Self-catalyzed InP nanowires grown by VLS-MBE on silicon for photonics

Jean-Baptiste Barakat^{1a}, R. Anufriev^{1b}, H. Dumont^{1a}, P. Regreny^{1a}, N. Chauvin^{1b}, C. Bru-Chevallier^{1b}, G. Patriarche², B. Salem³, M. Gendry^{1a}

¹Institut des Nanotechnologies de Lyon, UMR5270 CNRS ^{a-}École Centrale de Lyon, 36 Avenue Guy de Collongue, 69134 Écully, France ^{b-}INSA de Lyon, 7 Avenue Jean Capelle, 69621 Villeurbanne, France ²Laboratoire de Photonique et de Nanostructures, UPR20 CNRS, Route de Nozay, 91460 Marcoussis, France ³Laboratoire des Technologies de la Microélectronique, UMR5129 CNRS UJF/CEA, 38054 Grenoble, France

jean-baptiste.barakat@ec-lyon.fr

Silicon photonic deals with the integration of optical functions on chip and among others light emission which could be realized with III-V semiconductor compounds. Nanowires (NWs) grown by catalyst-assisted vapor-liquid-solid (VLS) method seems to be a very efficient way to integrate defect-free III-V compounds of high structural and optical qualities on silicon (Si), despite the highly mismatched interface between these materials. To ensure compatibility with Si technology, it is highly desirable to develop Au-free catalysts for the epitaxial growth of III-V NWs on Si. Our objective is to demonstrate that InP NWs could be successfully grown on Si(111) but also on Si(001) by solid-source Molecular Beam Epitaxy (MBE) using indium droplets as seeds.

Indium droplets of controlled diameter were deposited in-situ in the MBE reactor before the NW growth. We investigated several main growth parameters (growth temperature, indium and phosphorus fluxes) in order to favour the InP NW nucleation as a function of the indium droplet diameter. We notice that the presence of a thin silicon oxide layer onto silicon substrate is a limiting point to promote the nucleation step for epitaxial NWs. A bimodal NW distribution has been highlighted with column-like NWs and rod-like NWs. We successfully achieve rod-like InP NWs grown at 380°C with 100% verticality on Si(111). High-resolution transmission electron microscopy and X-ray diffraction reveal a Zinc-Blend structure with a high density of twins and stacking faults. Photoluminescence measurements of NWs show a weak intensity peak around 1.45 eV which is correlated to these poor structural properties. We are now working to improve the nucleation step focusing on the Si substrate preparation (exposure to phosphorus, arsenic or gallium flux before the indium droplet deposition) and the structural and optical properties of these self-catalyzed InP NWs on Si substrates and on patterned Si surfaces.