Characterization of metal contacts on semiconducting Nanowires using electrical biasing in a transmission electron microscope

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Semiconductor nanowires (NWs) are promising candidates for many device applications ranging from electronics and optoelectronics to energy conversion and spintronics. To allow successful device integration the contact quality between for example a NW and metal is of paramount importance. An interesting approach to create an atomically abrupt contact with low electrical resistance on NWs of group IV (silicon and germanium) is to create a metal-semiconductor phase in the extremities of the NW. To understand and control the metal diffusion into the NW that creates a metallic phase, detailed characterization at atomic length scales is necessary to understand how the metal atoms diffuse and incorporate into the formed phase at the reaction front and how these parameters relate to the electrical properties of the same interface.

In this work we study two different kind of semiconducting NW devices fabricated on electron transparent Si_3N_4 membranes. We show in-situ phase propagation of a metal-semiconductor phase of Cu, Ni or Al in Ge NWs in the TEM while measuring the current through the device, and analyze the metal diffusion process.

Furthermore we study the contact of Au on a ZnO NW using in-situ electrical biasing and off-axis electron holography and compare with electro-optical characterization of the same device with the aim to obtain a three dimensional quantitative electrostatic description of the metal NW contact.