Sidewall versus axial growth of CdTe insertions in ZnTe/ZnMgTe core-shell nanowires

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On-demand single-photon sources with high efficiency are required to realize many of the applications of quantum optics. The most promising method to achieve high light-extraction efficiencies for a single photon sources is embedding a quantum dot (QD) in one-dimensional nanowire (NW) which operates as a photonic waveguide [1, 2].

In this work we present results obtained on CdTe QDs embedded in ZnTe-ZnMgTe core-shell NWs grown by molecular beam epitaxy on a (111)-Si substrates. Individual NWs are carefully studied by means low-temperature cathodoluminescence (CL). The advantage of this technique is the high spatial resolution allowing to detect the position of the QD-emission along the NW-axis. Dependent on growth conditions (playing with the growth temperature of CdTe insertion and Cd flux) we have found that the CL-emission related to CdTe insertions may originate from different parts along the NW-axis. The first type of NWs reveals a simultaneous emission from various parts of NW (mainly at the bottom of NW) despite of the fact that only one insertion has been introduced intentionally. The second type of NWs characterized by a relatively high growth temperature of CdTe insertion features emission of only single line as would be expected for one insertion (Fig. 1). The structure and elemental composition of the Cd rich area was also identified by TEM. Size and position of such areas are in good correlation with CL data for both types of NW.

Our results can be explained in terms of the mechanism of diffusion driven NW-growth [3]. At relatively low growth temperature of CdTe insertion, the diffusion length of adatoms on sidewalls is strongly limited and hence, CdTe is deposited on sidewalls below the its intentional position. Increasing the CdTe-deposition temperature we increase also the diffusion length of adatoms along NW and all adatoms may diffuse to the gold nanodroplet. As result, the CdTe insertion is introduced axially.

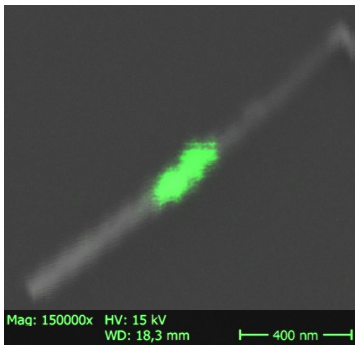

Fig 1. Monochromatic (λ=583nm) CL emission map of CdTe insertion in NW superimposed with SEM image of the NW.

In summary, we have demonstrated that CdTe insertions in NW can be grown not only axially but also radially on the sidewalls. Optimization of the growth temperature of CdTe insertions and Cd flux leads to the growth of axial CdTe/ZnTe structures embedded with ZnMgTe coating shell.

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