Controlled synthesis of si nanowires on si substrates

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Abstract One-dimensional semiconductor nanostructures have recently attracted intense research attention due to their novel physical properties. In this study, we present a simple procedure for the synthesis of silicon nanowires (SiNws), with diameters of 30 nm and lengths up to several micrometers. We have used crystalline Si (100) substrates, covered by a thin film of gold. The nanowires were synthesized by thermal treatment, without any Si gas source, at ambient conditions with a flux of hydrogen and argon. A systematic investigation of the processing parameters has been made, and revealed that temperature, hydrogen flow rate, catalyst and substrate morphology are critical for the growth of SiNws. Furthermore, in this work we show that the use of different coatings on the Si substrate improves the SiNws growth. TiN-coating gives vertically aligned SiNws and silica nanospheres-coating produces a high density of SiNws. The synthesized SiNws have been characterized by FESEM and HRTEM microscopies, X-ray diffraction, and X-ray photoelectron spectroscopy. It has been demonstrated that the nanowires have a Si core and an external oxidized shell, indicating that an oxide assisted growth mechanism could be responsible for the formation of the Si Nws.

Related to the investigation of surface morphology of the Si substrate, we have successfully demonstrated that selective SiNws growth could be induced by local indentations on the Si substrate. The local pressure caused by the indentation process generates metastable Si, which enhances the catalyst aggregation in the indented areas and SiNws grow within indents. We have also achieved a simple method to grow SiNws on selective areas by depositing the Au catalyst exclusively on selected positions of different substrates by using masks.

References

[1] T. Yasui, Y. Nakai, Y. Onozuka, Thin Solid Films, **516** (2008) 859–862.
[2] F. Márquez, C. Morant, V. López, F. Zamora, T. Campo, E. Elizalde, Nanoscale Research Letters, 6:495 (2011)

Figures

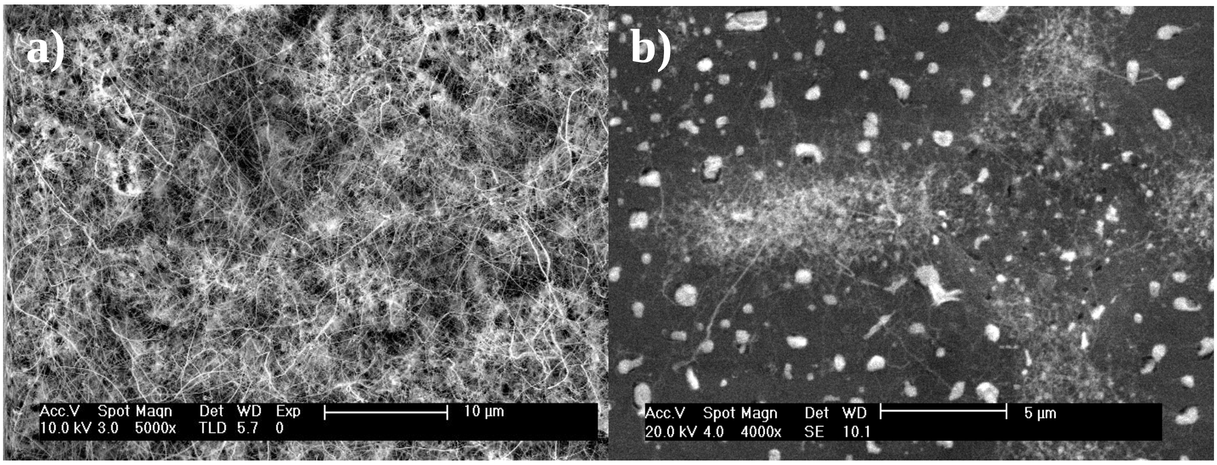

Figure 1. *The roughnes of the substrate surface promotes the growth of SiNws forests (a). Microindentations made on Si substrates before the Au deposition provide localized SiNWs growth on the created cracks (b).*

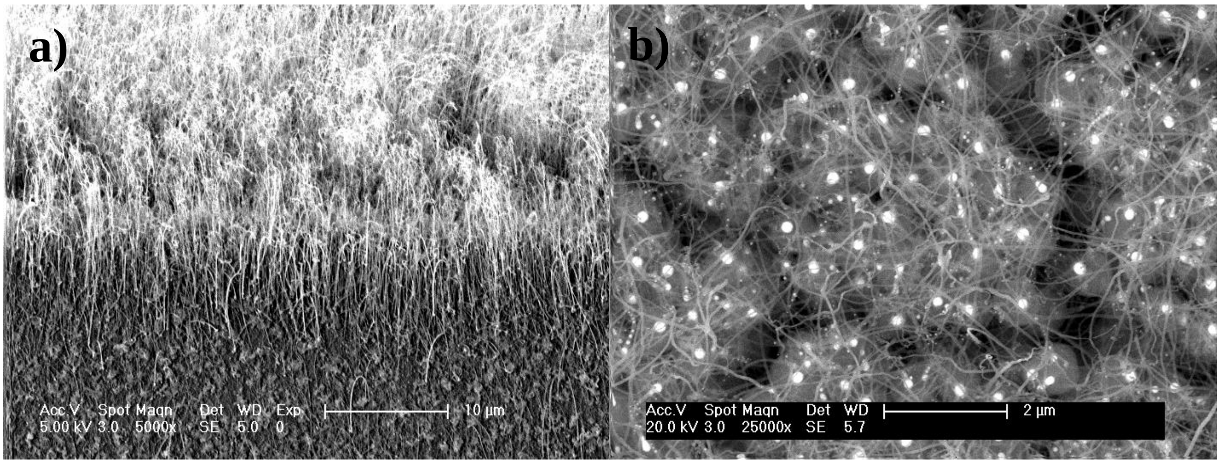

Figure 2. *TiN-coating gives vertically aligned SiNws (a) and silica nanospheres-coating produces a high density of SiNws (b).*

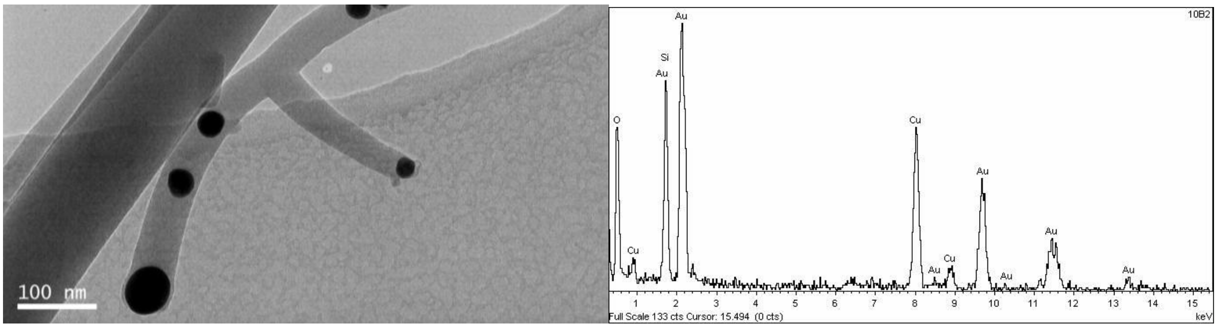

Figure 3. *TEM image of SiNws obtained by the TiN-coating procedure(a) and its chemical analysis (b).The copper element comes from the SiNws support.*

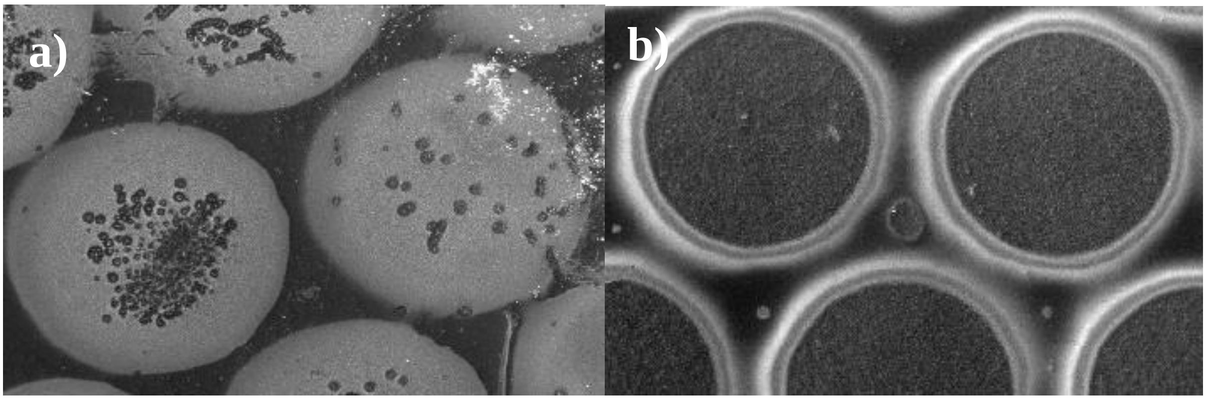

Figure 4. *The deposition of Au catalyst exclusively in patterned areas, allows a selective growth of SiNws on gold covered TiN/Si substrates (a) and on the edges of gold covered Si(111) surfaces (b). Circle patterns of 1 µm diameter.*