Abstract

The architecture of carbon nanotubes (CNTs) plays a significant role in determining their properties. Finding the right area of application is imperative to utilize the complete functionality and potential these nanostructures have to offer. The present research stems from this idea of exploring CNT applications that can exploit the wonderful properties these nanomaterials, both, in their bulk form as well as individual tubes, have to offer. In this work, two types of CNT architectures- vertically aligned (VACNTs) and junction CNTs have been studied to understand their CVD synthesis and derivative device applications.

The growth of VACNTs was performed on silicon substrate with patterned SiO_2 regions and the switching of the preferred growth site between silicon and silicon dioxide regions was demonstrated simply by controlling the growth environment rather than by patterning the catalyst. The influence of substrate patterning on the site selectivity and degree of alignment is discussed.

The extremely high absorbance and self-cleaning characteristics of VACNT forests were exploited to fabricate a highly sensitive and robust strain-free, optical-based, motion sensor. The influence of the design parameters on the sensor response has been carefully studied. The fabricated sensor successfully tracked fast-paced human wrist motion, displaying its applicability in real-life applications.

To explore the potential of individual CNTs in nanoscale electronic devices, multiterminal Y-junction CNTs were synthesized on GaAs substrate without the use of growth promoters. A detailed study of the tube and catalyst structure and composition has been conducted using electron microscopy and the probable mechanism behind the branching has been elucidated. Electrical measurements on individual three terminal Y-junction CNTs have also been undertaken in this study. A comparison of the electrical performance of such an intrinsically connected three-terminal tube and an extrinsically formed junction of two unbranched tubes has been made to examine the relevance of such molecular junctions in nanodevice applications.

With the current research, we attempt to provide insight and possible trends for CNT architecture-based device applications in the future.

Keywords: Vertically aligned carbon nanotubes (VACNTs), degree of alignment, CNT-based motion sensor, Junction carbon nanotubes, catalyst compositional inhomogeneity