Abstract

This thesis mainly focuses on two major issues: (a) the growth of 3C-SiC films and catalytic growth of 1D nanostructures on Si substrates in an induction heated cold wall APCVD and their characterization and (b) the possible applications of nanostructured surfaces for fabricating stable superhydrophobic surfaces and demonstration of low voltage electrowetting on these superhydrophobic surfaces.

As part of the preliminary growth experiments for optimization, heteroepitaxial growth of polycrystalline 3C-SiC films on two differently oriented silicon substrates i.e. Si (100) and Si (111) in a horizontal cold-wall atmospheric pressure chemical vapor deposition (APCVD) system at three different temperatures i.e. 1350 °C, 1300 °C and 1250 °C was carried out.

Catalytic growth of 3C-SiC nanowires and nanorods was performed via the VLS mechanism using five different catalysts i.e. chemically synthesized Au nanoparticles and DC sputtered thin films of Au, Cu, Ni and Ti. This was done by CVD at 1200 °C for 1 hour. Also, the effect of temperature on the growth of 3C-SiC nanorods using Ni thin film as a catalyst was studied. Finally, the growth process of 3C-SiC nanorods was optimized for Ni thin film catalyst at 1200 °C for 1 hour.

Also, a simple and novel CVD method for the mixed growth of random and self-aligned cubic (3C)-silicon carbide (SiC) nanorods was demonstrated in which VLS and VS growth could take place simultaneously. The random growth of nanorods followed the VLS mechanism and was observed only on the Ni coated substrate surface. On the other hand, self-aligned growth of 3C-SiC nanorods followed the VS mechanism and was observed only at the cross-section of the substrate facing the gas inlet end.

The formation of hierarchical Au/Pd nanostructures on the surface of CVD grown 3C-SiC nanorods via DC sputtering was demonstrated. These hierarchical Au/Pd nanostructures covered the exposed surface of the 3C-SiC nanorods and were physically adsorbed on it. Stable superhydrophobic surfaces were fabricated using these hierarchical Au/Pd nanostructures on a 3C-SiC nanorod network with micro/nano air pockets. A high contact angle (160°), low sliding angle (<5°) and a rubber ball- like behavior of a water droplet were observed. This demonstrates that nanostructures of hydrophilic materials, like, SiC etc., can be made superhydrophobic by coating them with high surface energy materials like metals rather than by modifying them with low surface energy materials, especially fluoropolymers, to make them hydrophobic or superhydrophobic.

Finally, low DC voltage irreversible electrowetting was demonstrated on these superhydrophobic surfaces using a deionized water droplet. The contact angle was modulated from 160° to 75° by applying a DC voltage.

Keywords: 3C-SiC, APCVD, Nanowires, Nanorods, Superhydrophobic, Electrowetting