Nanowire heterostructures and devices

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One-dimensional systems like carbon nanotubes and semiconducting nanowires were successfully fabricated already a decade ago [1,2], and it is now possible to turn them into electronic devices and circuits [3,4]. However, only a few attempts have been made to incorporate heterostructures into one-dimensional structures [5]. Recently, transport measurements on nanowires containing heterostructures were reported [6,7]. This is a step towards making heterostructure devices in one-dimensional systems, which could have an importance for low dimensional systems as the development of heterostructures had for semiconductor physics in the 60's.

In this presentation we will describe the growth of semiconductor nanowires by a chemical-beam epitaxy approach. The growth principle is based on the formation of a supersaturation of the growth species in a metal particle, which nucleates the growth of one-dimensional crystals made of for example InAs, GaAs and. Also the incorporation of heterostructures between highly mismatched materials in nanowires will be discussed and we will show that the hetero-interfaces are abrupt on the atomic scale and free from dislocations.

Transport measurements on nanometer scale objects requires good ohmic contacts in order to probe the properties of the object rather then the contacts themselves. We will briefly show how ohmic contacts can be formed to InAs nanowires and then the transport properties of these homogenous wires will be presented. We have also performed measurements on InAs nanowires containing single InP barriers from which a conduction band off-set between the InAs and the InP of $\approx$0.6 eV could be deduced.

Finally we will show transport measurements on nanowire heterostructure devices consisting of a double barrier structure displaying negative differential conductance and having peak to valley ratios as high as 50:1 at liquid He temperatures.

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