LMGP
Laboratoire des matériaux et du génie physique
une vision des matériaux

Grenoble INP

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Internship proposal (Master or final project engineering school) at the LMGP

Visualising the incipient growth of ZnO ultra thin films on InGaAs for tailoring contact resistivity

Abstract

Thanks to its high electron mobility, n-InGaAs material is a promising candidate to overcome the intrinsic limits of silicon, but the best way to contact it and reach low contact resistance has yet to be determined. The insertion of ultrathin ZnO insulator in between the metallic contact and the semiconductor appears to be a good solution. The internship/PhD work address the issue of the contact interface crystallographic and chemical structure, in relation with the electrical performance.

Detailed internship proposal

The improvement of silicon-based microelectronics devices, for high performance and/or low power consumption, will require overcoming substantial channel mobility and source/drain (S&D) carrier injection issues. Thanks to its high electron mobility, n-type InGaAs is a promising candidate to overcome some of the intrinsic limits of Si, but the best way to contact it and reach low contact resistance has yet to be determined. The insertion of an ultrathin oxide insulator between the metallic contact and the III-V semiconductor (InGaAs) appears to be a good solution. The magnitude of the contact resistance is highly dependent on the interface crystallographic structure, chemical states, composition, and local point defects, which govern the band structure, band offset, and Defect Induce Gap State (DIGS). **The goal of the project is to address the issue of the contact interface structure in relation with the electrical performance. The main scientific objectives are fourfold : a) to control the incipient growth mechanism of ZnO ultrathin films Atomic Layer Deposition, with *in situ* multiprobe characterization tool, b) to visualize the crystallographic structure and chemical states of the ZnO-InGaAs interface, c) to study the effect of the metallic capping on the ZnO layer, d) to correlate the semiconductor/oxide and metal/oxide interfaces properties to the electrical resistivity in order to optimize it.** This work, which focuses on the contact resistance issue, could have an immediate application to Light Emitting Diodes (LEDs) or photovoltaic cells.

For the purpose of the project the student will use the new ALD / MOCVD MOON reactor, installed at LMGP, which was designed for *in situ* characterization of oxide materials during growth with a multiprobe approach (*www.lmgp.grenoble-inp.fr, FM2N team)*. MOON is a unique instrument which can be used in-house as a CVD or ALD reactor allowing *in situ* substrate curvature measurements, photoluminescence measurements and Raman spectroscopies. In addition, it can be moved to the SIRIUS beamline at synchrotron SOLEIL (St Aubin), allowing *in situ* Surface X-ray diffraction, Grazing Incidence Small Angle Scattering, X-ray fluorescence and X-ray spectroscopy. The MOON equipment is in operation and has been used for the first time in May 2014 at SOLEIL for studying the growth of ZnO on Si and sapphire substrates by ALD with a diethylzinc and nitrous oxide precursors.

During the internship the student will focus on the first objective, i.e. to understand and control the incipient growth mechanism of ZnO ultrathin films (about 1nm) Atomic Layer Deposition on InGaAs substrates in the MOON reactor. *Ex situ*, structural and chemical characterizations of the thin films and interfaces will be carried with Grazing incidence X-ray diffraction and reflectivity at the CMTC platform and at the ESRF (BM2) and with High Resolution Transmission Electron Microscopy. The electrical properties of a complete metal/ZnO/InGaAs stack might be investigated during the internship.

Location

The candidate will work within the LMGP, Materials and Physical Engineering Laboratory, in the team FM2N in collaboration with other laboratories (Leti, Grenoble ; SOLEIL and ESRF synchrotrons ; SIMAP, Grenoble INP ; IM2NP (Marseille)).
LMGP Web Site: http://www.lmgp.grenoble-inp.EN/

Profile & requested skills

The candidate is a high school, engineering school and / or Master student whose training focuses primarily on materials science, crystallography surface sciences and physics of semiconductors. Very good aptitudes for working in a team, as well as for talking and writing in English will be appreciated. We are looking for very motivated students, interested in pursuing with a PhD.

Subject could be continued with a PhD thesis : YES
Stipend: an internship stipend will be provided.

CONTACT

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