Nanowires at Fke

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During the last 10 years, important progress has been made in the growth of ideal 1D structures, such as carbon nanotubes and semiconductor nanowires. These 1D systems promise to be an exciting field for basic and applied research. At sufficiently small sizes solids exhibit significantly different mechanical, optical, electrical and magnetic properties, when compared to bulk material of macroscopic size. Their low dimensionality means that they exhibit quantum confinement effects. For example, narrowing the wire's diameter increases its band gap, compared to the bulk material. Controlled growth of non-carbon based 1D structures at well-defined locations has been demonstrated only in few examples. Therefore, an understanding of the growth kinetics, the physical and chemical processes on the nanoscale, and their dependence on the growth parameters and template properties is necessary. Researchers are making impressive progress in growing nanowires with precisely controlled properties with all sorts of different technologies including the realization of atomically abrupt heterostructure interfaces inside a nanowire. This better control could give nanowires an edge over carbon nanotubes in some of the same early applications ranging across sensors, batteries, solar cells, medical diagnostics, and high performance electronic devices.

With respect to sensors we demonstrated the formation of a complementary metal-oxide semiconductor (CMOS) compatible micro scale pH sensor with an antimony (Sb) nanowire (NW) network as the solid state pH electrode. The sensor is formed combining well known semiconductor processing techniques with a focused ion beam (FIB) based approach inducing the self assembled formation of Sb nanowires in room temperature ambient without using any additional material source.

As reliable contacts for nanoscale electronic devices we explored an approach for the formation, of copper-germanide/germanium nanowire heterostructures with atomically sharp interfaces. The copper-germanide (Cu_3Ge) formation process is enabled by a chemical reaction between metallic Cu pads and vapor-liquid-solid (VLS) grown Ge-NWs. The atomic scale aligned formation of the Cu_3Ge segments is controlled by in situ SEM monitoring thereby enabling length control of the intrinsic Ge-NW down to a few nm. The single crystal Cu_3Ge/Ge/Cu_3Ge heterostructures were used to fabricate p-type Ge-NW field effect transistors with Schottky Cu_3Ge source/drain contacts.