InAs QD formation on GaAs(110) by Bi-surfactants

W. Martyanov,[1] R.B. Lewis,[2] H. Janssen,[1] C.S. Schulze,[1] P. Farin,[1] R. Zielinski,[1] A. Lenz,[1] L. Geelhaar,[2] and H. Eisele[1]

[1] *Technische Universität Berlin, Institut für Festköperphysik, Hardenbergstr. 36, 10623 Berlin, Germany*

[2] *Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7, 10117 Berlin, Germany*

While on GaAs(001) and GaAs(111)A three-dimensional (3D) growth of InAs quantum-dots (QD) can be observed, on the GaAs(110) surface the InAs deposition typically results in a two-dimensional (2D) layer, which relaxes plastically. But {110} facets of III/V-semiconductors materials often form the sidewalls in self-assembled GaAs nanowire growth. The growth of QDs on these sidewalls is of high interest for light emitting devices [1]. Recently, it was show that the presence of surface Bismuth (Bi) induces 3D formation of InAs on GaAs(110) by modifying the surface energy [2]. Furthermore, Bi exposure on already grown 2D InAs layers causes a morphological phase transition, resulting in a rapid re-organization of the 2D layer into 3D nanostructures. These 3D islands exhibit optical properties of quantum dots and hence open up the possibility to generate linearly polarized single photons due to the C_2 symmetry [1].

In this contribution, we investigate these 3D InAs QDs and the wetting layers grown on GaAs(110) substrate using cross-sectional scanning tunneling microscopy (XSTM), in order to get an idea about the actual structure after capping. For this purpose, we cleaved the sample containing capped InAs/GaAs(110) layers with different growth conditions and different Bi exposure during growth. Atomically resolved XSTM images allow for the characterization of the geometric structures in terms of size, density, and atomic composition depending on the presence of Bi and on the amount of deposited InAs. Furthermore, we carry out stoichiometric analysis of the chemical composition by analyzing the variation of local lattice parameter [3]. Due to the growth temperature, the Bi itself was not found within the samples, but acts only as a surfactant. Under these conditions, the 3D QDs form preferentially at steps of the GaAs(110) surface and are confined by high-indexed interfaces. They do not homogeneously consist of pure InAs, but are intermixed by the GaAs capping material. Further on, we found also lateral composition variations within the wetting layers, influencing obviously the light emission. Thus, we are able to contribute to better understanding of the growth mechanisms of InAs/GaAs(110) with Bi in order to improve the properties for possible device applications and on nanowire sidewall facets.

[1] P. Corfdir *et al.*, Phys. Rev. B **96**, 045435 (2017).
[2] R.B. Lewis *et al.*, Nano Lett. **17**, 4255 (2017).
[3] A. Lenz *et al.*, J. Vac. Sci. Technol. B **29**, 04D104 (2011).