PREPARATION AND CHARACTERIZATION OF SINGLE-CRYSTALLINE SILICON NANOWIRE ARRAYS

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In the last years, one-dimensional (1D) nanostructured materials, such as semiconductor nanowires have attracted much attention because of their special physical properties and their potential applications in various fields [1]. It has been demonstrated that compared to the two dimensional thin film semiconductors, 1D materials exhibit superior optoelectronic, mechanical and thermal properties. On the other hand, silicon (Si), is as a consequence of its excellent performance, the most important semiconducting material since the Si-based devices have dominated microelectronic technology for many decades. In the last years, silicon nanowires (SiNWs), have attracted much attention because of their unique properties and their compatibility with the Si-based microelectronics. Then, SiNWs are attractive for applications in field-emission devices, chemical sensors, spintronics and photonics [2].

In the present work SiNW arrays have been synthesized by self-assembly electroless metal deposition (EMD) nanoelectrochemistry. The synthesized SiNW arrays have been submitted to SEM, TEM and HRTEM studies.

The SEM images of a typical SiNW array synthesized by the SAEMD-nanoelectrochemistry approach on n-type Si(100) substrate (30 min etching) are shown in Fig. 1. SEM observations reveal that large quantities of silicon nanowires arrays could be produced on the silicon wafer chip. The density of SiNW arrays (Fig. 1a) is about $10^9/cm^2$, which shows little changes with different etching times. Figure 1b shows the cross-section details of the SiNW array in which all SiNWs are distinguishable and most of them are vertical to the wafer surface, exhibiting a length about 30 μm and diameters in the range of 100-160 nm.

Furthermore, the morphology and structure of SiNWs have been characterized in detail using TEM and HRTEM analysis. The SiNW were single crystalline, as shown by the FFT pattern (inset of Fig. 2) and HRTEM image of the Si lattice of a SiNW in Fig. 2. A further detailed analysis of HRTEM indicates that the axial crystallographic orientation of the SiNWs is the [100] direction, which is identical with the orientation of the initially used silicon wafer.

References:

[1] B. K. Teo and X. H. Sun, Chem. Rev., **107** (2007) 1454.
[2] Z. Huang, H. Fang and J. Zhu, Adv. Mater., **19** (2007) 744.

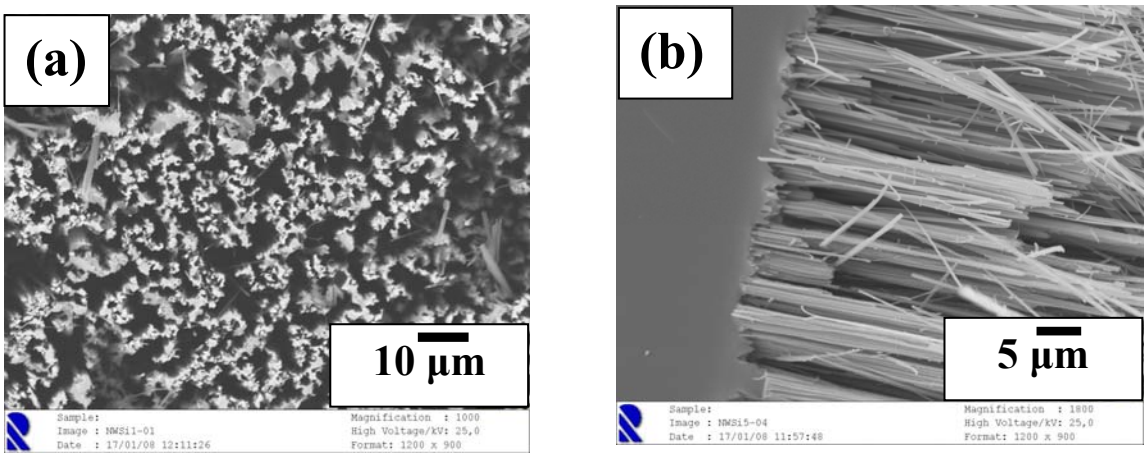

Figure 1: SEM images of SiNW arrays: (a) top view and (b) cross-sectional view.

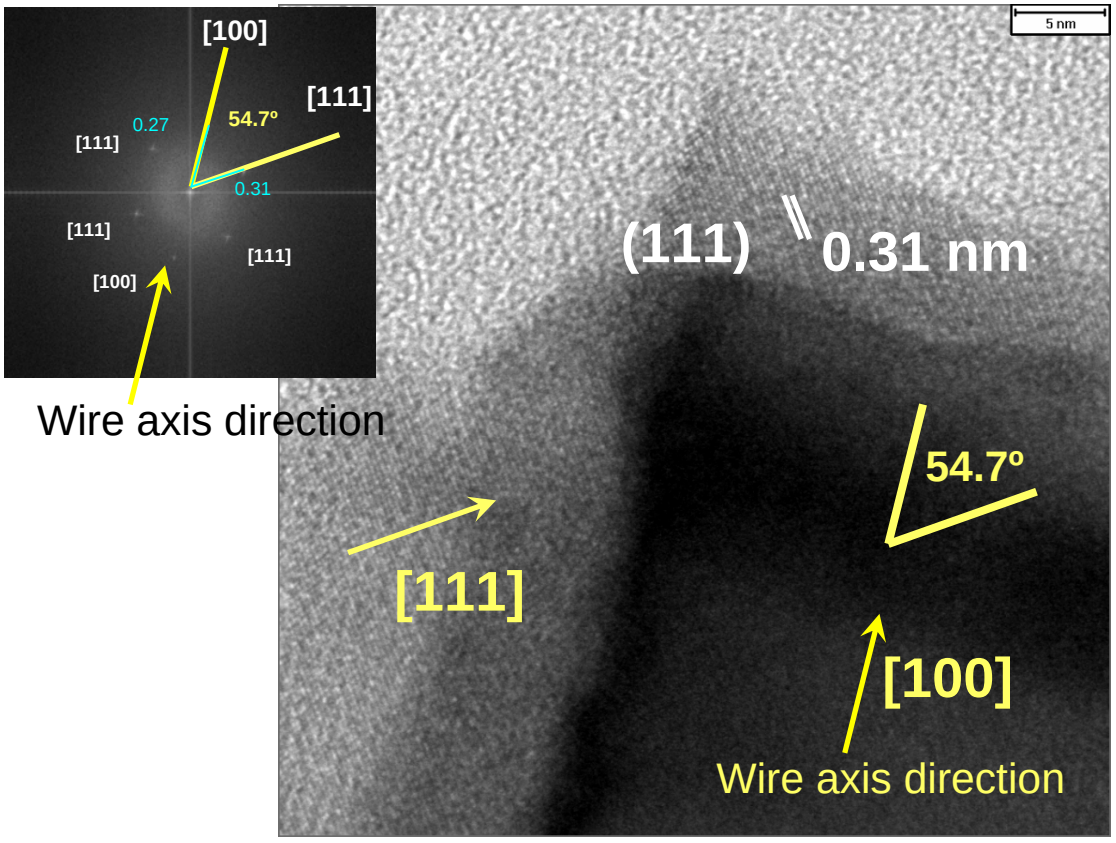

Figure 2: Typical HRTEM of an individual Si nanowire. Inset: FFT of the HRTEM image.