Germanium for mid-infrared plasmonic bio-sensing

Plasmonics sensors operating in the mid-infrared region (3-12 μm) of the electromagnetic spectrum are very promising tools for biology, medicine and safety/security applications. These sensors exploit surface plasmon resonances in specifically designed nanostructures to allow the optical detection of specific molecules at very low concentrations. So far, plasmonic applications have been based on metals such as gold, silver, or aluminum, which display resonant plasma oscillations in the visible range. As the plasma frequency is proportional to the square root of the carrier density, the electrodynamic equivalent of a metal at IR frequencies should have electron densities in the $10^{19} - 10^{20}$ cm$^{-3}$, which are the typical values reached in heavily doped semiconductors. In the framework of the european project GEMINI (Germanium mid infrared plasmonics for sensing) we are realizing heavily doped germanium thin films epitaxially grown on silicon as a new material platform for the development of a new class of plasmonics integrated sensors.

The thesis activity will be focused on the epitaxial growth of heavily doped germanium thin films by LEPECVD (Low-energy plasma-enhanced chemical vapor deposition) and on the nano-fabrication of Hall bars structures by UV lithography and dry etching. The processed Hall bars structures will be used to perform Hall effect measurements at room temperature (to measure the doping density) and as a function of temperature (to investigate the carrier scattering mechanisms at different doping levels).

Skills acquired during the thesis work:
- Epitaxial growth of semiconductors by LEPECVD
- Micro-fabrication techniques (UV lithography, plasma etching, e-beam evaporation of metals)
- Working with a closed cycle cryostat
- Four point Hall measurements
- Carrier mobility measurements as a function of temperature

List of selected publications: