EVIDENCE OF GOLD ON LATERAL SURFACES OF GOLD CATALYZED SILICON NANOWIRES

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Silicon nanowires have attracted a lot of interest recently, as they are regarded as key building blocks of future electronic and opto-electronic devices. Recent publications have clarified a great deal about the role of the gold catalyst particle and its influence on the final shape of the wires [1, 2, 3].
Hannon et al [2] already showed convincing indirect evidence that gold, diffusing from the catalyst particle, is also present on the lateral sides of the wires and the substrate. Here we present direct evidence of gold on the lateral sides of the wires by means of STEM (Scanning Transmission Electron Microscopy) images in combination with EDX (Energy Dispersive X-ray) analysis measurements (fig.1) and SEM (Scanning Electron Microscopy) images.
Silicon nanowires were grown by the Vapour-Liquid-Solid (VLS) mechanism using gold as the catalyst and silane as the precursor. Measurements were realized on a FEI TITAN microscope working at 300kV.
Kodambaka[4] et al showed that the diffusion of gold during growth depends strongly on the presence of oxygen. The present results seem to be specific to the Au-catalyzed VLS growth system without the presence of oxygen. As we do not work under UHV conditions, we can not exclude the possibility of traces of oxygen present during growth, however it is clear that the amount is insufficient to block the diffusion of gold over the wire surface. An approximate calculation shows that the nanowire sidewalls are covered by one monolayer of gold during growth. After growth has finished, de-wetting of the monolayer occurs and a pattern of homogeneously sized gold nanoparticles is formed. This implies a constraint on the nanowire length and a tapered shape, as the volume of the catalyst particle decreases during growth. Furthermore, the presence of gold on the nanowire sidewalls will undoubtedly have an effect on the optical and electrical properties.

References:

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[4] Kodambaka, S.; Hannon; J. B.; Tromp, R. M.; Ross; F. M.; *Nano Letters*, **6** (2006**)** 1292

Figures:

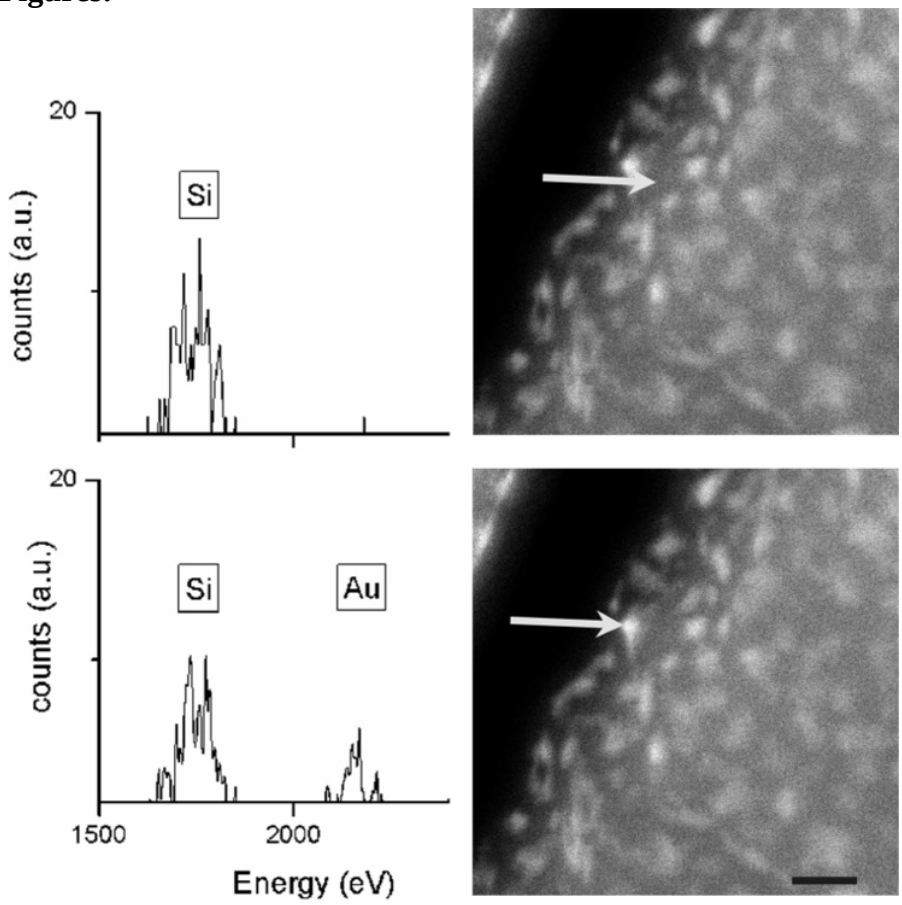

fig.1 EDX spectra and STEM images of a silicon nanowire. An arrow indicates where the EDX spectrum has been taken. The brighter particles are unambiguously gold rich clusters, as three typical gold lines appear in the EDX spectrum around 2200 eV. The scale bar is 10 nm..