ELECTROCHEMICAL GROWTH OF COPPER NANOWIRES: STRUCTURE PROPERTIES

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There are many applications for which metallic nanowires may become important: for electronic and optoelectronic nanodevices, for metallic interconnects of quantum devices and nano devices. Moreover, applications of these materials include electron field emitters, nanoelectrodes for electrochemical experiments, magnetic sensors based on the giant magnetoresistance effect and anisotropic optical filters.

Template synthesis is an elegant electrochemical approach for the fabrication of nanowires, attracting attention. Arrays of metal and semiconductor nanowires are obtained by electrodeposition in porous templates such as anodic aluminum oxide (AAO) films and nuclear track membranes.

One of the main challenges in nano-technology is the development of nanometer-scale objects with a size distribution as narrow as possible around a controllable value of the mean size and shape, and with a crystal structure as perfect as possible.

In the current work, the structural properties of electrochemically grown copper nanowires in AAO membranes are studied.

Twenty-namometer nominal pore diameter AAO commercial filter discs were used as templates for the nanowires synthesis. The wires were grown potentiostatically. The morphology and crystallinity of the copper nanowires were studied by means of scanning electron microscopy (SEM), X-ray diffraction (XRD) and transmission electron microscopy (TEM) analysis.

Fig. 1 shows a SEM image of the tilted view of the electrodeposited Cu nanowire arrays after the template has been dissolved. The copper nanowires are dense, continuous, straight and uniform in diameter along the entire length. The diameter of the copper nanowires varied from 207 to 282 nm with an average of 230 nm.

A representative XRD pattern of a copper nanowire array is shown in Fig. 2. It shows three intense peaks, which are at the same position as polycrystalline copper standard, indicating that copper nanowires with face-centered cubic crystal structures have been fabricated. However, the (200) peak is larger than expected for a random polycrystalline sample, indicating strong texturing. This means that there is a preferred growth direction, the (200) crystal plane of the Cu nanowire arrays. Template based synthesis of Cu nanowires by electrodeposition with a (220) plane preferred orientation has been reported in the literature [1,2], but to the best of our knowledge, there are no reports for copper nanowire arrays with a (200) preferred orientation.

A texture analysis study and a proposed nucleation and growth model in order to explain this particularly preferred orientation will be discussed.

REFERENCES

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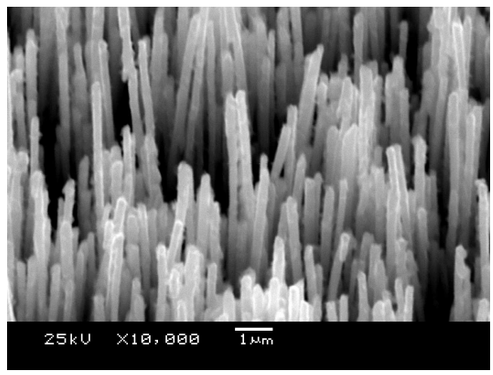

Fig. 1. Scanning electron micrograph of Cu nanowire arrays after the alumina template has been dissolved. (pore diameter, 20 nm).

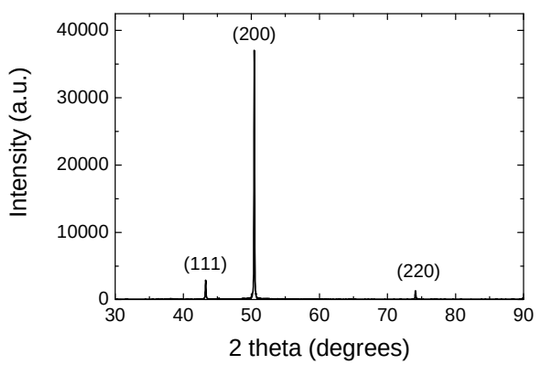

Fig. 2. XRD pattern of the Cu nanowire arrays.