Title

Development and characterization of plasmonic gas sensing devices with integrated microporous gas-storage layer.

Description and Objectives

Develop gas sensors, e.g. CH4 and CO2 in ppm-ppb range, through synthesis of integrated microporous storage, modeling and nanofabrication of plasmonic structures, characterization via FTIR and Raman spectroscopies.

The aim of the proposed research topic is the development of miniaturized gas sensors for CH_4 or CO_2 detection at concentrations ranging from ppm to ppb. This will be achieved through the modeling of the electromagnetic field enhancement near metallic microstructures with plasmonic properties for surface-enhanced infrared absorption (SEIRA) spectroscopy or surface-enhanced Raman scattering (SERS). The confinement of the gas molecules will be achieved with the synthesis of micro-porous environment on top of the metallic microstructures.

Different activities will contribute to this aim.

A vast part of the research activity will focus on the development of different microporous materials (e.g. polymers with intrinsic microporosity, metallorganic frameworks, polyaromatic frameworks, micro-porous alumina, etc.) through different synthetic routes and their morphological, physico-chemical and functional characterization. The main characterization methods may include electron microscopies, X-ray spectroscopies, optical spectroscopies, and scanning probe microscopies. The synthesis and fabrication of the porous framework will be integrated on a solid chip sensing device for low gas concentrations by optimizing the deposition/growth conditions.

Clean-room fabrication of metallic micro and nanostructures will be used to develop the plasmonic platforms in association with the modeling of the plasmonic enhancements with finite element methods calculations (COMSOL), guiding the choice of the materials and the engineering of the metallic structures with dimensions suitable to match the infrared and/or Raman vibrations of the analyte. Among the intended substrate materials for the realization of the gold microstructures, silicon carbide (SiC), calcium fluoride (CaF_2), sapphire (Al_2O_3) and silicon substrates will be tested, verifying the structural and related optical properties of the substrates' material (e.g. transmittance/reflectance and optical constants) upon necessity in order to maximise their performances.

This research topic is funded by INRiM and co-proposed by Dr. Eleonora Cara (INRiM) and Prof. Giorgio Gatti (UPO). They can be reached via email for further information at e.cara@inrim.it and giorgio.gatti@uniupo.it. The academic tutor is Prof. Barbara Bonelli (PoliTO). The main working locations are INRiM (Strada delle Cacce 91, Torino) and UPO (Dipartimento per lo Sviluppo Sostenibile e la Transizione Ecologica, Piazza Sant'Eusebio 5, Vercelli).

Skills and competencies for the development of the activity

MS in Chemistry, Materials Science, Physics or related Engineering / Good written and oral English / Experience in either materials synthesis, FEM simulations, nanofab, FTIR, Raman spectroscopy or plasmonics.