Optically active heterostructures in II-VI nanowires

P. Wojnar
Institute of Physics, Polish Academy of Sciences, Al Lotników 32/46, 02-668 Warsaw, Poland

In this presentation, our recent progress in the growth and studies of telluride nanowires fabricated in a molecular beam epitaxy (MBE) process by employing a vapor-liquid-solid (VLS) growth mechanism will be overviewed. In the first part, the activation of optical transitions in the near band edge emission region from CdTe [1] and ZnTe [2] nanowires will be presented. This goal has been achieved by embedding the nanowires into (Cd,Mg)Te and (Zn,Mg)Te coating shells, respectively. The role of these shells relies on the passivation of the nanowire surface states.

Moreover, the impact of the strain acting on the nanowire cores arising from the lattice mismatched shells will be discussed. In particular the variation of the energy gap depending on strain conditions in the nanowire cores will be studied by means of optical methods [3]. The maximum change of ZnTe energy gap is as large as 120 meV with respect to the unstrained conditions and can be tuned in a continuous manner by adjusting shell parameters. This opens a path towards an effective band gap engineering using these structures.

Subsequently, it will be demonstrated that the strain lifts the degeneracy of light and heavy hole bands. In the case of tensely strained nanowire cores, which is the case for ZnTe/(Zn,Mg)Te core/shell nanowires, the topmost valence band are the heavy holes [4]. In contrast, when the cores are subject of a compressive strain, which is the case for CdTe/(Cd,Mg)Te core/shell nanowires, the light holes become the ground state of the optical transitions.

Finally, it will be focused on the introduction of optically active CdTe insertions into ZnTe nanowires [5]. Most importantly, it will be demonstrated that, depending on growth conditions, one obtains either axial or radial CdTe insertions. The latter structures consist, therefore, of several radial shells ZnTe/CdTe/ZnTe/(Zn,Mg)Te, whereas CdTe shell is the optically active shell due to the smallest energy gap. CdTe growth direction is controlled by means of its deposition temperature. At 350 °C CdTe grows only axially, whereas at 310 °C and 290 °C, there is also significant deposition on nanowire sidewalls resulting in radial core/shell heterostructures. The increase of the growth temperature above 360 °C induces a strong CdTe desorption which leads to the absence of any CdTe-related emission. It will demonstrated, in particular, that one can obtain structures in which axial and radial CdTe insertions coexists in the same nanowire.

The research has been supported by the National Centre of Science (Poland) grant DEC-2011/01/D/ST5/05039

[1] Wojnar P *et al.*, Nanotechnology 2017, **28**, 045207
[2] Wojnar P *et al.*, Nanotechnology, 2013, **24,** 365201
[3] Wojnar P *et al.*, Appl. Phys. Lett. 2014, **104,** 163111
[4] Szymura M *et al.* Nanoletters 2015, **15**, 1972
[5] Wojnar P *et al.* Nanoscale 2016**, 8**, 5720

*Contact: wojnar@ifpan.edu.pl