Structural- and Size-Dependent Silver-Cation Exchange in CdTe Nanowires

Andreas Nielsen,[a] Tobias Kipp,[a] and Alf Mews[a]

[a] *University Hamburg: Department of Physical Chemistry, Hamburg, Germany*

Cation exchange on nanostructures has been a widely researched and discussed topic for the past years. However, focus was mostly placed on single-crystalline systems such as quantum -dots, -rods, -platelets, and heterostructures of such[1–4].

We investigated the silver-cation exchange behavior on small-diameter (8 nm) CdTe nanowires (NW) of primary-wurtzite and polytypic (zinc-blende and wurtzite) crystal structures. Our findings indicate that the primary-wurtzite structured nanowires exhibit a pronounced interphase-state at low silver concentrations during the exchange process (Fig. 1-left) while the polytypic nanowires (Fig. 1-middle) form a crystalline Ag_2Te phase at once. Further, investigations on large-diameter (25 nm) CdTe nanowires (Fig 1-right) show a diameter dependency of the exchange process.

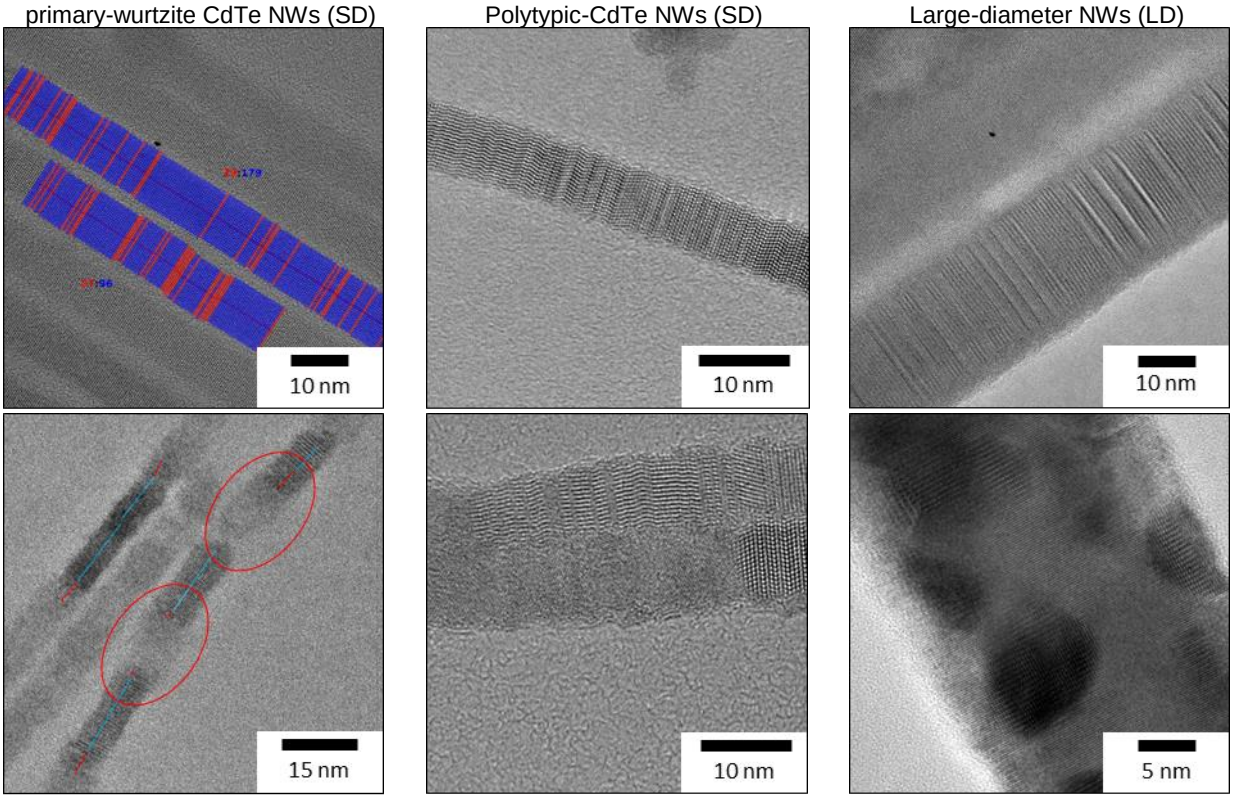

Figure 1: HRTEM images of small-diameter (8 nm) CdTe NWs with primary-wurtzite structure (left), polytypic wurtzite/zinc-blend structure (middle), and large-diameter (25 nm) NWs (right). The upper image shows the NWs before and the lower ones after cation exchange. Regions marked in blue are WZ and in red are ZB segments.

The HRTEM images show the formation of extensive amorphous regions (representing the interphase-state) after limited silver-ion exchange for the primary-WZ NWs (left). The amorphous regions transform into crystalline Ag_2Te upon increased silver concentration. In contrast, in the polytypic NW system (middle) a crystalline Ag_2Te phase forms instantaneously, covering the full NW diameter, at the same conditions. Further, in large-diameter NWs (right) silver addition induces the formation of randomly distributed spots at the NWs surface. Those results indicate a direct dependency of the cation exchange mechanism to the templates crystal structure and diameter.

1) J.B.Rivest et al., *Chem. Soc. Rev.* **42,** 89–96 (2013).
2) P.K. Jain et al., *J. Am. Chem. Soc.* **132,** 9997–9999 (2010).
3) H. Li et al., *Nano Lett.* **11,** 4964–4970 (2011).
4) C. Bothe et al., *Angew. Chemie Int. Ed.* **54,** 14183–14186 (2015).