon such as electromagnetic induced transparency (EIT).
Yasuyuki Tsuboi

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Educational Background:
1990 Bachelor of Engineering, Osaka University  
(Department of Chemistry, Faculty of Science)
1995 Doctor of Engineering, Osaka University  
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Professional Career:
1995-1996: Fuji PhotoFilm Co. Ltd.
1996 -1999: Research Associate, Kyoto Institute of Technology.
1999-2001: Assistant Prof & Lecturer, Kyoto Institute of Technology.
2001 – 2013: Associate Prof., Hokkaido University.
2013 ~ present: Professor, Osaka City University (current position)

1998-2001: Researcher JST, PRESTO (area of “Structure and Transformation”)
2001-2004: Head of SORST project (JST).
2004 ~ present: Laser System Inc. Ltd. Technical Advisor
2010 ~ 2014: Researcher JST, PRESTO (area of “Photoenergy Conversion Systems”)

Research Interests:
Laser Chemistry, Microspectroscopy, Plasmonics, Laser micro/nano-Processing, Polymer Dynamics

Selected Publications

Plasmonic Optical Tweezer toward Molecular Manipulation

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Plasmonic enhanced electromagnetic field is applicable not only to SERS but also to chemical reaction promotion, and also even to optical trapping. Plasmon-based optical trapping is quite intriguing and is currently attracting much attention in nano-photonics and related research fields, since optical trapping based on surface plasmon can potentially overcome several disadvantages of conventional optical trapping technique using a focused laser beam, i.e.; (i) the conventional technique requires an intense focused laser light and a complicated optical set up to manipulate a small nanoparticle, and (ii) the spatial resolution in the trapping is, as a matter of course, regulated to be more than several hundred nanometers by a diffraction limit of an incident light. As has been predicted theoretically and verified experimentally, an electromagnetic field of incident light should be considerably localized and enhanced at a nano-junction or a nano-gap between metal nanoparticles, so called gap-mode excitation. A schematic illustration for such plasmon-based optical trapping is displayed in the figure.

When photochemically-active species is trapped at such a plasmonic nan-gap, photon, plasmon, and the photoactive species should be simultaneously coupled in the same nano-space. We consider that such situation is an ideal photochemical reaction field in which they interact with each other with great efficiency to promote photochemical reaction yield. The goal of our study is to incarnate such situation. We have developed a plasmonic optical tweezer system and succeeded in novel trapping so far.

References

8th RSC-CSJ Joint Symposium 2017
– Recent Developments in Plasmonics –

■ Date               March 18th (Sat), 2017  9:00-17:20
■ Venue              S3; Room J29,  House B, Bldg. 4,
                     Hiyoshi Campus, Keio University
                     Yokohama, Kanagawa, Japan

■ Hosted by
The Chemical Society of Japan (CSJ)
Co-hosted by The Royal Society of Chemistry (RSC)
Features

1. Suzuki-Coupling of Ar-Cl substrates
2. Borylation of bulky Ar-Cl substrates
3. Regioselective C-H borylation
4. Caged phosphines allow catalysts to be stable in the air.
5. Palladium is separated from the products by Celite filtration.

Reactions

\[
\text{R} - \text{Cl} + \text{Pd(OAc)}_2 \to \text{R} - \text{B} \quad (\text{toluene, 16 h})
\]

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<th>[Pd]/[L]</th>
<th>NMR Yield (%)</th>
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Borylation of bulky Ar-Cl substrates

References


Product List

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Online Catalog: www.e-reagent.com
USA: labchem@wakousa.com
Europe: biochem@wako-chemicals.de
Others: cservice@wako-chem.co.jp