Patterned CVD Growth of SWNTs for Device Application

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Several patterned growth techniques of single-walled carbon nanotubes (SWNTs) by modifing the dip-coating process are discussed. The conventional concept of using SiO_2 patterned Si substrates to selectively grow 3D carbon nanotube structures can be applied to a dip-coating method followd by alcohol CVD growth. High-quality vertically aligned single-walled carbon nanotube (SWNT) patterns can be easily obtained by this protocol [1]. Apart from the sintering of catalyst into Si at high temperature, the difference in surface wettability between Si and SiO_2 also plays an important role in this selective growth, which leads us to a novel method of patterning the growth on chemically modified surfaces as shown in Fig.1 .

The more elaborate patterned growth is based on the controll of wettability of substates [2]. Surface wettability strongly affects the deposition of catalyst in dip-coating process. By functionalizing the silicon surface using a classic self-assembled monolayer (SAM) and then selectively removing the SAM by ultraviolet (UV) light, the catalyst can be dip-coated onto only the hydrophilic areas of the substrate as shown in Fig. 2. This method can simplify fabrication without sacrificing the resolution in the case of using conventional UV photolithography. Furthermore, by utilizing an electron beam instead of UV, the line width of an SWNT pattern can be easily reduced to 50 nm. The patterned region can be easily located and visualized under a scanning electron microscope (SEM).

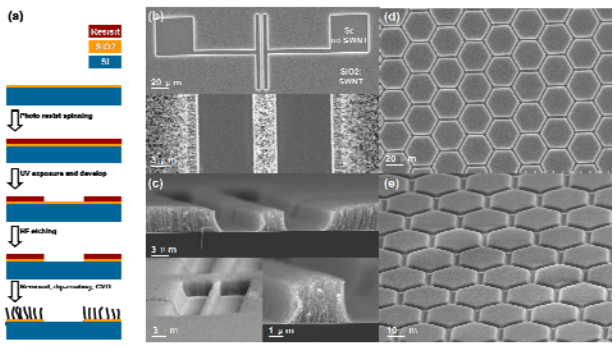

Figure 1 3D structure of SWNTs by conventional SiO_2 patterned Si substrate. (a) Schematic showing the substrate fabrication and selective growth; (b) Top and (c) side view SEM images of an electrode-shaped pattern, where SWNTs only grew in the SiO_2 regions. (d) Top and (e) side view images of hexagon patterns.

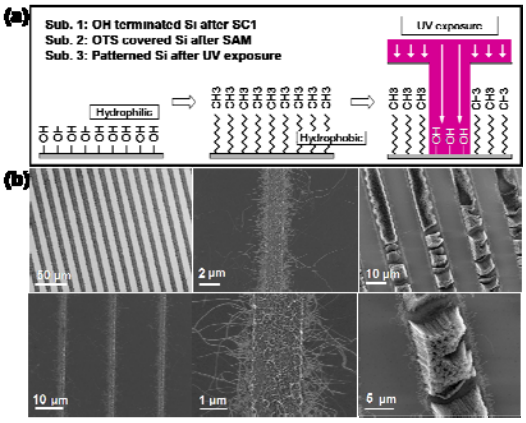

Figure 2. Selective growth of SWNTs by hydrophilic-hydrophobic patterns using the removal of OTS SAM by UV exposure. (a) Schematics; (b) SEM images of random and vertically aligned SWNT line-shape patterns.

References:

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