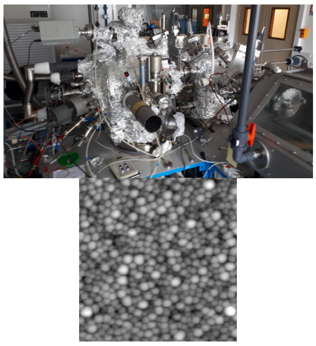
Institut de Recherche Interdisciplinaire de Grenoble

Master / PhD Thesis Project

Synthesis and study of GeSn/Si quantum dots

The optical information processing by the silicon technologies has been facing a major obstacle for many years: the availability of a bright and CMOS compatible light source. The recent discovery of the laser effect in thick layers of the $Ge_{1-x}Sn_x$ alloy makes this perspective a viable route owing to the real integrative potential of GeSn (which is an all group IV alloy). However, the today encountered thick layers of GeSn are infra red emitters, typically in the 2.2-5 µm range [1], and do not fit with the current telecom standard, in the 1.3-1.6 µm range. To give GeSn a broader applicative impact, tailoring the photon emission energy to higher values can be considered by taking advantage of the electronic confinement in GeSn/Si quantum dots. Based on this, the first objective of this experimental internship is to refine our knowledge on the synthesis of GeSn/Si quantum dots grown in our Molecular Beam Epitxy (MBE) tool. This topic, for this alloy, is still underexplored at the international level. In particular, the candidate will focus his (her) growth activities towards a better understanding of the parameters governing the Sn incorporation in the Ge matrix, the size and density of the dots, as well as strategies for layer capping, with the aid of structural characterization tools (SEM, AFM, Raman spectroscopy, and TEM in the frame of a collaboration). The second objective, that is no less necessary for qualifying these objects, and still little discussed in the literature, is drawing a detailed view of the potential barriers at the Si (Ge) and $Ge_{1-x}Sn_x$ interface. This point will be the subject of a complementary study by means of optical and electrical spectroscopy techniques (photocurrent and electrical impedance), carried out on standard $Ge_{1-x}Sn_x$ samples comprising well determined thin layers of known tin content and crystal stress state (collaboration with the CEA-LETI and the growth team regarding the synthesis of GeSn layers via the CVD approach). To that end, an introductory microfabrication activity will be proposed and will give the candidate the opportunity to fabricate his (her) own study-oriented devices.



IV-IV molecular beam epitaxy tool and example of uncapped GeSn dots on Si grown in our equipment (AFM, field of view 500 nm)

Continuation in a PhD is possible, with a view to studying the electronic states of these objects, as well as integrating them in optical resonators. For this work, collaborative in nature, the candidate must have skills in solid state physics and physics of semiconductors and appreciate the experimental work.

[1] J. Chrétien et al, ACS Photonics 2019, 6, 10, 2462–2469 (2019)

APPLY NOW!

To apply for this position, send your application (including CV) by e-mail to: nicolas.pauc@cea.fr

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