Postdoctoral position available (from May 1, 2024)

Plasmonic sensors based on two-dimensional assembly of gold nanoparticles for the detection of pollutants and biomarkers

Context : New nanostructured or two-dimensional materials, thanks to their specific intrinsic properties, -optical, -magnetic, -electrical, -catalytic, -mechanical, etc. hold great potential for the fabrication of ultrasensitive nanodevices, for screening, early diagnosis of diseases or detection of pollutants. Among them, **compact 2D-assembly of gold nanoparticles**, bare or functionalized, are promising systems for SERS (Surface-Enhanced Raman Scattering) sensors [ref-1] , chemiresistive gas sensors for the detection of volatile organic compounds, particularly those present in breath and associated with pathologies [ref-2] or also for deformation sensors [ref-3]. To improve the reproducibility, response times, sensitivity and selectivity of these sensors, we propose to use gold nanoparticles that are monodispersed in shape and size, with sharp edges, to obtain a homogeneous spatial distribution of these nanoparticles on various substrates. When the inter-particle distances are very small, the electromagnetic hot spots located in the nanogaps enable enhancement of light-matter interaction, in an extremely localized way, and in particular heat and charge transfers from the gold surface to the adsorbed molecules, for sensor applications, photochemistry and photocatalysis.

Research program : For several years now, our research has been focusing on the synthesis of high-quality gold nanoparticles, optimized in size and shape to generate light, heat or charge carriers, and presenting sharp tips and edges. The control of the interface between the gold nanoparticle and its environment (chemical coatings) is the second key point in which we are specialized. The applications targeted so far, concern plasmonics and health [ref-4]. An 18-month **postdoctoral fellowship is available** in our group, for a motivated young researcher interested in applying his knowledge to the preparation of plasmonic thin films for the fabrication of sensors. The research consists in developing a 2D-self-assembly know-how of these gold nanoparticles, at the liquid-liquid interface (water/oil) and at the water/air interface (Langmuir-Blodgett) following protocols from the literature. These gold nanoparticles can be coated with an insulating organic monolayer or a silica layer whose thickness and porosity can be modulated at will (sol-gel chemistry). These nanometric films will be transferred to various substrates (transparent, conductive, flexible, stretchable, etc.) for sensor applications. This work, funded by the ANR (Agence National de Recherche, **POPCORN** and **CARICATURES** projects), will take place in the EDifices NAnométriques Laboratory (DRF-IRAMIS-NIMBE-LEDNA) located in the Paris region at CEA-Saclay. The properties of these nanostructures will be studied in collaboration with experts.

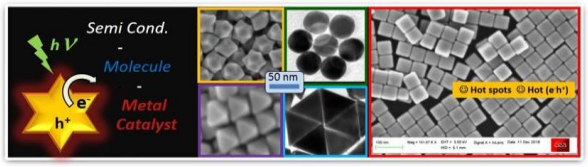

Figure: Left: schematic diagram of an optically active hybrid gold nanoparticle. Center: various gold nanoparticle synthesized at CEA. Right: 2D self-assembly of gold nanocubes ideal for the formation of numerous electromagnetic hot spots and also generation of hot charge carriers (e-,h+).

Application : We are looking for candidates with a PhD and ideally a previous experience in 2D-assembly of nanoparticles. This 18-month postdoctoral fellowship at the Institute NIMBE of CEA Saclay (CNRS UMR3685) can begin starting from May 1,2024. Candidates can apply by sending their CV and a cover letter highlighting their experience and motivation for undertaking this project. Contact information for one or two reference persons should also be provided. Applications should be sent to: Dr Sylvie Marguet, sylvie.marguet@cea.fr (Websites : perso; team)

REF-1: (a) Vazquez-Iglesias-*Bioactive Materials*-**2024**, *«SERS sensing for cancer biomarker: Approaches and directions "*

(b) cao et al, iscience **2023**, "Ultrasensitive discrimination of volatile organic compounds using a microfluidic silicon SERS artificial intelligence chip »

REF-2: (a) Shang- *Adv. Sensor Res.*-**2023**, "Flexible, Fibrous, and Rigid Chemiresistive VOC Sensors with Nanoparticle-Structured Interfaces"

(b) Peng-*Nature Nanotech*-**2009** "Diagnosing lung cancer in exhaled breath using gold nanoparticles";

(c) Nakhleh-*Nanomedicine*-2014, "Monolayer-capped gold nanoparticles for disease detection from breath"

REF-3 : Moreira-*Nanotechnology*-**2013** "Electron transport in gold colloidal nanoparticle-based strain gauges"

REF-4: (a) D. Ge-*Photonics Research*-**2022** " Advanced hybrid plasmonic nano-emitters using smart photopolymer"

(b) Synthesis and assembly of gold nanoparticles of various morphologies and coatings for optimized gold/molecule nanohybrids, S Marguet, **2021**, PEP21-2nd Summer School on Photothermal Effects in Plasmonics;

(c) **2022**, *Unité communication de la DRF (CEA)*: « Plasmonique : synthèse à façon de nanoparticules d'or fonctionnalisées »;