Nanocomposites consisting of magneto-plasmonic core and smart polymer shell designed for new concept of selective and sensitive detection

Karolina Siskova[1*], Mariusz Uchman[2], Radek Ostruszka[1], Hoang Yen Nguyenová[1], Katarzyna Bys[2], Josef Kapitan[3], Miriam Guadano Sanchez[4] & Nekane Guarrotxena[4]

[1]*Dept. Of Experimental Physics, Faculty of Science, Palacký University in Olomouc, Czech Republic*
[2]*Faculty of Science, Charles University in Prague, Czech Republic*
[3]*Dept. Of Optics, Faculty of Science, Palacký University in Olomouc, Czech Republic*
[4]*Nanohybrid and Interactive Polymers Group, Institute of Polymer Science and Technology, Spanish National Research Council (ICTP-CSIC), Madrid, Spain*

ABSTRACT

Nanocomposites containing magnetic (e.g. magnetite) and plasmonic nanoparticles (e.g. Au and/or Ag) combined with smart polymers have been known for several years already. Concomitantly, selective and sensitive detection of species via surface-enhanced Raman scattering (SERS) spectroscopy represents the goal applicable in many domains, such as in medicine and/or when solving environmental issues (1, 2). The highest SERS enhancement in hydrosols (i.e. plasmonic nanoparticles dispersed in aqueous solutions) is usually obtained when hot spots are formed, that can be caused by nanoparticles aggregation for instance. Here, we would like to present a new concept of species SERS detection that differs from the regular SERS approach. It is based on species spontaneous aggregation induced by the nanocomposite shell design as we have demonstrated recently (3). Indeed, due to the presence of thermoresponsive polymer around plasmonic core, it is possible to increase the SERS signal via a decreased distance of detected species and plasmonic surface at slightly elevated temperatures (3). Therefore, the developed nanomaterial enables the detection of micromolar and submicromolar concentrations of selected macrocyclic species, e.g. highly charged porphyrins (3). The SERS detection can be then regarded as a two-step process: (i) species preconcentration near nanocomposite surface via its spontaneous aggregation and (ii) species SERS signal increase owing to polymeric shell shrinkage at slightly elevated temperatures. Macrocyclic, highly charged molecule, i.e. porphyrin (hence, perfectly soluble in water) that possess fluorescent properties has been intentionally chosen as a model adsorbate to prove the concept recently (3). Different degree of its fluorescence quenching can serve as another, albeit indirect proof of the whole idea. During the talk we would like to show other successful examples of SERS detection via magneto-plasmonic nanocomposites.

GRAPHICAL ABSTRACT

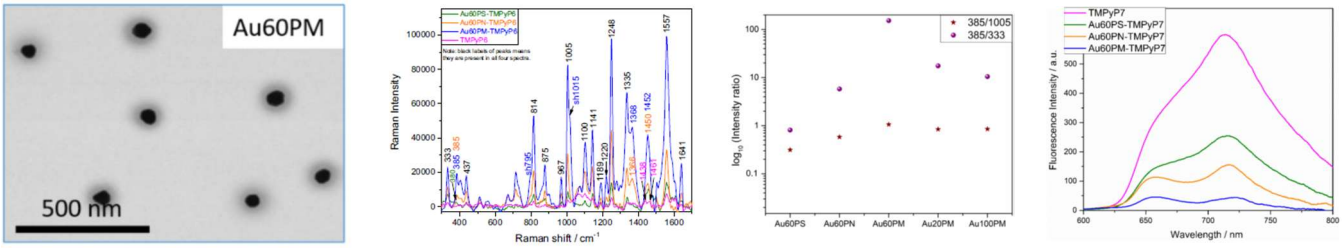

Figure Caption: TEM image of the most perspective nanocomposite (on the most left); SERS signals and derived intensity ratios of the marker bands of the selected cationic porphyrin using different nanocomposites under study (middle graphs); fluorescence signals obtained from the cationic porphyrin interacting with representative nanocomposites (on the most right).

KEYWORDS

Nanocomposite, nanomaterial, thermo-responsive polymer, Au nanoparticle, nanoparticle surface coating, SERS, cationic porphyrin.

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BIOGRAPHY

RNDr. Karolina Siskova, Ph.D. serves as an associate professor at Department of Experimental Physics, Faculty of Science, Palacký University Olomouc, in the Czech Republic, Europe. She is the head of the research group called Nanostructures for biomedical and environmental applications where mentors four postdocs and supervises three PhD, one Master and one Bachelor students. At the Department of Experimental Physics, she teaches and guarantees two main courses about nanomaterials and one course concerning vibrational spectroscopy. Furthermore, she provides several lectures within the other courses guaranteed by Departments of Physical Chemistry and/or Biophysics. Her research interest includes optically active metal and metal-oxide nanostructures (nanoclusters, nanoparticles) and their combination with other functional nanostructures (e.g. magnetic) that enable the designed construction of multifunctional nanocomposites. She closely collaborates with polymer scientists (e.g. prof. Nekane Guarrotxena from ICTP-CSIC in Spain and dr. Mariusz Uchman from Faculty of Science, Charles University in Prague, Czech Republic) to develop new organic-inorganic functional nanomaterials. Furthermore, she is interested in light-matter interaction, investigates mechanisms of nanocomposite formation and structure-property relationship, and exploits several spectroscopic techniques. She was awarded by Czech French joint-degree PhD in physical chemistry by Charles University in Prague and in interface of physics, chemistry and computing science with biology by Université Pierre et Marie Curie in Paris in 2006 (supported by Czech and French governments, respectively). Her postdoc stay was realized at University of California in Santa Barbara, USA, in the laboratories of prof. Quyen Thuc Nguyen, and was fully financed by Fulbright Foundation in 2008-2009. She received several awards (e.g. by Spectroscopic Society of J.J. Marci, Fulbright certificate, Faculty of Science UPOL Dean´s award for teaching in 2023, reviewer certificate from ACS as well as Science of the Total Environment). Her h-index reached 22 according to Web of Science where 61 articles have been recognized and cited so far (1891 times without self-citations on 11th February 2026).