ANNUAL REPORT

SEPTEMBER – DECEMBER 2012

BioNanoPlasmonics Laboratory
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Overview

RESEARCH PROGRAMM

The research activity of the BioNanoPlasmonics Lab is focused on the synthesis and formation mechanisms of metal, semiconductor, magnetic and hybrid 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.

GROUP MEMBERS

The group, led by Prof. Luis M. Liz-Marzán started with an initial team of nine researchers (5 postdoctoral research associates, 3 Ph.D. students and 1 research assistant) and one project manager. Two additional postdocs and Ph.D. students, as well as one laboratory technician, are expected to join the laboratory in 2013.

PUBLICATIONS

During the short period at CICBiomagune, 6 scientific articles in high impact factor journals (including Angew. Chem. Int. Ed., ACS Nano and Nano Letters) were published.

RESEARCH FUNDING

Two EU Small collaborative projects (SACS and SAVVY) were funded during 2012. Another two European projects (the Infrastructures project ESMI and the ERC Advanced Grant PLASMAQUO) funded in 2010 and 2011, respectively, were transferred to CICbiomaGUNE.

GROUP MEMBERS

Group Members

Prof. Luis M. Liz-Marzán
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Funding

European Soft Matter Infrastructure (ESMI)

European Union (FP7-INFRASTRUCT-2010-1, 262348)
2010-2014
Funding: 7.800.000 € U. Vigo/biomaGUNE: 395,345 €
Principal Investigator: Luis M. Liz Marzán
(Coordinator: J.K.G. Dhont, FZ Jülich)

Development of plasmonic quorum sensors for understanding bacterial-eukaryotic cell relations (PLASMAQUO)

European Research Council (ERC Advanced Grant 267867)
2011-2016
Funding: 2.247.630 €
Principal Investigator: Luis M. Liz Marzán

Self-assembled virus-like vectors for stem cell phenotyping (SAVVY)

European Union (Collaborative Project. Small or mediumscale focused research project, 310445-2)
2013-2015
Funding: 3.782.729 € biomaGUNE: 468.234 €
Principal Investigator: Luis M. Liz Marzán
(Coordinador: J. Lahann, Karlsruhe Institute of Technology)

Self-Assembly in Confined Space (SACS)

Unión Europea (Collaborative Project. Small or mediumscale focused research project, 310651-2)
2013-2016
Funding: 3.500.000 € biomaGUNE: 254.895 €
Principal Investigator: Luis M. Liz Marzán
(Coordinador: J. Hofkens, K. Univ. Leuven)

Research Publications

6. A. Sánchez-Iglesias, M. Grzelczak, T. Altantzis, B. Goris, J. Perez-Juste, S. Bals, G. Van Tendeloo, S.H. Donaldson Jr., B.F. Chmelka, J.N. Israelachvili, L.M. Liz-Marzán, *Hydrophobic Interactions Modulate Self-assembly of Nanoparticles*
ACS Nano, **2012**, *6*, 11059-11065.

5. A. Sánchez-Iglesias, B. Rivas-Murias, M. Grzelczak, J. Pérez-Juste, L.M. Liz-Marzán, F. Rivadulla, M.A. Correa-Duarte, *Highly Transparent and Conductive Films of Densely Aligned Ultrathin Au Nanowires Monolayers*
Nano Lett., **2012**, *12*, 6066-6070

4. M. Chanana, L.M. Liz-Marzán, *Coating matters: the influence of coating materials on the optical properties of gold nanoparticles*
Nanophotonics, **2012**, *1*, 199-220

3. N. Pazos-Pérez, A. Wittemann, C.S. Wagner, J.M. Romo-Herrera, L.M. Liz-Marzán, F.J. Garcia de abajo, A. Fery, R.A. Alvarez-Puebla, *Organized plasmonic clusters with high coordination number and extraordinary SERS enhancement*
Angew. Chem. Int. Ed. **2012**, *51*, 12688–12693

2. R.A. Alvarez-Puebla, L.M. Liz-Marzán, *SERS Detection of Small Inorganic Molecules and Ions*
Angew. Chem. Int. Ed. **2012**, *51*, 11214–11223

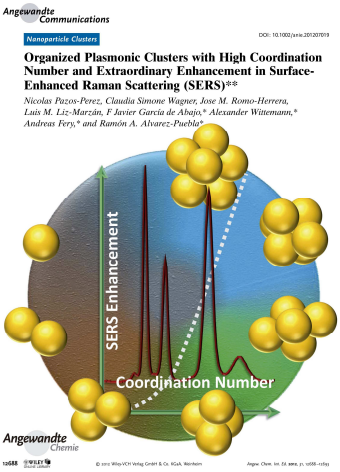
1. B. Pelaz, S. Jaber, D. Jimenez de Aberasturi, V. Wulf, T. Aida, J.M. de la Fuente, J. Feldmann, H.E. Gaub, L. Josephson, C.R. Kagan, N.A. Kotov, L.M. Liz-Marzán, H. Mattoussi, P. Mulvaney, C.B. Murray, A.L. Rogach, P.S. Weiss, I. Willner, W.J. Parak, *The State of Nanoparticle-Based Nanoscience and Biotechnology: Progress, Promises, and Challenges*
ACS Nano **2012**, *6*, 8468-8483

Abstracts of Selected Publications

Angew. Chem. Int. Ed. 2012, **51**, 12688–12693

Organized plasmonic clusters with high coordination number and extraordinary SERS enhancement

N. Pazos-Pérez, A. Wittemann, C.S. Wagner, J.M. Romo-Herrera, L.M. Liz-Marzán, F.J. Garcia de abajo, A. Fery, R.A. Alvarez-Puebla



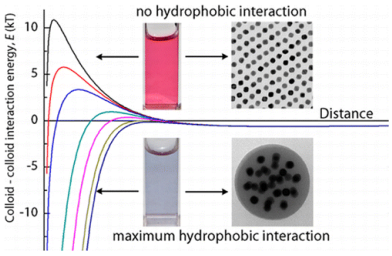
Highly symmetric gold nanoparticle clusters with coordination numbers up to seven were produced by using coating with block copolymers. The resulting clusters were separated by density gradient centrifugation and characterized by using SEM and optical spectroscopy.

We demonstrated ultrasensitive direct and indirect SERS sensing, thus corroborating the outstanding optical performance of these clusters with robust enhancement factors that are over three orders of magnitude higher than those of single particles.

ACS Nano, 2012, **6**, 11059-11065

Hydrophobic Interactions Modulate Self-assembly of Nanoparticles

A. Sánchez-Iglesias, M. Grzelczak, T. Altantzis, B. Goris, J. Perez-Juste, S. Bals, G. Van Tendeloo, S.H. Donaldson Jr., B.F. Chmelka, J.N. Israelachvili, L.M. Liz-Marzán,



Polystyrene (PS)-stabilized spherical gold nanoparticles dispersed in tetrahydrofuran can form clusters upon the addition of water, which is a poor solvent for PS. Additionally, the growth of the clusters can be quenched by the addition of a polymeric surfactant comprising hydrophobic (PS) and hydrophilic (poly(acrylic acid)) blocks (PS-b-PAA). While the amphiphilic nature of the polymeric surfactant allows for sequestration of clusters inside the hydrophobic core, the hydrophilic outer surface of the micelles (comprising the PAA blocks) ensures stability in polar solvents and allows improved visualization. Geometrical features of the nanoparticle clusters, such as aggregate size and interparticle distance, are controlled by adjusting the diameter of the gold nanoparticles and the length of PS chains. Such control over cluster size, interparticle distance, and overall optical response makes these structures promising candidates for drug delivery, especially if release of internal cargo is required. It is important to note, that the copolymer used here is a model system that can be replaced by conducting or biodegradable copolymers, bringing new solutions for problems in biosensing or energy conversion.

INVITED LECTURES

Invited Lectures at Conferences, Curses and Workshops

1. *Diagnosis and Sensing Using Gold Nanoparticles* **(Plenary)**
   11th European Biological Inorganic Chemistry Conference
   Granada, 12–16 Sep 2012
2. *Colloidal Plasmonic Nanostructures*
   Conferencia Española de Nanofotónica (CEN2012)
   Carmona, 1–4 Oct 2012
3. *Colloid Science for Nanoplasmonics*
   Minisymposium on Colloidal Plasmonic effects: Theory, Synthesis and Characterisation,
   Donostia, 19 Nov 2012
4. *Colloidal Nanoplasmonics*
   Reunión de Jóvenes Investigadores en Coloides e Interfases (JICI-I),
   Benidorm 11-13, Dec 2012

Scientific Collaborations

P. Mulvaney (U. Melbourne)
F. J. García de Abajo, (CSIC, Madrid)
A. Fery (U. Bayreuth, Germany)
S. Bals (U. Anwerpen)
W. Parak (U. Marburg, Germany)
N. A. Kotov (U. Michigan, USA)
J. Israelachvili (U. California, USA)
F. Rivadulla (U. Santiago de Compostela, Spain)

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