Self-catalyzed grown InAs/GaSb core-shell nanowire arrays

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InAs and GaSb are almost lattice matched belonging to the so called ”6.1Å family” [1]. When in contact, the structure has a broken gap heterointerface. In a core-shell nanowire (NW) geometry, these particularities make the combination interesting for low power electronic devices (TFETs) and the study of new physical properties, i.e. two-dimensional topological isolator behavior [2]. The selective growth in array offer the advantage of easier growth parameter optimization and better uniformity of the core-shell structure. In this paper, we present the growth and morphological and structural analysis of InAs/GaSb core-shell NW arrays. Preliminary results of DC electrical measurements are also discussed.

For the InAs/GaSb core-shell NW array growth, Si (111) substrates covered with 20 nm thermal SiO_2 were used. Two-dimensional, periodic arrays of nano-sized holes were patterned in the oxide thin film using E-beam lithography and dry and wet chemical etching. The core-shell NWs were grown by MBE using for both As and Sb, valved cracker sources. The growth of InAs NW arrays was optimized regarding the yield and morphology, the best growth parameters being substrate temperature (T_s) 480°C, In rate 0.08 µm/h and As beam equivalent pressure (BEP) $4x10^{-5}$ mbar. It came out that the substrate preparation is crucial for achieving a high NW yield. Based on previous results [3], the growth of GaSb shell was investigated similarly obtaining optimum growth conditions for T_s 330°C, Ga rate 0.1 µm/h and Sb_{BEP} $1.5x10^{-6}$ mbar. Fig. 1 shows an SEM image of an InAs/GaSb core-shell NW array.

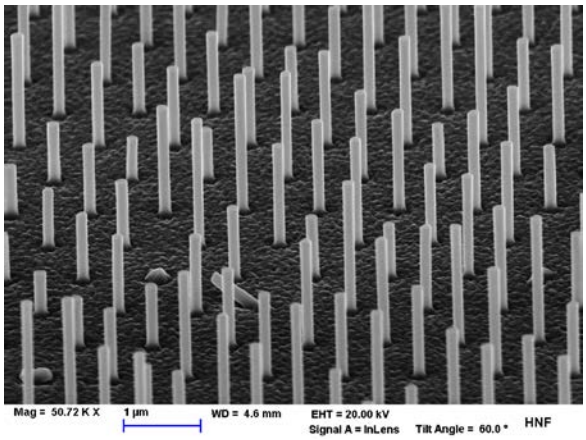

Fig.1: SEM image of an InAs/GaSb core-shell NW array.

The coherent epitaxial growth was proved by TEM analysis. The low lattice mismatch (0.6%) between InAs and GaSb combined with the one-dimensional geometry results in misfit dislocation free core–shell NWs.

Additionally, the TEM results show that the crystalline structure of the InAs core NWs, with stacking faults and twins, continues into the GaSb NW shell.

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[2] L.Du et al., Phys. Rev. Lett. 114, 096802 (2015)
[3] T. Rieger et al, *Nanoscale* **7**, 7356 (2015).

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