Western Nanofabrication Facility

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Vapor-liquid-solid growth of Si wires on Si

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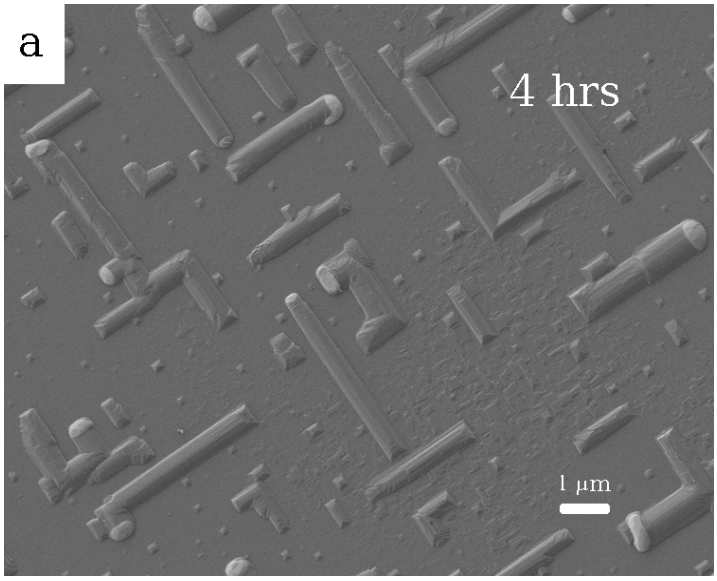
The vapor-liquid-solid (VLS) growth, first discovered in the 1960s, is the most investigated process for Si wire synthesis. The name vapor-liquid-solid reflects the pathway of Si. First, Si comes from the vapor phase to the substrate covered with liquid silicon-gold nanoparticles, that act as a preferred sink for arriving silicon atoms. Then silicon diffuses through the liquid "droplet", and when its concentration exceeds saturation point, the excess Si precipitates as a solid wire at the gold/substrate interface.

In this project, we have been using molecular beam epitaxy (MBE) to grow silicon wires on Si (001) and Si (111) substrates. Scanning electron microscopy (SEM) images obtained at the Western Nanofabrication Facility (LEO 1540XB FIB/SEM) for silicon grown on Si(001) substrate are very intriguing. Si wires are growing epitaxially along in-plane Si <110> crystallographic directions (Fig. 1a), the liquid-solid interface of the growing wire is oriented along Si <111> direction to minimize the surface energy contribution to the total energy (Fig. 1b).

The results obtained in our work suggest that commonly accepted VLS growth model still needs to be refined. In particular, our results indicate that surface diffusion of Si ad-atoms on the substrate plays a significant role in the wire growth and has to be incorporated in the model.



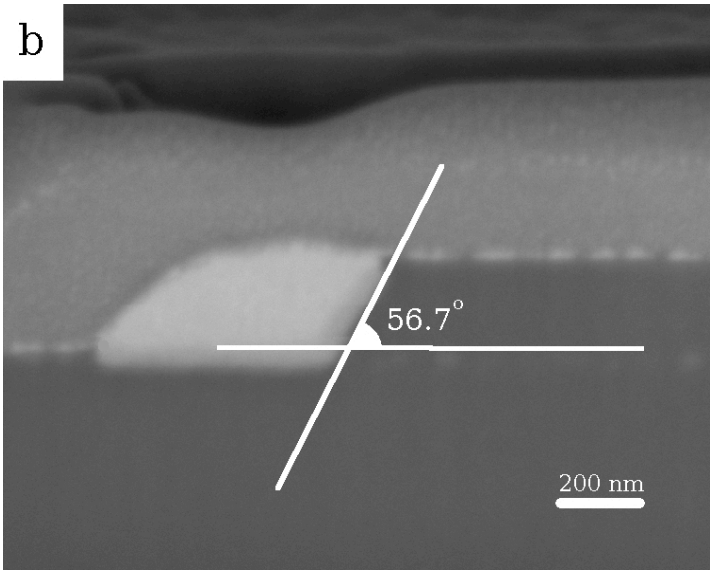


Figure 1. a) SEM planar views of Si wires obtained on Si(100) substrate at T = 650 °C using 1nm Au film annealed at 600 °C for 30 min. The Si deposition time is indicated on the figure. b) High resolution SEM image of the Si wire cross-section performed with focused ion beam along the growth direction. The theoretical value for the liquid-solid interface oriented along Si (111) direction is 54.7°

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