

NANO HIGHLIGHT

Functionalized Nanowires for Electromechanical Detection of Molecules

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Nano-electromechanical systems (NEMS) are emerging as processes are being developed for fabricating structures in the nanometer dimensional range. While offering vastly expanded capabilities such as unprecedented sensitivity to force or to added mass, NEMS present engineers with unprecedented challenges in materials processing, device design, fabrication and integration.

Two approaches are utilized for accessing the nanometer domain, the top-down (derived from standard microfabrication paradigm of thin-film deposition, lithography and etching) and bottom-top (synthetic approach). An example of bottom-up approach is the vapor-liquid-solid (VLS) growth process. Through this process, large arrays of nanowires can be grown *vertically* with tight diameter control (Fig. 1a). By merging the top-down and bottom-top approaches, we have recently been able to achieve *lateral* growth of silicon nanowires (Fig. 1b). This is an important step towards the realization of a number of NEMS-based devices, including mechanical resonant sensors, nanoseparation devices and thermoelectric generation.

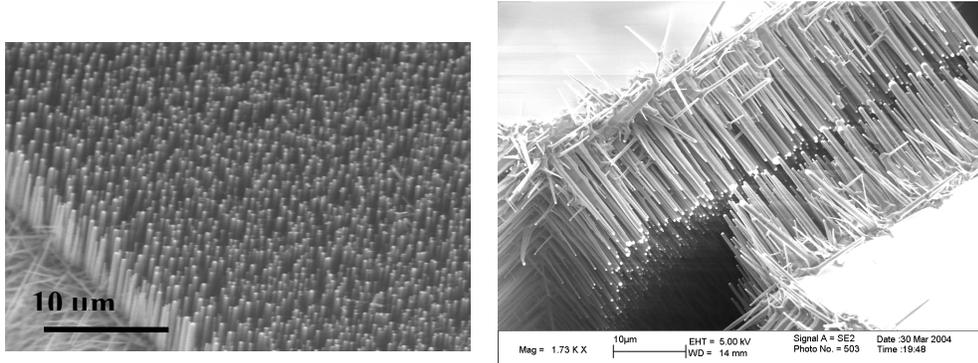


Fig. 1. SEM images of Si nanowires (a) vertically aligned; (b) horizontally aligned.

In addition, SiC nanowire growth has been realized at 1100–1200°C by chemical vapor deposition via the VLS mechanism. Methyltrichlorosilane was chosen as the precursor with a Si:C ratio of 1:1. Pt or Ni evaporated on Si, Al₂O₃, or SiC substrates served as VLS catalysts. Figure 2(a) shows a transmission electron micrograph of 3C-SiC nanowires grown at 1200°C, with diameters of 15–200 nm and lengths of up to several tens of microns. The direction of nanowire growth is exclusively $\langle 111 \rangle$ (Fig. 2(b)). Vertical arrays of SiC nanowires were obtained on 6H-SiC(0001) substrates, where growth is epitaxial. A scanning electron micrograph is shown in Fig. 2(c), viewing at an angle of 40°. Well-aligned wires are seen in the inset with Pt droplets on their tips.

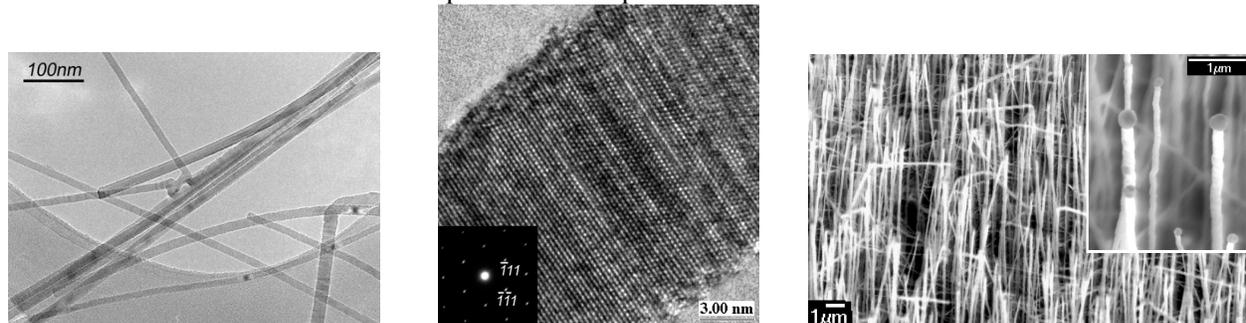


Fig. 2. (a) TEM morphology of SiC nanowires synthesized at 1200°C; (b) HRTEM image of an individual SiC nanowire. The inset electron diffraction pattern taken along [101] indicates the wire growth direction is $[\bar{1}11]$; (c) Vertical array of SiC nanowires on 6H-SiC(0001) substrates.