

2013

# BioNanoPlasmonics Laboratory Activity Report



BioNanoPlasmonics Laboratory  
Biofunctional Nanomaterials Unit,  
CIC biomAGUNE,  
Paseo de Miramón 182,  
20009 Donostia - San Sebastián, Spain

[www.bionanoplasmonics.com](http://www.bionanoplasmonics.com)  
[twitter.com/BNPLab](https://twitter.com/BNPLab)

# TABLE OF CONTENTS

## Table of Contents

OVERVIEW	3
GROUP MEMBERS	4
SCIENTIFIC OUTPUT	6
SCIENTIFIC COLLABORATIONS	15
FUNDING	16

# GROUP MEMBERS

## Overview

### RESEARCH PROGRAMME

The research activity of the BioNanoPlasmonics Lab is focused on the synthesis and formation mechanisms of nanoparticles with controlled composition, size and morphology; the creation of colloidal composites, including functionalized carbon nanotubes; nanostructured thin films and nanoparticle ordered arrays in two and three dimensions; the optical characterization of nanoparticles and their assemblies; and the use of metal nanoparticles as biosensors. The group is closely linked to the Colloid Chemistry Group at the University of Vigo, where it was located until recently.

### SCIENTIFIC OUTPUTS

The scientific activity of BioNanoPlasmonics Laboratory in 2013 can be summarized as it follows: 26 publications in high impact scientific journals, 5 ongoing PhD theses, 2 conferences and workshops organized, 20 invited lectures and 3 awards.

### GROUP MEMBERS

In 2013 the group led by Prof. Luis M. Liz-Marzán has grown and it is now composed by 16 researchers (9 postdoctoral research associates, 5 Ph.D. students and 2 research assistants) and a project manager. Additionally, one student has started at the University of Liverpool, who will be co-supervised by Prof. Mathias Brust and Prof. Liz-Marzán.



# GROUP MEMBERS

## Group Members

**Prof. Luis M. Liz-Marzán**  
Ikerbasque Professor



llizmarzan@cicbiomagune.es

**Dr. Marek Grzelczak**  
Ikerbasque Junior Researcher



mgrzelczak@cicbiomagune.es

**Dr. Lakshminarayana Polavarapu**  
Postdoctoral Research Associate



lpolavarapu@cicbiomagune.es

**Dr. Amane Shiohara**  
Postdoctoral Research Associate



ashiohara@cicbiomagune.es

**Dr. Judith Langer**  
Postdoctoral Research Associate



jlanger@cicbiomagune.es

**Dr. Sergey Novikov**  
Postdoctoral Research Associate



snovikov@cicbiomagune.es

**Dr. Marta Norah Sanz**  
Postdoctoral Research Associate



msanz@cicbiomagune.es

**Dr. Juan José Giner**  
Postdoctoral Research Associate



jjginer@cicbiomagune.es

**Dr. Yusong Wang**  
Postdoctoral Research Associate



ywang@cicbiomagune.es

**Dr. Marta Ibisate**  
Postdoctoral Research Associate



mibisate@cicbiomagune.es

**Andrea La Porta**  
Ph. D. student



alaporta@cicbiomagune.es

**Marc Coronado**  
Ph. D. student



mcoronado@cicbiomagune.es

# GROUP MEMBERS

Leonardo Scarabelli  
Ph. D. student



lscarabelli@cicbiomagune.es

Ana Belén Serrano  
Ph. D. student



aserrano@cicbiomagune.es

Denis Rodriguez  
Ph. D. student



drodriguez@cicbiomagune.es

Ana Sánchez-Iglesias  
Research Assistant



asanchez@cicbiomagune.es

Ada Herrero  
Research Technician



aherrero@cicbiomagune.es

Dr. Anna Llanes-Pallàs  
Project Manager



allanes@cicbiomagune.es

## VISITING RESEARCHERS

- **Elmira FarrokhTakin** (IIT Pisa) Nov 2012-Feb 2013
- **Dr. Eko Adi Prasetyanto** (Université de Strasbourg) May 2013

## Scientific Output

### AWARDS

#### 2013 ECIS-Rhodia Prize

Awarded to Prof. Luis Liz-Marzán by the *European Colloid and Interface Society*. This Prize is granted every year to a European scientist for original scientific work of outstanding quality, described in one or several publications, patents or other documents made public in the previous five years. Hence, the ECIS-Rhodia Prize is for recent work within the field of colloid and interface science. The prize will be delivered during the next ECIS Conference, where Liz-Marzán gave the closing plenary lecture.

#### Best presentation and best poster presentation awards at Iberian Colloids and Interfaces Meeting

The 5th Iberian Meeting on Colloids and Interfaces (rici5) took place on July 26-28 at the University of the Basque Country in San Sebastian. Several awards were given to young researchers among them to Leonardo Scarabelli (best oral presentation award) and Denis Rodriguez-Fernandez (best poster presentation award) students from the BioNanoPlasmonics Lab.

### EDITORIAL ACTIVITY

Since January 2013, Luis Liz-Marzán is member of the **Board of Reviewing Editors of Science**, published by the American Association for the Advancement of Science (AAAS, USA)

Since January 2013, Luis Liz-Marzán is member of the **Editorial Advisory Board of ACS Nano**, published by the *American Chemical Society* (EE.UU.)

### INVITED LECTURES AT CONFERENCES, CURSES AND WORKSHOPS

1. *Multifunctional Composite Colloidal Microgels for Catalysis and Detection*  
**Delft Discussions on Soft Matter**, Delft (The Netherlands), 29 Ene 2013
2. *Directed assembly of plasmonic nanoparticles*  
**International Magnifyco Workshop**, Barcelona (Spain), 20–22 Feb 2013
3. *Functional Porous Materials by Encapsulation and Growth of Gold Nanoparticles* (**Featured Lecture**)  
**Hybrid Materials 2013**, Sorrento (Italy), 3–7 Mar 2013
4. *Directing the Morphology and Assembly of Gold Nanoparticles*  
**Spring ACS National Meeting 2013**, New Orleans, 7–11 Apr 2013
5. *Biosensing with Gold Nanoparticles*  
**ImagineNano**, Bilbao (Spain), 21–23 Apr 2013
6. *Using Polymers to Direct the Growth and Assembly of Gold Nanoparticles* (**Plenary**)  
**Frontiers in Polymer Science**, Sitges (Spain), 21–23 May 2013
7. *Nanoplasmonic Biodetection*  
**Workshop on “Division from A to Z”**, Madrid (Spain), 7 Jun 2013
8. *Novel Optical Effects Derived from Plasmon Coupling*  
**Symposium on Plasmon-based Chemistry and Physics**, Leuven (Belgium), 19–20 Jul 2013
9. *Tailoring Nanometals for Surface Enhanced Raman Scattering*  
**International Conference on Photochemistry (ICP 2013)**, Leuven (Belgium), 21–26 Jul 2013
10. *Templated Growth of Gold Nanoparticles in Mesoporous Films and Sensing Applications*  
**Sol-Gel 2013**, Madrid (Spain), 25–30 Ago 2013

## SCIENTIFIC OUTPUT

11. *Engineering Metal Nanoparticles for Plasmonic Sensing*  
**Workshop on Bio-applications of SERS**, San Sebastián (Spain), 29–30 Ago 2013
12. *Directional Growth and Assembly of Plasmonic Colloids (Plenary)*  
**27<sup>th</sup> Conference of the European Colloid and Interface Society (ECIS)**,  
Sofia (Bulgary) 3-6 Sep 2013
13. *Quiralidad Nanoplasmónica*  
**Reunión Bienal de la RSEQ**, Santander (Spain) 15–18 Sep 2013
14. *Evolución Morfológica y Óptica de Nanopartículas de Oro Recubiertas de Plata*  
**Reunión Bienal de la RSEQ**, Santander (Spain) 15–18 Sep 2013
15. *Morphological Evolution and Optical Changes During Seeded Growth of Metallic and Bimetallic Colloids (Plenary)*  
**46<sup>th</sup> Biennial Meeting of the German Colloid Society**, Paderborn (Germany) 23-25 Sep 2013
16. *Colloidal Metal Nanoparticles. Synthesis and Sensing Applications*  
**Joint GLYCOPHARM – DYNANO Summer School**, Madrid (Spain) 30 Sep – 2 Oct 2013
17. *Nanoparticles on Templates. Carbon Nanotubes and Beyond*  
**Workshop on Emerging Materials**, Trieste (Italy) 11 Oct 2013
18. *Anisotropy in nanoparticles. Anisometric and Janus particles*  
**Sixth European School on Molecular Nanoscience**, Cuenca (Spain) 27 Oct – 1 Nov 2013
19. *Usando Nanopartículas para Biodetección*  
**Jornada de Nanotecnología**, Valencia (Spain) 15 Nov 2013
20. *Engineering Metal Nanoparticles for Plasmonic Sensing*  
**Instrumentation et Capteurs Environnementaux Workshop**, Toulouse (France) 2-4 Dic 2013

### INVITED SEMINARS

1. *Hybrid Nanomaterials for Plasmonic (Bio)Sensing*  
Bionand, Málaga (Mar 2013)
2. *Bionanoplasmonics*  
CIMA, Pamplona (May 2013)
3. *Colloidal Synthesis and Growth Mechanisms of Metal Nanoparticles*  
CIC nanoGUNE, San Sebastián (May 2013)
4. *Optical Studies of Colloidal Metal Nanoparticles and Assemblies*  
Materials Physics Center, San Sebastián (Jun 2013)
5. *Short Course on Nanomaterials (4h)*  
European Chemicals Agency, Helsinki (Jul 2013)
6. *Hybrid Nanomaterials for Plasmonic (Bio)Sensing*  
Università de Firenze, (Oct 2013)
7. *Colloidal synthesis of bimetallic and Janus nanoparticles*  
ISIS, Université de Strasbourg, (Dic 2013)

### PRESENTATIONS AT CONFERENCES FROM GROUP MEMBERS

#### Dr. Marek Grzelczak

*Self-replicating Nanocrystal Gene* (oral)

Quantum 13, Nobel Pitch, San Sebastian (Spain), 01 Oct 2013.

*Gold Nanowires as SERS Substrates* (poster)

1st SAVVY Workshop: Applications of SERS to biodetection, San Sebastian (Spain), 30 August 2013.

*Exploiting Hydrophobic Interactions in Directed Self-assembly of Gold Nanoparticles* (oral)

5th Iberian Meeting on Colloids and Interfaces, San Sebastian (Spain), 26 June 2013.

## SCIENTIFIC OUTPUT

*Integration of Cobalt Oxide Nanoparticles within Molecular and Polymeric Photo-catalysts for Generation of Oxygen from Water* (poster)

3rd International Colloids Conference - Colloids & Energy, Xiamen (China), 21 April 2013.

*Steric Hindrance Induces Cross-like Self-assembly of Gold Nanodumbbells* (poster)

*Hydrophobic Interactions Modulate Self-assembly of Gold Nanoparticles* (oral)

3rd International Conference on Multifunctional, Hybrid and Nanomaterials, Sorrento (Italy), 3 March 2013.

Dr. Lakshminarayana Polavarapu

*Colloidal gold and silver for nanoplasmonic sensing and imaging* (highlight presentation)

Euromat 2013, Sevilla (Spain) 8-13 Sept. 2013

*Synthesis and modification of metal nanoparticles in organic medium for plasmonic applications* (poster)

5th Iberian Meeting on Colloids and Interfaces, RIC15, Donostia-San Sebastián (Spain), 26-28 June 2013

*Plasmonic nanoparticle building blocks for SERS applications* (poster)

Applications of SERS to Biodetection, CICbiomaGUNE, San Sebastian (Spain), 29-30 August 2013

Dr. Amane Shiohara

*Gold nanostar as a sensing device* (poster)

5th Iberian Meeting on Colloids and Interfaces, RIC15, San Sebastián (Spain), 26-28 June 2013

Dr. Judith Langer

*SERS performance of gold nanostars* (poster)

5th Iberian Meeting on Colloids and Interfaces, RIC15, Donostia-San Sebastián (Spain), 26-28 June 2013

*Gold nanostars on flexible support as sensing device* (poster)

Applications of SERS to Biodetection, CICbiomaGUNE, San Sebastian (Spain), 29-30 August 2013

*Gold nanostar as sensing device* (poster)

WITec GmbH Workshop on High Structural and Spatial Resolution using Raman Confocal and Scanning Probe Microscopy, Madrid (Spain) 6-7 November 2013

Dr. Sergey Novikov

Surface enhanced Raman scattering microscopy with substrates fabricated by Au & Ag “nano-inks” (poster)

5th Iberian Meeting on Colloids and Interfaces, RIC15, Donostia-San Sebastián (Spain), 26-28 June 2013

*Novel nanoparticles spiky-dumbbells: characterization of single particles* (poster)

Applications of SERS to Biodetection, CICbiomaGUNE, San Sebastian (Spain), 29-30 August 2013

Dr. Marta N. Sanz Ortiz

*Noble metal nanoparticles coated with mesoporous materials* (poster),

5th Iberian Meeting on Colloids and Interfaces RIC15, San Sebastián (Spain), 26 -28 June 2013

*Hybrid mesoporous materials with plasmonic and luminescent functionalities* (poster),

International Conference on Photochemistry ICP 2013, Leuven (Belgium), 21 – 26 July 2013

Dr. Juan José Giner Casares

*Self-assembled 2D arrays of Au nanoparticles* (poster)

5th Iberian Meeting on Colloids and Interfaces, San Sebastian (Spain), 26 -28 June 2013



# SCIENTIFIC OUTPUT

## Dr. Yusong Wang

*Development of graphene derivative-gold nanostar composite as an active SERS material* (poster)  
1st SAVVY Workshop: Application of SERS to Biodetection, San Sebastián (Spain), 29-30 August 2013

*Development of Reduced Graphene Oxide-Gold Nanostar Composite As an Active SERS Material* (oral)  
1st SAVVY Workshop: Application of SERS to Biodetection, San Sebastián (Spain), 29-30 August 2013

## Leonardo Scarabelli

*Optimized synthesis of Gold Nanorods* (oral presentation)  
SoftComp Annual Meeting 2013 jointly with ESMI, Rimini (Italy), 27-31 May 2013

*Optimized synthesis of Gold Nanorods* (oral presentation)  
5th Iberian Meeting on Colloids and Interfaces (RICI-5), San Sebastian (Spain), 26-28 June 2013

*Optimized synthesis of Gold Nanorods* (oral presentation)  
Primera Reunión de Jóvenes Investigadores en Coloides e Interfases (JICI 2012), Benidorm (Spain), 10-12 December 2013

## Andrea La Porta

*PS-PAA-Capped Gold Nanostars as SERS substrate for the detection of hydrophobic molecules* (poster)  
5th Iberian Meeting on Colloids and Interfaces, Donostia (Spain), 26-28 June 2013

*Gold Nanowires as SERS Substrates* (poster)  
Applications of SERS to Biodetection, Donostia (Spain), 29-30 August 2013

## Marc Coronado

*Enzymatic Modulation of Gold Nanorods: Applications in Biosensing* (poster)  
3rd nano today conference, Singapore, 8-11 December 2013

## Ana Belén Serrano

*Formation of plasmonic heterostructures via covalent bond chemistry*, (poster),  
5th Iberian Meeting on Colloids and Interfaces" San Sebastian (Spain) 26th-28th June 2013

## Denis Rodriguez

*Colloidal Synthesis of Au semishells* (poster)  
Third International Conference on Multifunctional, Hybrid and Nanomaterials, Sorrento (Italy), 3-7 March 2013

*Metallic Janus Particles* (poster)  
5th Iberian Meeting on Colloids and Interfaces, San Sebastian (Spain), 26-28 June 2013

## Ana Sánchez-Iglesias

*Steric Hindrance Induces Cross-like Self-assembly of Gold Nanodumbbells* (poster)  
Third International Conference on Multifunctional, Hybrid and Nanomaterials, Sorrento (Italy), 3-March 2013

*Steric Hindrance Induces Cross-like Self-assembly of Gold Nanodumbbells* (poster)  
5th Iberian Meeting on Colloids and Interfaces, RICIS, San Sebastián (Spain), 26-28 June 2013

*Single particle characterization of gold spiky-dumbbells* (poster)  
1st SAVVY Workshop: Application of SERS to Biodetection, San Sebastián (Spain), 29-30 August 2013

# SCIENTIFIC OUTPUT

## CONFERENCE AND WORKSHOP ORGANISATION

Co-Chair of Symposium B (Functional hybrid nanomaterials, nanocomposites and their applications) of the **Third International Conference on Multifunctional, Hybrid and Nanomaterials (Hybrid Materials 2013)**, Sorrento (Italy), 3–7 Mar 2013.

Organizer of **Workshop on Applications of SERS to Biodetection**, Donostia – San Sebastián (Spain), 29-30 Ago 2013.

Scientific Board of the **17th International Sol-Gel Conference**, Madrid, 25 – 30 August 2013.

Scientific Board of the **15th Iberian Meeting on Colloids and Interfaces**, San Sebastian, 26–28 June 2013.

Scientific Board of the **International Conference on Materials for Advanced Technologies (ICMAT 2013)**, Singapore, 30 June – 5 July 2013.

## RESEARCH PUBLICATIONS

1. A.K. Samal, L. Polavarapu, S. Rodal-Cedeira, L.M. Liz-Marzán, J. Pérez-Juste, I. Pastoriza-Santos, *Size Tunable Au@Ag Core-Shell Nanoparticles: Synthesis and SERS Properties* *Langmuir* **2013**, 29, 15076–15082
2. L. Scarabelli, M. Grzelczak, L.M. Liz-Marzán, *Tuning Gold Nanorod Synthesis Through Pre-reduction with Salicylic Acid* *Chem. Mater.* **2013**, 25, 4232–4238
3. M. Coronado-Puchau, L. Saa, M. Grzelczak, V. Pavlov, L.M. Liz-Marzán, *Enzymatic Modulation of Gold Nanorod Growth and Application to Nerve Gas Detection* *Nano Today* **2013**, 8, 461–468
4. B. Goris, A. De Backer, S. Van Aert, S. Gómez-Graña, L.M. Liz-Marzán, G. Van Tendeloo, S. Bals, *3D elemental mapping at the atomic scale in bimetallic nanocrystals* *Nano Lett.* **2013**, 13, 4236–4241
5. V. López-Puente, S. Abalde-Cela, P.C. Angelomé, R.A. Alvarez-Puebla, L.M. Liz-Marzán, *Plasmonic Mesoporous Composites as Molecular Sieves for SERS Detection* *J. Phys. Chem. Lett.* **2013**, 4, 2715–2720
6. E. Heydari, I. Pastoriza-Santos, R. Flehr, L.M. Liz-Marzán, J. Stumpe, *Nanoplasmonic Enhancement of the Emission of Semiconductor Polymer Composites* *J. Phys. Chem. C* **2013**, 117, 16577–16583
7. A. Sánchez-Iglesias, M. Grzelczak, L.M. Liz-Marzán, *Solvent-induced division of plasmonic clusters* *Soft Matter* **2013**, 9, 9094–9098
8. S. Gómez-Graña, B. Goris, T. Altantzis, C. Fernández-López, E. Carbó-Argibay, A. Guerrero-Martínez, N. Almora-Barrios, N. López, I. Pastoriza-Santos, J. Pérez-Juste, S. Bals, G. Van Tendeloo, L.M. Liz-Marzán, *Au@Ag Nanoparticles: Halides stabilize {100} facets* *J. Phys. Chem. Lett.* **2013**, 4, 2209–2216
9. Z. Xu, L. Xu, L.M. Liz-Marzán, W. Ma, N.A. Kotov, L. Wang, H. Kuang, C. Xu, *Sensitive Detection of Silver Ions Based on Chiroplasmonic Assemblies of Nanoparticles* *Adv. Opt. Mater.* **2013**, 1, 626–630
10. I. Pastoriza-Santos and L. M. Liz-Marzán, *Reliable Methods for Silica Coating of Au Nanoparticles* *Methods in Molecular Biology*, **2013**, 1025, XIV, 302

11. S. Gómez-Graña, J. Pérez-Juste, R. A. Alvarez-Puebla, A. Guerrero-Martínez and L. M. Liz-Marzán, *Self-assembly of Au@Ag Nanorods Mediated by Gemini Surfactants for Highly Efficient SERS-Active Supercrystals*  
*Adv. Opt. Mater.* **2013**, *1*, 477–481. **Cover page.**
12. V. Juvé, M. F. Cardinal, A. Lombardi, A. Crut, P. Maioli, J. Pérez-Juste, Luis M. Liz-Marzán, N. Del Fatti, and F. Vallée, *Size-Dependent Surface Plasmon Resonance Broadening in Non-Spherical Nanoparticles: Single Gold Nanorods*  
*Nano Lett.* **2013**, *13*, 2234–2240
13. D. Tsoutsi, L. Guerrini, J. M. Hermida-Ramon, V. Giannini, L. M. Liz-Marzán, A. Wei, and R. A. Alvarez-Puebla, *Simultaneous SERS detection of Copper and Cobalt at Ultratrace Levels*  
*Nanoscale* **2013**, *5*, 5841-5846
14. S. Mourdikoudis, M. Chirea, T. Altantzis, I. Pastoriza-Santos, J. Pérez-Juste, F. Silva, S. Bals, L.M. Liz-Marzán, *Dimethylformamide-mediated synthesis of water-soluble platinum nanodendrites for electrocatalytic ethanol oxidation*  
*Nanoscale* **2013**, *5*, 4776-4784
15. M. L. Debasu, D. Ananias, I. Pastoriza-Santos, L. M. Liz-Marzán, J. Rocha, L. D. Carlos, *All-In-One Optical Heater-Thermometer Nanoplatfom Operative From 300 to 2000 K Based on Er<sup>3+</sup> Emission and Blackbody Radiation*  
*Adv. Mater.* **2013**, *25*, 4868-4874. **Cover page.**
16. L. M. Liz-Marzán, *Plasmonics. Electron Oscillations and Beyond*  
*J. Phys. Chem. Lett.* **2013**, *4*, 1197-1198
17. L. Polavarapu, L. M. Liz-Marzán, *Growth and Galvanic Replacement of Silver Nanocubes in Organic Medium*  
*Nanoscale* **2013**, *5*, 4355 - 4361
18. M. Chanana, P. Rivera-Gil, M. A. Correa-Duarte, L. M. Liz-Marzán, W. J. Parak, *Physicochemical Properties of Protein-Coated Gold Nanoparticles in Biological Fluids and Cells before and after Proteolytic Digestion*  
*Angew. Chem. Int. Ed.* **2013**, *52*, 4179–4183
19. M. Grzelczak, L. M. Liz-Marzán *Colloidal Nanoplasmonics. From Building Blocks to Sensing Devices*  
*Langmuir* **2013**, *29*, 4652–4633. **Cover page.**
20. A. Lombardi, M. P. Grzelczak, A. Crut, P. Maioli, I. Pastoriza-Santos, L. M. Liz-Marzán, N. Del Fatti, F. Vallée, *Optical Response of Individual Au-Ag@SiO<sub>2</sub> Hetero-Dimers*  
*ACS Nano* **2013**, *7*, 2522–2531
21. S. Mourdikoudis, L.M. Liz-Marzán, *Oleylamine in nanoparticle synthesis*  
*Chem. Mater.* **2013**, *25*, 1465–1476. **Cover page. Most Read article from Chemistry of Materials between January and March 2013.**
22. Y. Zhao, L. Xu, L.M. Liz-Marzán, H. Kuang, W. Ma, A. Asenjo-García, J. Garcia de Abajo, N. A. Kotov, L. Wang, C. Xu, *Alternating Plasmonic Nanoparticle Heterochains Made by Polymerase Chain Reaction and Their Optical Properties*  
*J. Phys. Chem. Lett.* **2013**, *4*, 641–647
23. L. Polavarapu, L.M. Liz-Marzán, *Towards Low-cost Flexible Substrates for Nanoplasmonic Sensing*  
*Phys. Chem. Chem. Phys.* **2013**, *15*, 5288-5300
24. J. Pérez-Juste, I. Pastoriza-Santos, L.M. Liz-Marzán, *Multifunctionality in Metal@microgel Colloidal Nanocomposites*  
*J. Mater. Chem. A* **2013**, *1*, 20-26
25. L.M. Liz-Marzán, *Gold Nanoparticle Research before and after the Brust-Schiffrin Method*  
*Chem. Commun.* **2013**, *49*, 16-18
26. D. Rodríguez-Fernández, L.M. Liz-Marzán, *Metallic Janus and patchy particles*  
*Particle Part. Syst. Charact.* **2013**, *30*, 46–60. **Cover page.**

## ABSTRACTS OF SELECTED PUBLICATIONS

**Langmuir** 2013, **29**, 4652–4663

### Colloidal Nanoplasmonics: From Building Blocks to Sensing Devices

M. Grzelczak, L.M. Liz-Marzán

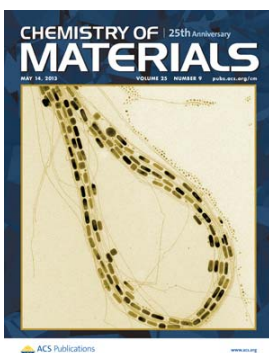


Nanoplasmonics is a rapidly developing field of research and technology, which is based on the ability of small metal particles to strongly interact with light of wavelength significantly larger than their size. The development of nanoplasmonics has been closely associated to the application of colloid science to the controlled growth of metal nanocrystals in solution and to directing the self-assembly of such nanocrystals into organized arrays with enhanced collective properties. Engineering the morphology and the assembly of metal nanoparticles is a key step toward the fabrication of devices with great potential in detection and diagnosis, as well as in a wide variety of other fields. In this Feature Article we provide an overview of the recent work in our laboratory, which in our view somehow reflects the evolution of the field itself and provides guidelines for future research.

**Chem. Mater.**, 2013, **25**, 1465–1476

### Oleylamine in Nanoparticle Synthesis

S. Mourdikoudis, L.M. Liz-Marzán

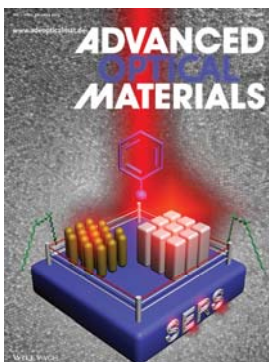


Wet-chemistry approaches based on organic solvents have proven highly efficient for the preparation of several types of metallic, metal-oxide and semiconductor nanostructures. This Short Review focuses on the use of oleylamine (OAm) as a versatile reagent for the synthesis of various nanoparticle systems. We describe the ability of OAm to act as a surfactant, solvent and reducing agent depending on additional synthesis parameters. The specific role of OAm either alone, or in combination with other reactants, to form nanostructures using a wide range of organic or inorganic compounds as precursors, is analyzed. In certain cases OAm can form complex compounds with the metal ions of the corresponding precursor, leading to metastable compounds that can act as secondary precursors and be decomposed in a controlled way to yield nanoparticles. We also point out that OAm-stabilized particles are often able to be dispersed in a variety of organic solvents yielding solutions with enhanced colloidal stability over long periods of time and the potential to find applications in a number of different fields. **Most read article from Chemistry of Materials between January and March 2013.**

**Adv. Opt. Mater.**, 2013, **1**, 477–481

### Self-assembly of Au@Ag Nanorods Mediated by Gemini Surfactants for Highly Efficient SERS-Active Supercrystals

S. Gómez-Graña, J. Pérez-Juste, R. A. Alvarez-Puebla, A. Guerrero-Martínez and L. M. Liz-Marzán

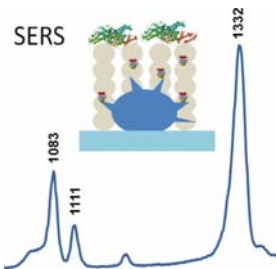


The fabrication of supercrystals of standing core-shell gold-silver nanorods stabilized by gemini surfactants provides SERS substrates with high optical activity, large homogenous sensing areas and the potential to maximize the SERS signal with respect to their gold nanorod supercrystal counterparts.

*J. Phys. Chem. Lett.*, 2013, 4, 2715–2720

Plasmonic Mesoporous Composites as Molecular Sieves for SERS Detection

V. López-Puente, S. Abalde-Cela, P.C. Angelomé, R.A. Alvarez-Puebla, L.M. Liz-Marzán



Application of surface-enhanced Raman scattering (SERS) spectroscopy to the ultrasensitive analysis of small molecules in biological samples is complicated by signal contamination by ubiquitous macromolecules such as proteins, nucleic acids, or lipids. We present a proof-of-concept study of the application of composite films comprising branched gold nanoparticles embedded in mesoporous thin films, which act as molecular sieves. The inorganic mesoporous layer only allows the diffusion of small molecules toward the plasmonic particles while preventing the contact of macromolecules in solution with the optical sensor.

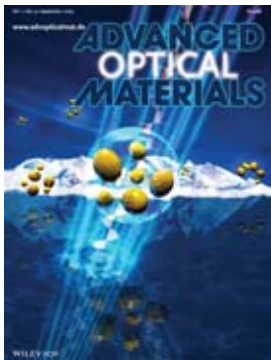
A presentation of this work can be viewed at ACS LiveSlides™ <http://pubs.acs.org/iapps/liveslides/pages/index.htm?mscNo=jz4014085>

Work highlighted in *C&EN*.

*Adv. Opt. Mater.*, 2013, 1, 626–630

Sensitive Detection of Silver Ions Based on Chiroplasmonic Assemblies of Nanoparticles

Z. Xu, L. Xu, L.M. Liz-Marzán, W. Ma, N.A. Kotov, L. Wang, H. Kuang, C. Xu

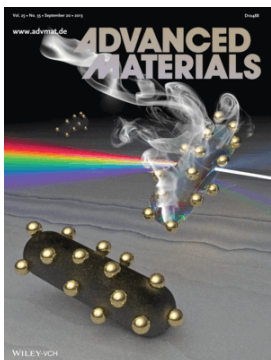


The formation of an optically active plasmonic assembly through DNA recognition mediated by silver ions is reported, and a sensitive and selective chiroptical detection system is fabricated with a detection limit of approximately 2 pM for silver ions.

*Adv. Mater.*, 2013, 25, 4868–4874

All-In-One Optical Heater-Thermometer Nanoplatform Operative From 300 to 2000 K Based on Er<sup>3+</sup> Emission and Blackbody Radiation

M. L. Debasu, D. Ananias, I. Pastoriza-Santos, L. M. Liz-Marzán, J. Rocha, L. D. Carlos

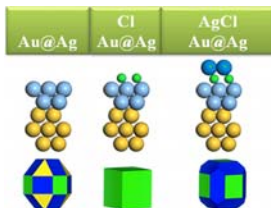


The use of plasmonic nanoparticles as sources of heat attracted much interest in the last decade. Ratiometric nanothermometers with high-spatial resolution, in turn, emerged only in the last couple of years as a very active field of research. Suitable nanoplatforms integrating heaters and thermometers, however, have not yet been realized, despite their great potential in nanophotonics and biomedicine. We present in this communication a step forward towards assessing the local temperature of laser-excited gold nanostructures using an all-in-one nanoplatform comprising (Gd,Yb,Er)<sub>2</sub>O<sub>3</sub> nanorods (thermometers) that were surface-decorated with gold nanoparticles (heaters). The local temperature is calculated using either Boltzmann's distribution (300 – 1050 K) of the Er<sup>3+</sup> up-conversion <sup>2</sup>H<sub>11/2</sub>→<sup>4</sup>I<sub>15/2</sub>/<sup>4</sup>S<sub>3/2</sub>→<sup>4</sup>I<sub>15/2</sub> intensity ratio, or Planck's law (1200 – 2000 K) for a white-light emission ascribed to the blackbody radiation. The surface temperature increase of the (Gd,Yb,Er)<sub>2</sub>O<sub>3</sub> nanorods and the operating range of the nanothermometers can be tuned via the amount of AuNPs. An outstanding result of this study is the unambiguous attribution of the white-light emission to an incandescence process, which settles the existing controversy on the subject.

*J. Phys. Chem. Lett.*, 2013, **4**, 2209–2216

[Au@Ag Nanoparticles: Halides stabilize {100} facets](#)

S. Gómez-Graña, B. Goris, T. Altantzis, C. Fernández-López, E. Carbó-Argibay, A. Guerrero-Martínez, N. Almora-Barrios, N. López, I. Pastoriza-Santos, J. Pérez-Juste, S. Bals, G. Van Tendeloo, L.M. Liz-Marzán



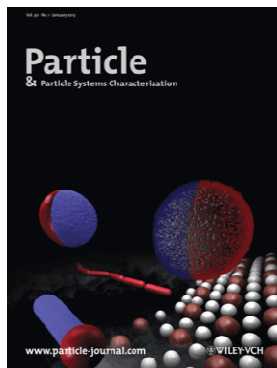
Seed-mediated growth is the most efficient methodology to control the size and shape of colloidal metal nanoparticles. In this process, the final nanocrystal shape is defined by the crystalline structure of the initial seed as well as by the presence of ligands and other additives that help to stabilize certain crystallographic facets. We analyze here the growth mechanism in aqueous solution of silver shells on pre-synthesized gold nanoparticles displaying various well-defined crystalline structures and morphologies. A thorough three-dimensional electron microscopy characterization of the morphology and internal structure of the resulting core-shell nanocrystals indicates that {100} facets are preferred for the outer silver shell, regardless of the morphology and crystallinity of the gold cores. These results are in agreement with theoretical analysis based on the relative surface energies of the exposed facets in the presence of halide ions.

A presentation of this work can be viewed at *ACS LiveSlides*<sup>TM</sup>  
<http://pubs.acs.org/iapps/liveslides/pages/index.htm?mscNo=jz401269w>

*Part. Part. Syst. Charact.*, 2013, **1**, 46–60

[Metallic Janus and Patchy Particles](#)

D. Rodríguez-Fernández, L.M. Liz-Marzán



The concepts of Janus and patchy particles are relatively new in nanoscience. Much effort has been made during recent years to devise and fabricate asymmetric particles with multiple compositions and functionalities due to their interesting properties and potential applications in a variety of fields such as catalysis, optical imaging, or drug delivery. Here, recent advances in the field of Janus particles are highlighted, focusing on nanoparticles comprising (at least) one metallic component, which is responsible for the most interesting properties of the particles. First, the main synthetic approaches are summarized, i.e., phase separation, masking, and self-assembly techniques, and then the special properties, applications, and future prospects of metallic Janus particles are described.

## Scientific Collaborations

J. Pérez-Juste, I. Pastoriza-Santos (U. Vigo)  
A. Guerrero-Martínez (U. Complutense Madrid)  
M. Brust (U. Liverpool)  
F. J. García de Abajo (ICFO, Barcelona)  
N. A. Kotov (U. Michigan, USA)  
N. Del Fatti and F. Vallée (U. Lyon)  
W. Parak (U. Marburg, Germany)  
J. Rocha and L. D. Carlos (U. Aveiro, Portugal)  
R. A. Alvarez-Puebla (U. Rovira i Virgili, Tarragona, Spain)  
V. Pavlov (CIC biomaGUNE, Spain)  
S. Bals (U. Anwerp, Belgium)  
N. López (ICIQ, Spain)  
L. De Cola (ISIS, France)  
M.M. Stevens (Imperial College London, UK)  
J. Lahann (KIT, Germany)  
F. Stellacci (EPFL Lausanne, Switzerland)

# RESEARCH FUNDING

## Research Funding

Ikerbasque Basque Foundation for Science



ERC Advanced Grant 267867



European Commission FP7-NMP-2012-310651



European Commission FP7-NMP-2012-310445



European Commission FP7-INFRASTRUCT-2010-1, 262348



European Commission Network of Excellence



Spanish MINECO (grant no. MAT2010-15374)





2013

# BioNanoPlasmonics Laboratory Activity Report

