Graphene covered nanowires and SiC nanotubes fabricated by CVD

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Introduction

One-dimensional (1D) nanomaterials, nanowires (NWs) and nanotubes, are a highly successful extension of the silicon industry's products. This kind of structures have the advantages such as large junction area, high integration density and high specific surface area. The other important thing is that the carbon based materials such as C and SiC has an affinity for cells and does not affect cells or tissues, making them very popular for biological applications. We have now started to investigate nanowire structures coated with different substances. Now we focused on the preparation of nanowire silicon carbide silicon shell core structures as well as silicon carbide nanotubes, which are expected to be used in biomedical applications.

The aim of this study is to develop a method to obtain special 1D structures of sufficiently good quality by chemical vapor deposition and to grow SiNWs covered with graphene and SiC.

Fig 1. Schematic illustration of the fabrication procedure for graphene covered Si nanowires.

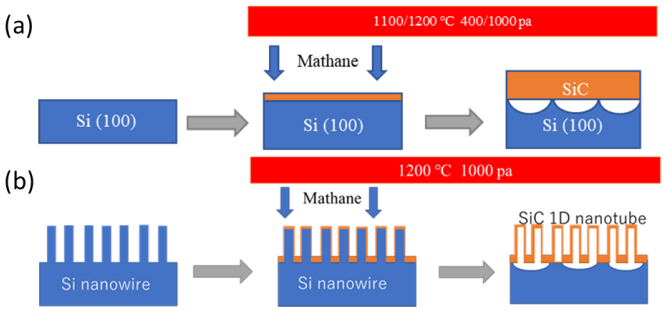

Fig 2. (a) Schematic of SiC film experiment. (b) Schematic of SiC nanotube experiment.

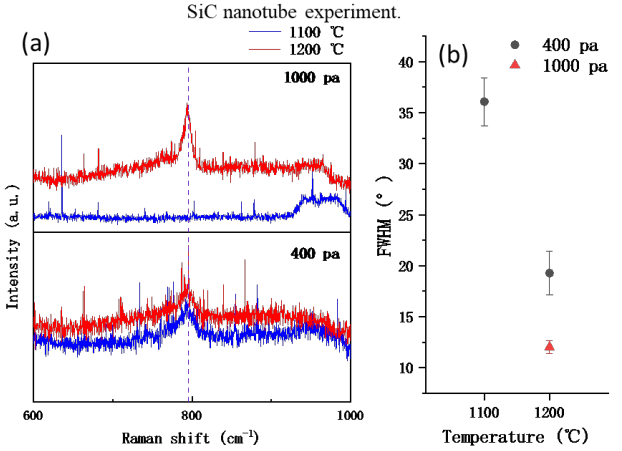

Fig 3. (a) Raman spectra of SiC grown on Si(100) substrate. (b) FWHM of SiC phonon peaks.

Experimental section

The graphene preparation process is shown in Figure 1, where PEI/glucose is spin-coated onto SiNWs and annealed in a reducing environment at 1000 °C. The graphene is then sputtered onto a-C catalyst. In the reducing environment, the polymer was decomposed to a-C. The nickel catalyst was then sputtered onto the a-C. The final sample was annealed in an inert atmosphere at 875 °C to catalyze the a-C to graphene. The nickel catalyst was etched with Marble's reagent. And to obtain the shell-core structure of silicon nanowires, carbon and silicon films were first prepared, and then both were subjected to diffusion reaction by chemical vapor deposition to finally obtain the shell-core structure through diffusion [1]. The silicon carbide nanotubes were prepared as shown in Figure 2, and the nanowires were eliminated by the diffusion reaction to obtain the outer nanotube structure.

Results and discussion

For the prepared graphene coverd SiNWs, the samples were observed by SEM and carbon D, G and 2D peaks were observed in the Raman spectra. The results of TEM measurements clearly showed graphene layers. As for the experiments on the preparation of silicon carbide, we succeeded in detecting the presence of silicon carbide peaks in the Raman spectra, confirming that the synthesis of silicon carbide can be obtained out in this way, while the cavities under the generated silicon carbide films indicate their feasibility in the production of nanotubes.

[1] H. J. Fan, U. Gösele, and M. Zacharias, *Small*, vol. 3, no. 10. pp. 1660–1671, Oct. 2007. doi: 10.1002/smll.200700382.