Low Dimensional Materials and Catalysts

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Growth and characterization of metallic nanowires: Cu, Fe and Cu/Fe

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The one-dimensional nanostructures such as wires, rods, tubes have attracted increasing research efforts as a result of their fascinating properties superior to their bulk counterparts. Referring to the Cu nanowires, they are expected to play an important role as interconnects units in electronic devices with nanoscale dimensions due to the low resistivity (≈1.68×10−8Ω•m). With the addition of Fe, the nanowires can form compound magnets, while the magnetic properties related to the structural ordering of Fe.

A novel method has been developed in our group for fabricating the freestanding metallic nanowires, involving only the physical vapor deposition (PVD) [1]. Both FCC (Cu) and BCC (Fe) nanowires have been successfully produced via this method. The morphology of the Cu wires grown on the Si substrate is demonstrated in Figure 1. The dimensions of the wires range from 50 to 400 nm in diameter and 1 to 200 μm in length, which give the aspect ratio up to 1000:1. The characterizations indicate that the FCC Cu whiskers grow along the crystallographic direction of <011> while the BCC Fe whiskers grow parallel to <001>.

For the purpose of understanding the growth mechanism of the whiskers, bimetallic nanowires are synthesized by alternating the depositing materials. The subsequent electron microscopic investigations show two phases on the nanowire. A Cu-rich and a Fe-rich phase as depicted in the figure 2. This proves a root growth fashion. Chemical analysis, such as EDX and EELS are carried out to determine the chemical distribution in the two different phases.

The Si substrates are sensitive to the deposition temperature. At temperature lower than 650°C, interdiffusion of Cu and Si happens in both wires and the substrate, which gives result of the formation of Cu_xSi_y alloys. To avoid the interdiffusion, barrier layers (W) and other substrates (W, MgO, Al_2O_3, Nitride Si) are applied. It turns out that the wires can be obtained on different substrates with the aids of amorphous C layer, while the C layer provides preferred nucleation sites for the wire growth.

The electrical and magnetic properties are tested for Cu and Cu/Fe wires separately. Both 726ft he tests indicate the promising potential 726ft he726 applications 726ft he wires.

1. G. Richter, K. Hillerich, D. Gianola, *et al*. *Nano Letters,* 2009*, 9*, 3048-3052.

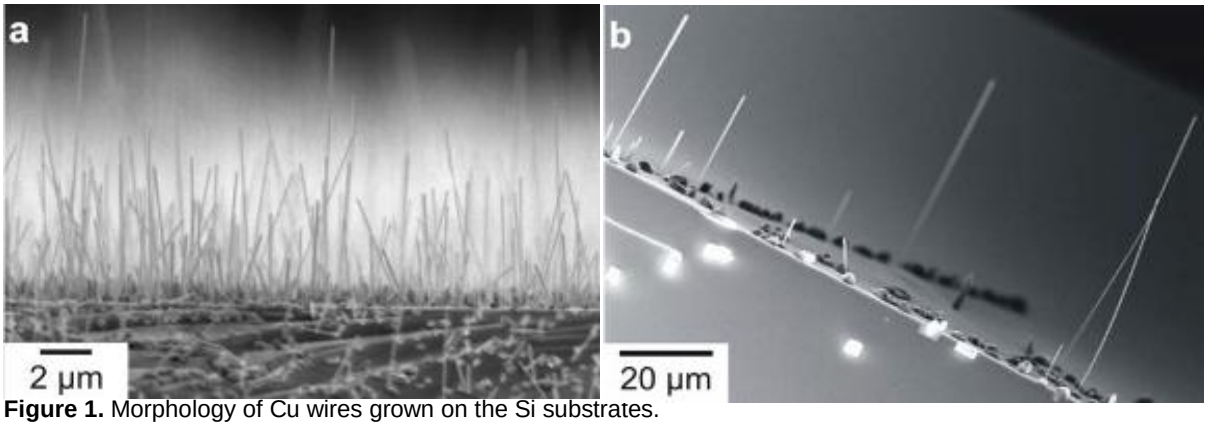

Figure 1. Morphology of Cu wires grown on the Si substrates.

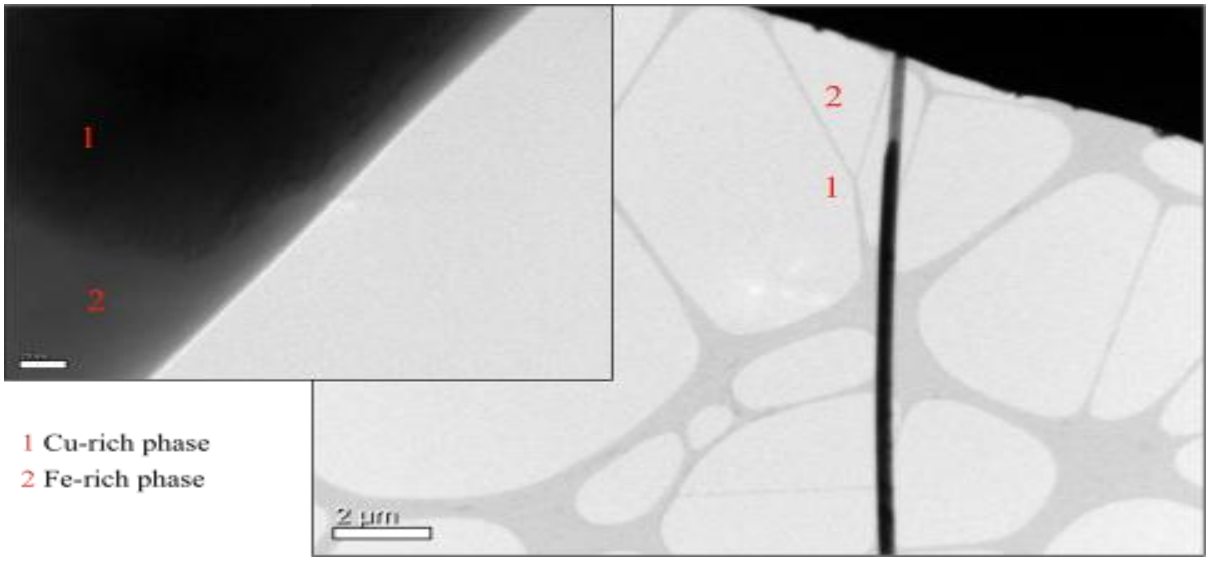

Figure 2. Indication of the 2 different phases on the Cu/Fe wires.