Core-shell nanowires for piezotronics

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Piezotronic devices, which associate the piezoelectric and the semiconducting properties of materials, have been demonstrated since 2007 by Z.L Wang in Georgia Tech [1]. Nanogenerators for the energy harvesting [2], mechanically activated field effect transistors [3] or pressure sensors [4] have been fabricated using ZnO nanowires, a piezoelectric and semiconducting material.

The drawbacks of ZnO are its low carrier mobility [5] and its low piezoelectric coefficient [6]. An alternative to ZnO could be core-shell nanowires considering a semiconducting core as Si, GaAs or Ge and a piezoelectric shell as functional oxide ($PbZrTiO_3$ or $BaTiO_3$) or as piezopolymer (P(VDF-TrFE)). This kind of nanowires may have better piezoelectric and semiconducting properties and could allow a modularity of the integrated functions: we could by instance use a ferroelectric shell to create field effect nanowires transistors.

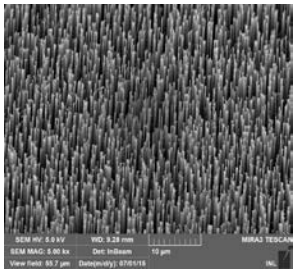

Figure 1: Sem picture of self-catalysed GaAs nanowires

The aim of this work is the elaboration and the characterisations of the GaAs cores with a ferroelectric or a piezoelectric shell using different kind of materials: functional oxides or piezopolymer. The objective is to prove that a mechanical field effect on the nanowires permits to modify its electric transport.

In this contribution, we will report on the preparation of self-catalysed GaAs cores by using Molecular Beam Epitaxy and of different shells deposited by various methods (sol-gel, sputtering, molecular beam epitaxy). We will present advanced structural characterizations (DRX, HRTEM) as well as measurements methods of individual nanowires mechanical properties. We will also report on methods for the electrical and electromechanical measurements.

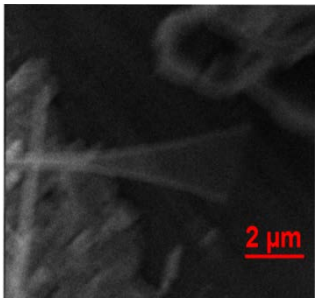

Figure 2 : SEM picture of a nanowire at its resonant frequency

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