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Dynamic studies of the growth of Si and Ge nanostructures

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By making observations in real time during the growth of nanostructures, it is possible to obtain kinetic data which help us to determine the physical phenomena controlling growth. In this presentation we will describe the growth of Si and Ge nanowires by the vapour-liquid-solid process. Observations were made in a transmission electron microscope during ultra high vacuum chemical vapour deposition of Si and Ge onto substrates covered by Au catalyst. We will show that wire length and diameter are controlled by the diffusion of the catalyst along the wire surfaces, and that this diffusion is driven by a coarsening process. We will compare nanowire growth with the formation of Ge quantum dots by self-assembly during strained layer epitaxy, in which surface diffusion of Ge driven by coarsening also plays an essential role in controlling the structures formed. We will describe spontaneous roughening of Si and Ge nanowire surfaces, a phenomenon which may have analogues in the formation of surface roughness in SiGe alloy thin films. We will finally discuss the control of wire structure for the fabrication of novel devices.