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Characterization and Fabrication of Carbon Nanotubes Grown on Ceramic Substrates for High Temperature RFID Applications

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Carbon Nanotubes (CNTs) are very diverse nano-scale materials that carry excellent electrical, mechanical, and chemical properties. In this study, selectively growing randomly oriented multi-walled CNTs are fabricated in-house on ceramic substrates by using thermal Chemical Vapor Deposition (CVD) technique. The fabricated samples are then tested for field emission characteristics and assembled as diodes. We used a %99.4 pure ceramic (aluminum-dioxide) as the substrate to grow CNTs on its polished surface to be used in high temperature applications. Some of the substrates are patterned by using microfabrication technology. A metal catalysis layer(s) (iron and tungsten) is deposited onto the substrate using a sputtering system, where tungsten is used as the electrical contact of the device. After the metal film deposition, the substrate with the catalyst layer(s) is transferred to the thermal CVD chamber for CNTs growth. Field emission characteristics of the CNTs are measured in vacuum at varying temperatures and are used to characterize the CNT-based vacuum diodes. Each sample is packaged so a vacuum-diode configuration is formed, then placed in a Pyrex vacuum chamber for RF testing. Two antennas, one generating pulsed RF signal and one receiving the signal are used to trigger the CNTs-based diode. Diode, acting as an RFID tag, is forward-biased to a voltage below its turn-on voltage. The voltage and current generated at the application of pulsed RF signal (the turn-on voltage and current) are measured by a high-voltage probe and a Pearson coil, and analyzed. Diode is operated at elevated temperature ranging from room temperature to 200C.

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