There is a growing interest in synthesizing three-dimensional (3-D) carbon nanotube structures with multi-functional characteristics. Here, we report the fabrication of a novel composite material consisting of 3-D interconnected multi-walled carbon nanotubes (MWNTs) with Silicon Carbide (SiC) nano- and micro-particles. The materials were synthesized by a two-step process involving the chemical coating of MWNTs with Silicon oxide, followed by Spark Plasma Sintering (SPS). SPS enables the use of high temperatures and pressures that are required for the carbothermal reduction of silica and for the densification of the material into a 3-D composite block. Covalent interconnections of MWNTs are facilitated by a carbon diffusion process resulting in silicon carbide formation as silica coated MWNTs are subjected to high temperatures. The presence of SiC in the sintered composite has been confirmed through Raman spectroscopy, which shows the characteristic peak close to 800 cm$^{-1}$ and also Energy Filtered Transmission Electron Microscopy maps. X-ray Diffraction, Scanning Electron Microscopy, Energy Dispersive X-Ray Spectroscopy and High Resolution Transmission Electron Microscopy have also been used to characterize the produced material. Interestingly, the thermal property measurements of the sintered composite reveal a high thermal conductivity value (16.72 W/mK) for the material. From the electrical point of view, a 3-D variable range hopping (VRH) electron hopping was observed in the composite.
Fig. 1: High Resolution Transmission Electron Microscopy images of SiC/MWNT composite prepared by Spark Plasma Sintering.

Fig. 2: (a) Raman spectrum of the SiC/MWNT sample showing characteristic D, G and G' peaks for MWNTs and the SiC peak at 800 cm\(^{-1}\). (b) X-Ray diffraction data of SiC/MWNT composite. (c) Raman mapping of G peak position and (d) SiC peak position within a 30 µm x 30µm area.