UNIVERSITÀ DEGLI STUDI DI PALERMO

DEIM UNIPA – VIALE DELLE SCIENZE (EDIF. 9)

SEMICONDUCTOR NANO ANTENNAS FOR MID-INFRARED SENSING

ABSTRACT

The quest for novel plasmonic materials has been a lively area of research over the last few years. In the mid-infrared (mid-IR) spectral region, in particular, localized plasmon resonances in nanoparticles and nanoantennas hold promise for enhanced IR spectroscopies, with key applications in biology, medicine, and security. In this frame, the development of a CMOS-compatible plasmonic platform in the mid-IR could have disruptive effects for future technologies, allowing for cost-effective sensing devices integrated with electronics .

We report on the growth, fabrication and optical characterization of heavily-doped Ge antennas integrated on a Si substrate and we exploit them for the sensing of solid-phase and liquid-phase analytes . Epitaxial Ge is grown on Si by plasma-enhanced chemical vapor deposition, exploiting phosphorous as the dopant. We demonstrate two-wire gap antennas fabricated by electron-beam lithography and reactive ion etching techniques, displaying localized plasmon resonances in the important 8 to 13 μm molecular fingerprint region. We target the sensing of a thin polydimethylsiloxane (PDMS) layer (thickness of about 40 nm) and demonstrate an enhancement of two orders of magnitude in the collected signal, as derived from a comparison with the results of detailed numerical simulations. We also demonstrate real-life application such as the sensing of explosive simulants in the liquid phase, which is of interest for airport security screening. Finally, we use Ge antennas to demonstrate for the first time all-optical doping, ultrafast control of antenna resonances, and plasmon-enhanced third harmonic generation in the mid-infrared.

Our results represent a first experimental benchmark for group-IV mid-IR plasmonics and confirm that future CMOS sensing platforms could benefit significantly from plasmonic enhancements provided by integrated heavily-doped Ge-based devices.

INVITED SPEAKER BIO

Paolo Biagioni received his Ph.D. in Physics in 2007 from Politecnico di Milano (Italy) working on near-field optical microscopy and was then a Humboldt Fellow in the group of Prof. Bert Hecht in Würzburg (Germany) focusing on near-field polarization engineering with optical cross antennas and on the impedance description of plasmonic antenna circuits. He has been Assistant Professor since 2010 and Associate Professor since 2014 at the Physics Department, Politecnico di Milano (Italy).

His research interests are in nano-optics and plasmonics. At present his main activities are focused on:

- Linear and nonlinear properties of gold nanoantennas;
- Mid-infrared plasmonics and sensing with heavily-doped germanium;
- Subwavelength germanium resonators for enhanced light emission at telecom wavelengths;
- Polarization control and chirality at the nanoscale.

He is the coordinator of the FET-Open EU project GEMINI ('Germanium Mid-Infrared plasmonics for sensing').

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WHEN AND WHERE:
20/10/2016 - 13:00 – 14:00
U110

Coordinator: **Costantino Giaconia**
Session Chair: **Patrizia Livreri**