Growth of CdTe/(Cd,Mg)Te core/shell nanowires with high optical quality

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CdTe is commonly recognized as a semiconductor particularly well suited for photovoltaic applications due to its direct band gap of 1.5 eV at room temperature which ensures an effective absorption of the solar light spectrum. Although planar CdTe-based solar cells reach efficiencies up to 21% [1], the implementation of CdTe into efficient nanowire-based photovoltaic devices remains still a challenge. This is our main motivation for the growth of CdTe nanowires using Au-catalyzed vapor-liquid-solid growth mechanism in a system for molecular beam epitaxy.

Our previous attempts to grow CdTe nanowires by employing this technique resulted in poor quality 'crooked' nanowires travelling on the surface, whereas only a small percentage of nano-droplets developed into proper straight CdTe nanowires. Here, we have found that initializing the growth with a short ZnTe deposition helps to develop high density straight CdTe nanowire arrays. In the optical spectrum of CdTe nanowires, however, any emission close to the CdTe energy gap is not observable. That is the reason why CdTe nanowires are coated with a (Cd,Mg)Te shell, in the following step. As result a near band edge emission from CdTe nanowires is activated. This is most likely due to the passivation of surface states.

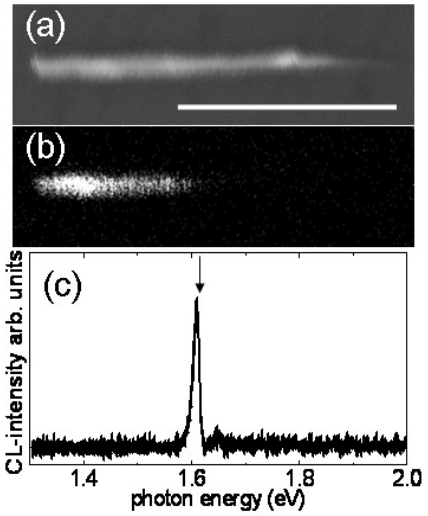

Figure 1. Cathodoluminescence (CL) from an individual CdTe/(Cd,MgTe) core/shell nanowire. Scanning electron microscope image of the investigated nanowire (a); monochromatic CL mapping at 1.61 eV (b); CL spectrum of this individual nanowire (c); scale bar is 1 μm

High optical quality of CdTe/(Cd,MgTe) individual nanowires is revealed by means of low temperature cathodoluminescence, Figure 1, and micro-photoluminescence. The optical emission spectrum from an individual nanowire consists only of the near band edge emission line without any significant contribution of defect related luminescence. Moreover, the role of the strain acting on CdTe nanowire core originating from the lattice mismatched shell is manifested by the increase of the emission energy with increasing shell thickness and Mg concentration in the shell. Microphotoluminescence study reveals that the CdTe near band edge emission is strongly linearly polarized along the nanowire axis, which is most likely due to the dielectric confinement.

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References:

[1] Green M A, Emery K, Hishikawa Y, Warta W, and Dunlop E D 2015 *Progress in Photovoltaics* **23** 805