

Physics Ph.D. Annual Report – First year

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Research activity

The main research topic of my first-year Ph.D. has been the fabrication and the characterization of plasmonic nanomaterials. In particular, I am involved in two main projects:

1. Realisation of a nanoscopic thermometer for the study of heat transfer at the nanoscale
2. Development of a robust and reliable technique for the fabrication of plasmonic nanostructures on insulating substrates via thermal scanning probe lithography.

Both projects have, as their final objective, the fabrication of nanostructures for investigating the mechanisms of heat transfer at the nanoscale. The first project is in collaboration with Istituto Italiano di Tecnologia (IIT) at Morego (GE) and is giving me the possibility to work in the Clean Room Facility in order to learn how to fabricate nanostructures via bilayer lift-off exploiting many material deposition and lithographic techniques like:

- Oxygen plasma
- Spin coating
- Thermal deposition
- Electron-beam deposition
- Atomic layer deposition
- Electron-beam lithography.

The second project is in collaboration with the Laboratorio di Nanostrutture of DIFI (Unige) and is based on other methods for the deposition and the patterning of the samples:

- Ozone bath
- Radio frequency sputtering
- Spin coating
- Thermal scanning probe lithography (NanoFrazor)
- Ion-beam sputtering.

For both processes also chemical procedures are required like the development and the lift-off of the resists, and each step can benefit a morphological, chemical and optical characterization by means of Atomic Force Microscopy, Scanning Electron Microscopy, Optical Microscopy, X-ray Photoelectron Spectroscopy, Transmission Spectroscopy and Spectroscopic Ellipsometry. The trial and error method is the core for the prosecution of these projects, but encouraging intermediate results have already been obtained. The necessity of analyzing systems via optical techniques with a microscopic resolution gave us the chance of realising a home-assembled micro-spectrometer setup for measures of transmittance.

In the meanwhile, I participated to other projects like the microscopic optical characterization of 2D materials (see the publication list), the optical characterization of 2D semiconductors as a function of the temperature and the realisation of plasmonic nanomaterials for ultrafast optical experiments.

Publications

- M. Magnozzi, T. Pflug, M. Ferrera, S. Pace, L. Ramò, M. Olbrich, P. Canepa, H. Ağircan, A. Horn, S. Forti, O. Cavalleri, C. Coletti, F. Bisio, and M. Canepa, *Local Optical Properties in CVD-Grown Monolayer WS₂ Flakes*, The Journal of Physical Chemistry C, **125 (29)**, 16059-16065 (2021).

Conferences

No conferences were attended in this year.

Courses and exams

- Introduction to nanophotonics and nanofabrication (Physics Ph.D. course) – Dr. Maria Caterina Giordano

Exam passed on 28/06/2021
- Biosensing (Physics Ph.D. course) – Prof. Ornella Cavalleri and Prof. Elena Angeli

Exam passed on 09/07/2021
- Fisica Computazionale/ Computational Physics (Master course in Physics) – Prof. Riccardo Ferrando and Dr. Davide Bochicchio
- First on-line School on Synchrotron Radiation “Gilberto Vlaic”: Fundamentals, Methods and Application (from 13/09/2021 to 17/09/2021)

Other activities

- First semester didactical tutor for the course “Fisica generale/General Physics” (1th year biomedical engineering Dibris Unige) – Prof. Luca Vattuone and Prof. Guido Gagliardi (24 hours)
- Second semester didactical tutor for the course “Fisica generale/General Physics” (1th year biomedical engineering Dibris Unige) – Prof. Luca Vattuone and Prof. Guido Gagliardi (16 hours)