Abstract

The advent of silicon technology transformed the field of microelectronics, resulting in more powerful and efficient devices. However, the current technological advancements demand devices that can function in harsh environments, such as high-power electronics and high temperatures. SiC is a key candidate in this context owing to its high thermal conductivity, thermal and chemical stability and low thermal expansion coefficient. SiC nanowires, with their nanoscale features, one-dimensionality, and inherent high-temperature stability, are advantageous for applications such as high-temperature sensors and supercapacitors. In this work, the Chemical vapor deposition (CVD) technique has been used to synthesize SiC and graphene-SiC nanowires using two different catalysts: iron (Fe) and nickel (Ni). The thesis explores the lower temperature growth of SiC nanowires using Fe thin film as the catalyst, the influence of carrier gas, growth duration and C:Si ratio on the morphology of the nanowires, the supercapacitor performance of the SiC-based nanowires and substrate-dependent polytypic transformation in SiC nanowires.

SiC nanowire growth using Fe thin film catalyst could be achieved at temperatures as low as 1100 ºC using atmospheric pressure CVD. This is explained based on melting point depression in Fe nanoparticles. The bamboo-like nanowires are oriented along the <111> direction, often showing micro-twins and stacking faults along this direction. SiC-graphene core-shell nanowires were grown using Ni catalyst by replacing the carrier gas with argon. In the presence of argon, the excess carbon in the reactor gets deposited on the SiC nanowire and is etched by species like CO_2 to subsequently form vertically oriented edge-rich graphene. The nanowires grown in hydrogen and argon are denoted as SiC_{NW} and SiC_{NW}-VERG. The SiC_{NWs} grow along the <111> direction, whereas the SiC_{NW}-VERG grow along the <110>. Cathodoluminescence spectroscopy reveals the defect-enhanced luminescence in SiC nanowires. In addition, SiC_{NWs}-VERG exhibit excellent superhydrophobicity and superior supercapacitor performance compared to $SiC_{NWs.}$ The measurement of supercapacitor performance of samples reveals that the best performance is given by SiC_{NW}-VERG grown for 45 minutes. Our results demonstrate that a hexagonal substrate influences the growth of a hexagonal polytype of SiC.The work done in this thesis offers a platform to understand the influence of various parameters on SiC and graphene-SiC nanowire growth, defects in SiC and supercapacitor behaviour of SiC and graphene-SiC nanowires.