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World Scientific Reference on Plasmonic Nanomaterials

Principles, Design and Bio-applications

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- ▶ **Volume 2: Plasmonic Nanoparticles: Synthesis and (Bio)functionalization**
- ▶ **Volume 3: Self-Assembly of Plasmonic Nanostructures**
- ▶ **Volume 4: Nanoparticle-Cell Interactions**
- ▶ **Volume 5: Plasmonics in Diagnostics and Therapy**

Editor-in-chief: Luis M Liz-Marzán
(CIC biomaGUNE, Spain)

Volume editors: Jwa-Min Nam (Seoul National University, Korea), **Jianfang Wang** (The Chinese University of Hong Kong, Hong Kong), **Zhihong Nie** (Fudan University, China) & **Kimberly Hamad-Schifferli** (University of Massachusetts Boston, USA & Massachusetts Institute of Technology, USA) & **Sebastian Schlücker** (University of Duisburg-Essen, Germany)



This is a book collection that encompasses multiple aspects of the exciting and timely field of nanoplasmonics, under the coordination of international plasmonic nanomaterials expert, Dr Luis Liz-Marzán. Plasmonics has a long history, from stained glass in ancient cathedrals, through pioneering investigations by Michael Faraday, all the way into the nanotechnology era, where it blossomed into an extremely active field of research with potential applications in a wide variety of technologies.

Given the breadth of the materials, phenomena and applications related to plasmonics, this Reference Set offers a collection of chapters within dedicated volumes, focusing on the description of selected phenomena, with an emphasis in chemistry as an enabling tool for the fabrication of, often sophisticated, plasmonic nanoarchitectures and biomedicine as the target application.

Readership: This will be an excellent go-to collection, both for beginners and for specialized researchers who aim at updated information and broadening their activity in nanoplasmonics and their applications.

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Basic principles of surface plasmon resonances are described, as well as those mechanisms related to related phenomena such as surface-enhanced spectroscopies or plasmonic chirality. Under the guidance of theoretical models, wet chemistry methods have been implemented toward the synthesis of a wide variety of nanoparticles with different compositions and tailored morphology. But often the optimal nanoarchitecture requires post-synthesis treatments, including functionalization of nanoparticle surfaces, application of external stimuli toward self-assembly into well-defined supraparticle structures and so-called supercrystals. All such nanomaterials can find applications in various biomedical aspects, most often in relation

to diagnosis, through either the detection of disease biomarkers at extremely low concentrations or the design of bioimaging methods for in vivo monitoring. Additionally, novel therapeutic tools can also profit from plasmonic nanomaterials, such as photothermal therapy or nanocatalysis.

The reference set thus offers comprehensive information of an extremely active subset within the world of plasmonic nanomaterials and their applications, which aims at not just collecting existing knowledge but also promoting further research and technology transfer into the market and the clinic.

▶ Volume 1: Principles of Nanoplasmonics

Volume editor: **Jwa-Min Nam**
(Seoul National University, Korea)



Nanoplasmonics is based on the interaction between light and plasmonic nanostructures where the size of a nanostructure is much smaller than the incident wavelength. Plasmonic materials are typically metallic nanostructures with a surface plasmon resonance that offers resonant collective oscillation of electrons, whereas tunable and amplifiable electromagnetic fields can be formed on their surface. The overall field of nanoplasmonics deals with the design, synthesis, fabrication and manipulation of plasmonic nanomaterials and nanodevices, discovering and understanding nanoscale plasmonic phenomena, development of tools and systems for exploring and utilizing these plasmonic materials, and phenomena and applications in various fields including optics, catalysis, biotechnology, medicine, and energy.

Fundamentals of Surface Plasmon

Hongxing Xu (Institute of Physics, Chinese Academy of Sciences, China)

Design and Synthesis of Plasmonic Nanoparticles

Hongyu Chen (Nanjing Tech University, China)

Nanofabrication of Plasmonic Structures

Inki Kim (Pohang University of Science and Technology (POSTECH), South Korea), Gwanho Yoon (Pohang University of Science and Technology (POSTECH) and Seoul National University of Science and Technology, South Korea), Younghwan Yang (Pohang University of Science and Technology (POSTECH), South Korea), Jungho Mun (Pohang University of

Science and Technology (POSTECH), South Korea) & Junsuk Rho (Pohang University of Science and Technology (POSTECH), South Korea)

Plasmon Enhanced Spectroscopy

Minji Ha (Seoul National University, South Korea), Jeong-Wook Oh (Hankuk University of Foreign Studies, South Korea), Jae-Ho Kim (Seoul National University, South Korea), Minho Kim (Seoul National University and Samsung Advanced Institute of Technology (SAIT), South Korea), Jae-Ho Hwang (Seoul National University, South Korea), Jiwoong Son (Seoul National University, South Korea) & Jwa-Min Nam (Seoul National University, South Korea)

Tunable Plasmonic Metacrystals: Self-Assembly, Plasmonic Properties, and Applications in Surface-Enhanced Raman Scattering

Yih Hong Lee, Charlynn Sher Lin Koh & Xing Yi Ling (Nanyang Technological University, Singapore)

Plasmon-modulated Nonlinear Upconversion Emission

Jijun He & Danguan Lei (City University of Hong Kong, Hong Kong)

DNA Nanotechnology for Plasmonics

Minji Ha (Seoul National University, South Korea), Jae-Ho Kim (Seoul National University, South Korea), Qian Li (Shanghai Jiao Tong University, China), Chunhai Fan (Shanghai Jiao Tong University, China) & Jwa-Min Nam (Seoul National University, South Korea)

Plasmonic Photothermal Nanomaterials

Kunlun Jiang, Jingrui Wu, Yuwei Qiu & Jung-Hoon Lee (City University of Hong Kong, Hong Kong)

Principles of Plasmonic Gold Nanoprobes-Based Bioassays

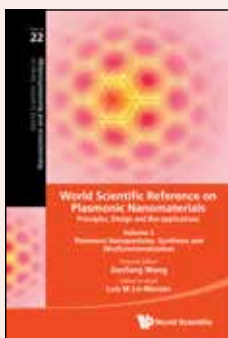
Yangzhouyun Xie & Xingyu Jiang (Southern University of Science and Technology, China)

Biomedical Applications of Plasmonic Nanoparticles

Shuai Hou & Hongwei Duan (Nanyang Technological University, Singapore)

▶ Volume 2: Plasmonic Nanoparticles: Synthesis and (Bio)functionalization

Volume editor: **Jianfang Wang** (The Chinese University of Hong Kong, Hong Kong)



This volume involves a wide range of aspects on the synthesis of plasmonic nanoparticles. It can provide readers an overall picture regarding the synthesis of plasmonic nanoparticles, which is the foundation of nanoplasmonics. In this regard, this volume is devoted to the synthesis and (bio) functionalization of plasmonic nanoparticles.

Synthesis of Colloidal Semiconductor Nanocrystals with Tunable Plasmonic Properties

Shasha Li, He Huang (The Chinese University of Hong Kong, Hong Kong and Beijing Computational Science Research Center (CSRC), China), Jing Wang (Beijing Computational Science Research Center, China) & Lei Shao (The Chinese University of Hong Kong, Hong Kong and Beijing Computational Science Research Center (CSRC), China)

Plasmon-Mediated Syntheses of Polyhedral Noble Metal Nanoparticles

Michelle L Personick (Wesleyan University, USA)

Plasmonic Nanocages

Carlos Fernández-Lodeiro, Jorge Pérez-Juste & Isabel Pastoriza-Santos (University de Vigo, Spain)

Synthesis of Porous Plasmonic Nanocrystals

Ruibin Jiang (Shaanxi Normal University, China)

Geometry-Controlled Synthesis of Quasi-One-Dimensional Plasmonic Nanostructures

Hui Wang & Yang Zhang (University of South Carolina, USA)

Template-Assisted Colloidal Synthesis of Plasmonic Nanocrystals

Zili Li, Shuang Liang, Mingyue Zhang, Zewei Wang & Zhiqun Lin (Georgia Institute of Technology, USA)

Templated Synthesis of Plasmonic Nanostructures

Ji Feng & Yadong Yin (University of California, Riverside, USA)

Synthesis and Functionalization of Anisotropic Silver Nanoparticles

Xiaolu Zhuo, Vished Kumar, Tsz Him Chow (The Chinese University of Hong Kong, Hong Kong), Jianfang Wang (The Chinese University of Hong Kong, Hong Kong) & Luis M Liz-Marzán (IKERBASQUE, Basque Foundation for Science and CIC biomaGUNE, Spain)

Synthesis and Function Improvement of Gold Nanorods, Silver Nanoprisms, and Chiral Nanoparticles for Bioapplications

Kosuke Sugawa (Nihon University, Japan)

Chirality Control of Plasmonic Nanostructures Using Biomolecules

Nam Heon Cho, Yae-Chan Lim, Hyeohn Kim & Ki Tae Nam (Seoul National University, South Korea)

Nanoparticle Assembly for Chiral Plasmonics

Jianxun Liu, Zhen Yin, Huilin He & Yan Jun Liu (Southern University of Science and Technology, China)

Stimuli Responsive Plasmonic Nanoparticles

Yiyi Liu & Wenlong Cheng (Monash University, Australia)

▶ Volume 3: Self-Assembly of Plasmonic Nanostructures

Volume editor: **Zhihong Nie**
(Fudan University, China)

This book volume contains nine chapters that bring great precision to understand the self-assembly of plasmonic nanostructures. It covers a broad range of topics from plasmonic coupling between plasmonic nanoparticles, to strategies of assembling them via surface ligands, soft/hard templates, and interfaces, to the characterization and application of such assemblies. It can serve as an entry for students or researchers who are new to the field of nanoparticle self-assembly.

Assembly, Motion and Coupling of DNA-coded Plasmonic Nanoparticles
Jinyi Dong (Suzhou Institute of Nano-Tech and Nano-Bionics, and Shanghai Tech University, China), Chao Zhou (Suzhou Institute of Nano-Tech and Nano-Bionics, and Shanghai Tech University, China) & Qiangbin Wang (Suzhou Institute of Nano-Tech and Nano-Bionics)

DNA-Based Self-Assembly
Alison Funston (Monash University, Australia)



Peptide-Based Methods for the Assembly of Plasmonic Nanostructures
Derong Lu & Hongwei Duan (Nanyang Technological University, Singapore)

Soft Molecules Induced Self-Assembly of Plasmonic Nanostructures
Jibin Song & Qinrui Fu (Fuzhou University, China)

Characterizing Self-Assembly of Plasmonic Nanostructures in Real Space and Reciprocal Space
Shan Zhou, Wenxiang Chen & Qian Chen (University of Illinois at Urbana-Champaign, USA)

Programmable Self-Assembly of Nanoparticles into Discrete Nanoarchitectures
Gang Chen (University of Central Florida, USA)

Designing Hot Spots in Plasmonic Assemblies through the Shape and Arrangement of Constituents
Anna Klinkova (University of Waterloo, Canada)

Two-Dimensional Plasmonic Nanoassemblies: Fabrication, Properties and Applications
Runfang Fu, Qianqian Shi, Zijun Yong, Yan Lu & Wenlong Cheng (Monash University, Australia)

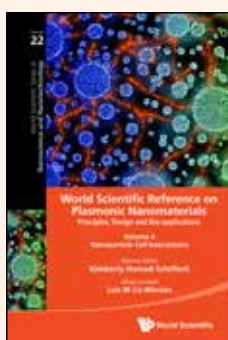
Polymeric N-Heterocyclic Carbenes to Functionalize Plasmonic Metal Nanoparticles
Jie He (University of Connecticut, USA)

▶ Volume 4: Nanoparticle-Cell Interactions

Volume editor: **Kimberly Hamad-Schifferli**
(University of Massachusetts Boston, USA & Massachusetts Institute of Technology, USA)

Because of their unique optical properties, plasmonic nanoparticles have been studied extensively for numerous applications in biology and medicine such as cancer therapies, diagnostics, and imaging. How they interact with cells and their biological environments emerged as a key issue for their development. While initially it was challenging to understand, it has become into a rich area of study. This volume seeks to cover key aspects about nanoparticle-cell interactions and the different innovations that stem from them.

Gold Nanoparticle-Blood Serum/Plasma Interaction: Fundamental Understanding and Implications in New Diagnostic Test Development
Qun Huo (University of Central Florida and Nano Discovery Inc., USA) & Tianyu Zheng (Nano Discovery Inc., USA)



Interface Engineering of Gold Nanostars for Bioapplications
Laura Fabris, Swarnapali Indrasekara (Rutgers University, USA)

The Nanoparticle Biomolecule Corona and Potential Biomedical Applications
Marilena Hadjidemetriou (The University of Manchester, UK)

Nanometal Toxicology: Immune or Not Immune that is the Question?
Kristen A Krupa (Air Force Research Laboratory and University of Dayton, USA) & Laura K Braydich (University of Dayton, USA)

Interaction of DNA and Peptide-Functionalized Gold Nanoparticles with Biological Systems
Amelie Heuer-Jungemann (Ludwig-Maximilians-University Munich, Germany), Maria-Eleni Kyriazi (University of Southampton, UK) & Antonios Kanaras (University of Southampton, UK)

Plasmonic Nanoparticles for Enhancement of Image-Guided Phototherapy
Ljubica Z Petrovic (Tufts University, USA), Vida Karimnia (University of Massachusetts Boston, USA), Srivalleesha Mallidi (Tufts University, USA) & Jonathan P Celli (University of Massachusetts Boston, USA)

Nanotechnology for Wound Healing
David Yeo (Agency for Science, Technology and Research (A*STAR), Singapore) & Chenjie Xu (City University of Hong Kong, Hong Kong)

▶ Volume 5: Plasmonics in Diagnostics and Therapy

Volume editor: **Sebastian Schlücker**
(University of Duisburg-Essen, Germany)

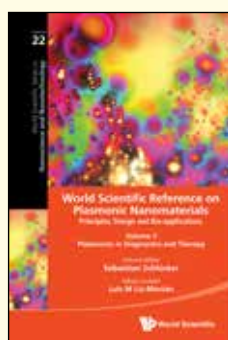
Plasmonic nanomaterials are ubiquitous in research and everyday life. A prominent example for the latter is the pregnancy test in which gold nanoparticles, conjugated to an antibody directed against the pregnancy hormone hCG, produce the reddish test and control lines on the nitrocellulose strip. This volume is focused on diagnostic and therapeutic applications of plasmonic nanomaterials, in particular gold nanoparticles due to their high chemical stability/inertness.

Fundamentals of Nanobiophotonics for Diagnostics and Therapy
Michael Erkelenz & Sebastian Schlücker (Univ. of Duisburg-Essen, Germany)

SPR+LSPR Biosensing
J Ricardo Mejia-Salazar (National Institute of Telecommunications, Brazil), J James Hernandez-Sarria (University of Sao Paulo, Brazil), Marystela Ferreira (Federal University of São Carlos, Brazil) & Osvaldo N Oliveira Jr Sarria (University of Sao Paulo, Brazil)

SERS Biosensors
Hao Wang, Laura Fabris (Rutgers University, USA)

Label-Free SERS Assays
Chen Liu (Friedrich Schiller University and Leibniz-Institute of Photonic Technology, Germany), Jürgen Popp (Friedrich Schiller University, Leibniz-Institute of Photonic Technology, and InfectoGnostics Research Campus Jena e. V, Germany) & Dana Cialla-May (Friedrich Schiller University, Leibniz-Institute of Photonic Technology, and InfectoGnostics Research Campus Jena e. V, Germany)



Label-Free SERS Microscopy
Janina Kneipp (Humboldt-Universität zu Berlin, Germany)

SERS Nanotags
Nana Lyu & Yuling Wang (Macquarie University, Australia)

iSERS Bioassays
Anupam Das & Jaebum Choo (Chung-Ang University, South Korea)

iSERS Microscopy for Cellular and Tissue Imaging Ex Vivo
Yuying Zhang (Nankai University, China)

Photoacoustic Imaging with Plasmonic Nanoparticles
Dmitry Nevozhay, Richard Bouchard & Konstantin V Sokolov (The University of Texas MD Anderson Cancer Center, Rice University and The University of Texas at Austin, USA)

Optical Coherence Tomography
Tamara Muñoz-Ortiz (Universidad Autónoma de Madrid, Spain), Riccardo Marín (Universidad Autónoma de Madrid, Spain), Dirk H Ortgies (Universidad Autónoma de Madrid, and Instituto Ramón y Cajal de Investigación Spain), Emma Martín Rodríguez (Universidad Autónoma de Madrid, Spain) & José García Solé (Universidad Autónoma de Madrid, Spain)

Magnetic Resonance Imaging
Xin Li (Donghua University, China and RWTH Aachen University, Germany), Mingwu Shen (Donghua University, China) & Xiangyang Shi (Donghua University, China)

Biomedical SERS: Spectroscopic Detection and Imaging In Vivo
Lucas A Lane (Nanjing University, China)

Controlled Delivery
Qirong Xiong (NTU, Singapore), Di Li (Nanyang Technological University, Singapore & Jiangnan University, China) & Hongwei Duan (NTU, Singapore)

Development of Gold Nanostars for Photothermal and Immunotherapy Applications
Yang Liu (Duke University, USA), Swarnapali De Silva Indrasekara (Duke University and University of North Carolina, USA) & Tuan Vo-Dinh (Duke University, USA)

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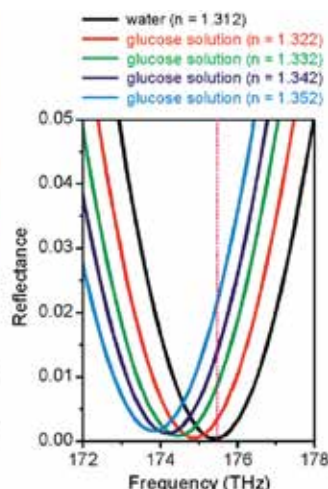
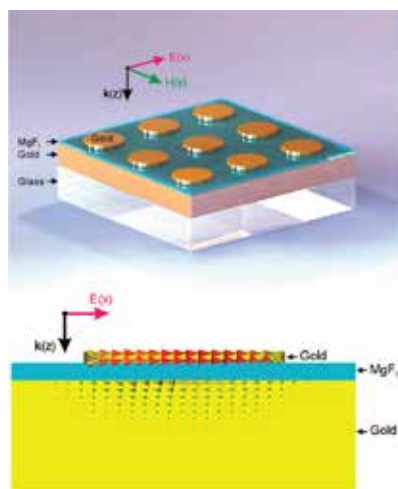
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& **Sebastian Schlücker** (*University of Duisburg-Essen, Germany*)

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This 5-volume reference set focuses on the fabrication and properties of plasmonic nanomaterials for biomedical applications.



About the Editor-in-Chief

Luis Liz-Marzán is Ikerbasque Professor and Scientific Director of the Center for Cooperative Research in Biomaterials, CIC biomaGUNE, in San Sebastián (Spain), since September 2012. He graduated in chemistry from the University of Santiago de Compostela, was postdoc at Utrecht University and Professor at the University of Vigo (1995–2012). He has also been Visiting Professor at various institutions worldwide. Liz-Marzán received numerous research awards, including a Humboldt research award, ACS Nano lecture award, Rhodia Prize of the European Colloid and Interface Society, Medal of the Spanish Royal Society of Chemistry, Jaime I Award in Basic Research, and more recently the Spanish National Award in Chemical Science and Technology. Professor Liz-Marzán has also been awarded 2 prestigious ERC Advanced Grants. He is also member of the Royal Spanish Academy of Sciences, the European Academy of Sciences and Academia Europaea. He is co-author of over 500 publications and 9 patents, and has delivered hundreds of invited lectures and seminars worldwide. Liz-Marzán has supervised over 30 PhD students and 50 postdocs, many of them currently holding academic positions worldwide. His major research activity is devoted to understanding the growth mechanisms of metal nanocrystals, tailoring their surface chemistry and directing their self-assembly into organized nanostructures. He also works on the design of biomedical applications based on the plasmonic properties of well-defined metal nanoparticles and nanostructures, including surface-enhanced Raman scattering.

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