Honorary Chair Professor Toyoko Imae's Research Report (2009.4.1~2013.8.10)

AFFILIATION:

(Since 2009, April 1) Honorary Chair Professor of Graduate Institute of Applied Science and Technology and Joint Chair Professor of Department of Chemical Engineering, National Taiwan University of Science and Technology, Taiwan, ROC

(Since 2006. April 1) Professor Emeritus of Nagoya University, Japan

(Since 2013, April 1) Visiting Professor of Tokyo University of Science

(Since 2013, September 1) Visiting Professor under Academic Icon to the Department of Pharmacology, Faculty of Medicine, University of Malaya

I. Awards and Honors

1) (2009) Award of Ministry of Environment for local environmental protection service, Japan
2) (2011) The 54th excellence paper award at the division of technology on oils and fats from Japan Oil Chemists' Society, Japan
3) (2012) An Academic Award from Helical Science Society, Japan
4) (2012-2013) Guest Lecturer of Kazakh Nationakl Technical University
5) (2013, April 1) Visiting Professor of Tokyo University of Science
6) (2013, September 1) Visiting Professor under Academic Icon to the Department of Pharmacology, Faculty of Medicine, University of Malaya

II. Patents

Application Publication

1) METHOD FOR MAKING CARBON NANOTUBE-LOADED ELECTRODE, CARBON NANOTUBE-LOADED ELECTRODE MADE BY THE METHOD; Toyoko Imae, Ampornphan Siriviriyanun; United States; No. US2013/0161066 A1; Jun. 27/2013

2) BIOCOMPARTIPLE CONFEITO-LIKE GOLD NANOPARTICLES, METHOD FOR MAKING THE SAME, AND THEIR BIOMEDICAL APPLICATIONS; Masaki Ujihara, Toyoko Imae; United States; No. US2013/0164842 A1; Jun. 27/2013

3) METHOD FOR MAKING CARBON NANOTUBE-LOADED ELECTRODE, CARBON NANOTUBE-LOADED ELECTRODE MADE BY THE METHOD; Toyoko Imae, Ampornphan Siriviriyanun; (Country :Taiwan, Application Type :Invention,

Filing Date：2011/12/23, Application No.：100148355) ; Patent/Publication No. TW 201328006 A1; July 1/2013

4) BIOCOMPARTIPLE CONFEITO-LIKE GOLD NANOPARTICLES, METHOD FOR MAKING THE SAME, AND THEIR BIOMEDICAL APPLICATIONS; Masaki Ujihara, Toyoko Imae; (Country：Taiwan, Application Type：Invention, Filing Date：2011/12/21, Application No.：100147776) ; Patent/Publication No.TW 201325614 A1; July 1/2013

Application

1 SYNTHESIS AND APPLICATION OF BIOCOMPATIBLE NANOPOROUS HYDROXYLAPATITE; Toyoko Imae; Taiwan; Invention;

2 FLUORESCENT HYBRID OF DENDRIMER AND GRAPHENE OXIDE Toyoko Imae, Ampornphan Siriviriyanun; Taiwan; Invention; 2012/11/30; 1010062

3 FLUORESCENT HYBRID OF DENDRIMER AND GRAPHENE OXIDE Toyoko Imae, Ampornphan Siriviriyanun; US; Invention; 2012/11/27; 1010061

4 EVALUATION METHOD OF ANTI-FINGERPRINT PROPERTY AND NON-FLUORINATED COATING MATERIALS WITH ANTI-FINGERPRINT PROPERTY; Toyoko Imae, Ampornphan Siriviriyanun; Taiwan; Invention;

5 EVALUATION METHOD OF ANTI-FINGERPRINT PROPERTY AND NON-FLUORINATED COATING MATERIALS WITH ANTI-FINGERPRINT PROPERTY; Toyoko Imae, Ampornphan Siriviriyanun; US; Invention; 2013/1/10; 1010061

III. Publications

Journals

1）Recent Advances in Fabrication of Anisotropic Metallic Nanostructures, Jadab Sharma and Toyoko Imae, J. Nanosci. Nanotechnol. 9, 19-40 (2009) **(Review article)**

2) Fabrication of dendrimer porogen-capsulated mesoporous silica via sol-gel process of silatrane precursor, Walairat Tanglumlert, Sujitra Wongkasemjit, and Toyoko Imae, J. Nanosci. Nanotech., 9, 1844-1850 (2009)

3) Surface Modification of Gold Nanorods by Organosilanes, Koji Mitamura, Toyoko Imae, Nagahiro Saito, and Osamu Takai, Composite Interfaces, 16 (2009) 377-385

4) Fluorescence investigations of oxygen-doped simple amine; in comparison with fluorescent PAMAM dendrimer, Chih-Chien Chu and Toyoko Imae, Macromol. Rapid Commun., 16, 89-93 (2009)

5) Functionalization of Gold Nanorods toward Their Applications, Koji Mitamura and Toyoko Imae, Plasmonics, 4 (2009), 23-30**. (review article)**

6) Synthesis of Poly(amido amine) Dendrimer with Redox-Active Spacers, Chih-Chien Chu and Toyoko Imae, Macromolecules, 42 (2009) 2295-2299

7) Perpendicular Superlattice Growth of Hydrophobic Gold Nanorods on Patterned Silicon Substrates via Evaporation-induced Self-assembling, Xiaoming Zhang and Toyoko Imae, J. Phys. Chem. C, 2009, 113 (15), 5947-5951

8) pH Dependent Encapsulation of Pyrene in PPI-core:PAMAM-shell Dendrimers, Dinakaran Kannaiyan and Toyoko Imae, Langmuir, 25 (2009) 5282-5285

9) Synthesis of Mo-SBA-1 catalyst via sol-gel process and its activity, Sujitra Wongkasemjit; Suparb Tamuang; Walairat Tanglumlert; Toyoko Imae, Materials Chemistry and Physics, 117 (2009) 301-306.

10) Styrene oxidation with H_2O_2 over Fe- and Ti-SBA-1 mesoporous silica, Walairat Tanglumlert, Toyoko Imae, Timothy J. White, Sujitra Wongkasemjit, Catalysis Communications, 10, 1070-1073, 2009.

11) Hierarchical Structures of Dendritic Polymers, Masaki Ujihara and Toyoko Imae, Polym. Int., 59, 137-144 (2010). **(Review article)**

12) Immobilization of amphiphilic dendron on silica particles toward the application to ultrahigh pressure liquid chromatography, Chih-Chien Chu, Norio Ueno, and Toyoko Imae, J. Nanosci. Nanotec., 10, 5324-5327 (2010).

13) Bio-modulation Approach for Gold Nanoparticles: Synthesis of Anisotropic to Luminescent Particles, Jadab Sharma, Yian Tai, and Toyoko Imae, Chemistry - an Asian Jurnal, 5, 70-73 (2010).

14) Characterization of mimetic lipid mixtures of stratum corneum, Xiaojuan Wang, Masaki Ujihara, Toyoko Imae, Akira Ishikubo, Yuki Sugiyama, and Tooru Okamoto, Colloids and Surfaces B: Biointerfaces, *78*, 92-100 (2010).

15) Visual observation of selective elution of components from skin-mimetic lipid membrane, Xiaojuan Wang, Masaki Ujihara, Toyoko Imae, Takuya Saiwaki, Akira Ishikubo, and Tooru Okamoto, Colloids and Surfaces B: Biointerfaces, 2010, 81, 174-177 (2010)

16) Damage/Recovery by Additive on Lipid Membrane as a Mimicry of Human Stratum Corneum, Yan Zhu, Toyoko Imae, Takuya Saiwaki and Takashi Oka, Langmuir, 26,

4951–4957 (2010).

17) Surface functionalization of carbon micro coils and their selective immobilization on surface-modified silicon substrates, Prashanta Dhoj Adhikari, Yian Tai, Masaki Ujihara, Chih-Chien Chu, Toyoko Imae, and Seiji Motojima, J. Nanosci. Nanotec., 10, 833-839 (2010).

18) Reinforcement on Properties of Poly(vinyl alcohol) Films by Embedding Functionalized Carbon Micro Coils, Prashanta Dhoj Adhikari, Masaki Ujihara, Toyoko Imae, Po-Da Hong and Seiji Motojima, J. Nanosci. Nanotec. 11, 1004-1012 (2010).

19) Sensitizing of Pyrene Fluorescence by β-cyclodextrin-modified TiO_2 Nanoparticles, Indrajit Shown; Masaki Ujihara; and Toyoko Imae, Journal of Colloid & Interface Science, 352, 232-237 (2010)

20) Synthesis of β-cyclodextrin-modified water-dispersible Ag-TiO_2 core-shell nanoparticles and their photocatalytic activity, J. Nanaosci. Nanotec., Indrajit Shown, Masaki Ujihara and Toyoko Imae, 11, 3284-3290 (2011)

21) Visual observation and characterization of fluorescent poly(amido amine) dendrimer in film state, Govindachetty Saravanan and Toyoko Imae, J. Nanosci. Nanotech. 11 (2011) 4838-4845.

22) Visual observation of avidin-biotin affinity by fluorescent G4.5 poly(amidoamine) dendrimer, Govindachetty Saravanan, Kenji Daigo, Toyoko Imae, and Takao Hamakubo, Colloids and Surfaces B: Biointerfaces, 83 (2011) 58–60.

23) Synthesis and Characterization of “Hairy Urchin”-like Polyaniline by Using β-Cyclodextrin as a Template, Adhimoorthy Prasannan, Tram Le Bich Truong, Po-Da-Hong, Narayanasastri Somanathan, Indrajit Shown and Toyoko Imae, Langmuir, 2011, 27 (2), 766-773.

24) A combination of hard and soft templating for the fabrication of silica hollow microcoils with nanostructured walls, Carlos Rodriguez-Abreu, Neus Vilanova, Conxita Solans, Masaki Ujihara, Toyoko Imae, Arturo Lopez-Quintela and Seiji Motojima, Nanoscale Research Letters, 2011, 6, 330.

25) Self-association behavior in water of an amphiphilic diblock copolymer comprised of anionic and dendritic blocks, Shin-ichi Yusa, Yoshihiko Shimada, Toyoko Imae, and Yotaro Morishima, Polymer Chemistry, 2, 1815-1821, 2011.

26) Selective immobilization of carbon micro coils on patterned substrates and their electrochemical behavior on ITO substrate, Prashanta Dhoj Adhikari, Toyoko Imae, and Seiji Motojima, Chemical Engineering Journal, 174 (2011) 693-698.

27) Intrinsically Fluorescent PAMAM Dendrimer as Gene Carrier and Nanoprobe for Nucleic Acids Delivery: Bioimaging and Transfection Study, Ya-Ju Tsai, Chao-Chin Hu, CHih-Chien Chu, and Toyoko Imae, Biomacromolecules, 2011, 12, 4283-4290.

28) "Two Photon Confocal Imaging Study: Cell Uptake of Two photon Dye-labeled PAMAM Dendron with HeLa Cells", H.-C. Tsai, T. Imae, G. Calderó, C. Solans,J. Biomed. Mater. Res. A., 100A, 746-756 (2012).

29) Network of sodium hyaluronate with nano-knots junction of poly(amido amine) dendrimer, Toyoko Imae and Shin-ichi Hamaguchi, Carbohydrate Polymers, 88 (2012) 352-360.

30) Fabrication of carbon microcoil/polyaniline composite by microemulsion polymerization for electrochemical functional enhancement, Indrajit Shown, Toyoko Imae, Seiji Motojima, Chemical Engineering Journal, 187 (2012) 380-384. **(cover-page illustration)**

31) Solution-based nano-plasmonic sensing technique by using gold nanorods", Fu Han Ho, Yung-Han Wu, Masaki Ujihara and Toyoko Imae, Analyst, 2012, 137, 2545-2548.

32) Syntheses and Characterizations of Multi-walled Carbon Nanotubes-Supported Palladium Nanocomposites, Walid Mohamed Rashad Daoush, Toyoko Imae, Journal of Materials Research, 27, 2012, 1680-1687.

33) Advantages of Immobilization of Pt Nanoparticles Protected by Dendrimers on Multiwalled Carbon Nanotubes, Ampornphan Siriviriyanun and Toyoko Imae, Phys. Chem. Chem. Phys., 2012, 14, 10622-10630.

34) Fabrication and Characterization of Dendrimer-Functionalized Mesoporous Hydroxyapatite, Nabakumar Pramanik, and Toyoko Imae, Langmuir, 2012, 28, 14018−14027.

35) Surface Immobilization of Carbon Nanotubes by β-cyclodextrins and Their Inclusion Ability, Vinod I. Bhoi[1], Toyoko Imae, Masaki Ujihara and C. N. Murthy, J. Nanosci. Nanotech., 2013 in press

36) Functionalization of Carbon Microcoils by Platinum-loading through Dendrimer Binder**,** A. Siriviriyanun, T. Imae, and S. Motojima, Sci. Adv. Mater., 2013, 5, 1-6.

37) Advantages of electrodes with dendrimer-protected platinum nanoparticles and carbon nanotubes for electrochemical methanol oxidation, Ampornphan Siriviriyanun and Toyoko Imae, Phys. Chem. Chem. Phys., 2013, 15, 4921-4929.

38) Controlling Wettability and hydrophobicity of Organo Clays Modified with Quaternary Ammonium Surfactants, Kinjal J Shah; Manish Kumar Mishra; Atindra D. Shukla; Toyoko Imae; Dinesh O Shah, J. Colloid Interface Sci. 407 (2013) 493-499

39) Renewable catalyst with Cu nanoparticles embedded into cellulose nano-fiber film, Ramaraju Bendi and Toyoko Imae, RSC Advances, in press

40) Versatile One-Pot Synthesis of Confeito-Like Au Nanoparticles and Their Surface-Enhanced Raman Scattering Effect, Masaki Ujihara and Toyoko Imae, Colloids and Surfaces A: Physicochemical and Engineering Aspects, in press

41) Fluorescence Quenching of Uranine on Confeito-Like Au Nanoparticles, Masaki Ujihara, Nhut Minh Dang, and Toyoko Imae, J. Nanosci. Nanotech., in press

Book

1) "Neutrons in Soft Mstter" Eds. By Toyoko Imae, Toshiji Kanaya, Michihiro Furusaka and Naoya Torikai, John Wiley & Sons Inc., Hoboken, New Jersey, March 2011, ISBN: 978-0-470-40252-8 (total 668 page)

Book chapter

1) Synthesis of water-dispersible carbon nanotube–fullerodendron hybrids in "Nanomaterials: Synthesis, Characterization, and Applications", Kumi Hamada, Toyoko Imae, Yu Morimoto, and Yutaka Takaguchi Editors, Edited by A. K. Haghi**,** Ajesh K. Zachariah**,** Nandakumar Kalariakkal *To Be Published* March 15th 2013 by Apple Academic Press – 296 pages Series: Advances in Nanoscience and Nanotechnology Apple Academic Press Inc., 3333 Mistwell Crescent, Oakville, Ontario, L6L 0A2 Canada

2) Physicochemical Properties of Dendrimers and Dendrimer-drug Complexes in "Dendrimer-based Drug Delivery Systems: from Theory to Practice" Toyoko Imae, Ed. by YiYun Cheng, John Wiley Sons., Inc., Chapter 3, 55-92 (2012)

3) Fabrication of dendrimers towards biological application in "Nanoparticles in Translational Science and Medicine" in "Progress in Molecular Biology and Translational Science" book series, Hsieh-Chih Tsai and Toyoko Imae, Ed. Antoni Villaverde, Academic Press (Elsevier) Part I, Chapter 3, 101-140, 2011

4) Structure of Dendritic Polymers and Their Films in "Neutrons in Soft Matter", Koji Mitamura and Toyoko Imae, Eds. Toyoko Imae, Toshiji Kanaya, Michihiro Furusaka, and Naoya Torikai, Wiley, 435-454, 2011

5) Mesophase Morphologies of Silicone Block Copolymers in a Selective Solvent Studied by SAXS, Dietrich Leisner, Md. Hemayet Uddin, M. Arturo López-Quintela, Toyoko Imae and Hironobu Kunieda, Self-Organized Surfactant Structures, edited by Tharwat F. Tadros, 161-174, 2010

IV. Research Projects Executed

Title of Research Project (For NSC grant applications, indicate grant number)	Role/ Position	Duration (MM/YY~ MM/YY)	Funding or Sponsoring Institution	Project Status	Total Expenses
The Development and Evaluation of Nano-Graphene-Oxide-Anticancer Drug Conjugates (UM.C/625/1/HIR/MOHE/MED/17)	PI	2013-2015	University of Malaya High Impact Research Grant	執行予定	RM100,000 /3years
発展効能化碳材料及其於緑能行程之応用	PI	2013/08/01-2014/07/31	行政院國家科學委員會	執行中	1,320,000NTD /year
整合型:多功能性有機/無機混成材料於智慧建材之應用 100H451201	共同 PI	2013/01/01 -2013/12/31	国立台湾科技大学建築中心頂尖計書	執行中	460,000NTD /year
整合型:多功能性有機/無機混成材料於智慧建材之應用 100H451201	共同 PI	2012/01/01 -2012/12/31	国立台湾科技大学建築中心頂尖計書	已結案	520,000NTD /year

技專院校想像力與科技實作能力培育計劃 - 比與比值科學思維推升技專院校學生奈米與製造之想像力與實作能力 100-2511-S-011-007-MY2	PI	2011/08/01 -2013/07/31	行政院國家科學委員會	**已結案**	1,459,000NTD /2 years
整合型:多功能性有機/無機混成材料於智慧建材之應用 100H451201	共同 PI	2011/06/01 -2011/12/31	国立台湾科技大学建築中心頂尖計書	**已結案**	450,000/NTD /6 months
表面抗污材料與製程技術開發先期評估計劃)	PI	2011	Foxlink Co. Ltd.	**已結案**	662,500NTD/
奈米碳管混成物之備製與其奈米技術之研究(Taiwan-India Collaboration Program 99-2923-M-011-002-MY3	PI	2010/1/1 -2012/12/31	行政院國家科學委員會	**已結案**	2,040,000NTD /3years
先進奈米複合材料的製備與藥物傳遞之研究(Formosa Collaboration Project) 99-2923-M-011-001-MY3	PI	2010/1/1 -2012/12/31	行政院國家科學委員會	**已結案**	4,350,000NTD /3years
新型態微米碳卷衍生之有機無機混成物的合成分析與性質探討 98-2923-M-011-002-MY2	Co-PI	2009/1/1 -2010/12/31	行政院國家科學委員會	**已結案**	1,488,000NTD /2years

V. Research Report

Research Targets

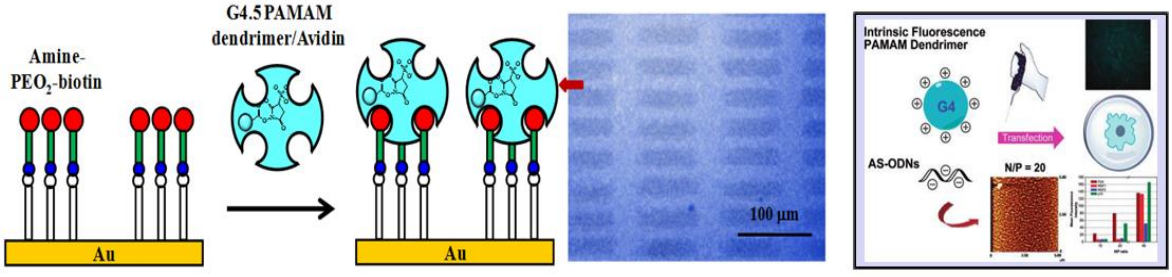
Our group, a “Nanoarchitecture and Nanotechnology” group, mainly focuses the target on the advanced nanomaterials for smart technology, especially, the fabrication of functional hybrids and composites (nanoarchitecture). The investigation is carried out using various materials such as soft materials (amphiphiles, polymers, and dendrimers), carbon materials (fullerenes, carbon nanotubes, carbon microcoils, graphenes and carbon nanohorns), nanoparticles (metal and metal oxide particles) and other inorganic materials (minerals and porous materials). Such materials can be incorporated as components in the hybrid and composite systems. The processes are performed by means of various techniques (nanotechnologies) like binding, adsorption, self-assembly, accumulation, lithography, etc., as well as traditional chemical syntheses and chemical binding. Thus-prepared hybrids/composites were characterized by means of the instrumentality of various methodologies of spectroscopy, microscopy,

thermodynamics, electrochemistry and so on. Such advanced materials can be incorporated as components to build up systems, devices, and sensors, which are applicable to energy, photonics, environmental and biomedical sciences. The investigations since 2009 can be summarized in the following titles.

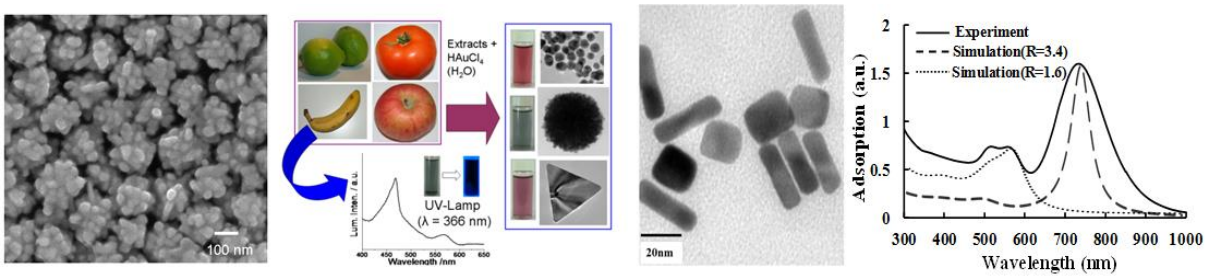
1. Anomalous luminescence property of dendritic polymers: Fundamental and biomedical application
2. Metal particles with unique shapes: Fabrication and biomedical application
3. Hierarchy structures of functional components on carbon materials: Construction and applications to energy/environmental/biomedical sciences
4. Biocompatible porous materials: Synthesis and application to environmental science
5. Eco-friendly cellulose firms: preparation and their functionalities

Representative researches

Visual Observation and Bioimaging Application of Fluorescent Poly(amido amine) Dendrimers: Since we have discovered the emission of blue fluorescence from poly(amido amine) (PAMAM) dendrimers, we characterized such luminescence. Especially, the visualization of fluorescent dendrimers is possible and indispensable for the utilization as an imaging agent. When an avidin molecule was labeled with these fluorescent dendrimers, it was confirmed by the observation of fluorescent dendrimers that avidin-bound fluorescent dendrimers interact selectively with biotins immobilized on the patterned substrates. (Govindachetty Saravanan, Kenji Daigo, Toyoko Imae, and Takao Hamakubo, Colloids and Surfaces B: Biointerfaces, 2011, 83 58–60.) On the other hand, the gene delivery and transfection toward rat C6 glioma cell lines were successfully evaluated by the blue fluorescence of PAMAM dendrimer. The fluorescent dendrimer revealed the lower vitro cytotoxicity toward C6 cells. The cellular uptake behavior could be directly analyzed by fluorescence microscopy and flow cytometry, without additional fluorescence labeling. Our preliminary results clearly indicated that fluorescent PAMAM dendrimers show the promise as gene/drug vehicles that can achieve delivery, transfection, and bioimaging at the same time. (Ya-Ju Tsai, Chao-Chin Hu, CHih-Chien Chu, and Toyoko Imae, Biomacromolecules, 2011, 12, 4283-4290.) This phenomenon is now applied to drug delivery systems.

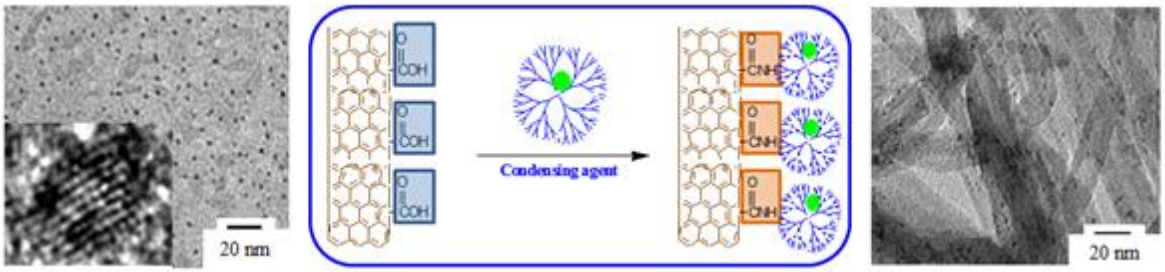


Chemical- and Bio-modulation of Gold Nanoparticles, Their Plasmonic Properties and Development of Solution-based Nano-plasmonic Sensing Technique: Plasmonic property of metal particles is worthy of remarks because of its unique physical phenomenon and valuable applications. Gold nanostructures with "confeito-like shape" have been synthesized by a solution-phase galvanic reaction or in a solution including fruit juice. An ultraviolet-visible absorption spectrum showed surface plasmon bands at 320 to 530 nm and a broad absorption band from 650 nm to near-infrared region. These nanostructures constitute an active substrate material for the surface-enhanced Raman scattering spectroscopy. (Jadab Sharma, Yian Tai, and Toyoko Imae, Chemistry - an Asian Jurnal, 2010, 5, 70-73.) Meanwhile, we have successfully demonstrated the novel sensing technique for monitoring the variation of solution concentrations and measuring the effective dielectric constant in a medium by means of an ultra-small and label-free nanosensor, the mechanism of which is based on the localized surface plasmon resonance of gold nanorods. This promising sensing and analytical technique can be easily used for investigating the nano-scale variations of mixing or reaction process in a micro/nanofluidic channel or the biological interaction in the cytoplasm of the cell. (Fu Han Ho, Yung-Han Wu, Masaki Ujihara and Toyoko Imae, Analyst, 2012, 137, 2545-2548.) Biocompatible confeito-like nanoparticles are also intended to be synthesized and applied on the phototherapy through use of plasmonic property.

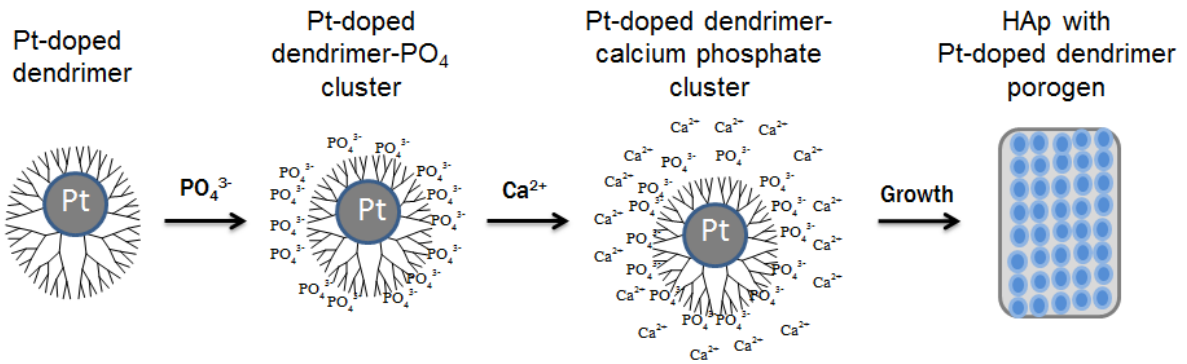


Advantages of Immobilization of Pt Nanoparticles Protected by Dendrimers on Multiwalled Carbon Nanotubes: Development of highly effective sensing systems is a universal desire owing to their worth. Pt nanoparticles (PtNPs) were synthesized in the presence of a poly(amido amine) (PAMAM) dendrimer as a stabilizer. Subsequently, PtNPs protected by dendrimers (DENPtNPs) were covalently immobilized on multiwalled carbon nanotubes (MWCNTs). PtNPs on MWCNTs dispersed with same aspect as the dispersion of DENPtNPs in water. Remarkable advantage is apparent from the enhanced electrochemical behavior of CNT/DENPtNPs loaded on the gold electrode. PtNPs promoted the electron transfer of MWCNTs and dendrimers contributed to uptake of redox materials, indicating the possible application of these hybrids as electrochemical sensing systems. (Ampornphan Siriviriyanun and Toyoko Imae, Phys. Chem. Chem. Phys., 2012, 14, 10622-10630.) Effective electrochemical detection of methanol oxidation has been confirmed using

electrodes with dendrimer-protected platinum nanoparticles and carbon nanotubes. (Ampornphan Siriviriyanun and Toyoko Imae, Phys. Chem. Chem. Phys., 2013, 15, 4921-4929). These electrodes are going to be applied for detecting contaminant pollutants and biological reactions.



Fabrication and Characterization of Dendrimer-Functionalized Mesoporous Hydroxyapatite: Since the first report of porous silica, the synthesis of porous materials is developed using various precursors. A successful synthesis of mesostructured hydroxyapatite (HAp) using poly(amido amine) (PAMAM) dendrimer porogens has been reported. The formation of a single-phase crystal in synthesized HAp particles was revealed. The formation of the mesostructural nature of HAp was proven with a specific surface area (56−63 m^2/g) and a certain pore size (4.7−5.5 nm). In addition, on the surface modification of mesoporous HAp particles using PAMAM dendrimer, the coating thickness corresponded to at least a double layer of dendrimer at pH 9 or higher, but it decreased sharply with decreasing pH below 9, indicating the strong non-electrostatic interaction of nonionic dendrimer with HAp. (Nabakumar Pramanik, and Toyoko Imae, Lngmuir, 2012, 28, 14018−14027.) The research is expanded to functionalize these mesoporous HAp and apply to an appropriate chemical reaction. The developed dendrimer-functionalized mesoporous hydroxyapatites may also be applicable in biocomposite material and/or bone tissue engineering.



Renewable catalyst with Cu nanoparticles embedded into cellulose nano-fiber film: The utilization of co-friendly resources is the main issues which humans must consider in current

situation, because we are losing natural resources so fast and bringing on environmental breakdown by necessity. A catalytic system was designed with nano-composites of Cu nanoparticles and cellulose nano-fiber (CNF). The uptake of active Cu nanoparticles into a CNF film was successfully achieved. The Cu-loaded CNF film showed the high catalytic activity towards the reduction of 4-nitrophenol, meanwhile the Cu-free CNF film had almost no-catalytic activity. The film was easily recycled, and its catalytic activity did not decrease significantly up to at least 10 cycles of the reaction. It was suggested that the Cu nanoparticles embedded in the CNF film efficiently promoted the catalytic reaction. Thus, this novel concept demonstrates its possibility to prepare the eco-friendly film-type catalytic system with a good selectivity. (Ramaraju Bendi and Toyoko Imae, RSC Advances, in press) The Green chemistry described above must be promoted in a positive way.