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Abstract

Terbium Iodide-Filled Single-Walled Carbon Nanotubes: Microscopy and Spectroscopy Investigations †

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Abstract: Terbium (III) iodide is an interesting chemical compound with unique chemical properties. The introduction of terbium iodide into single-walled carbon nanotubes (SWCNTs) is an environment-friendly process, and it leads to the development of new nanocomposites with improved properties. The embedded terbium iodide forms new one-dimensional atomic structures inside the SWCNTs. Moreover, the electronic properties of filled SWCNTs are modified. Here, the atomic structures of terbium iodide-filled SWCNTs are investigated using high-resolution transmission electron microscopy, and their microstructure, morphology, and filling degrees are studied. The electronic properties of filled SWCNTs are investigated using spectroscopy. Raman spectroscopy provides information on the charge transfer inside filled SWCNTs. The number of transferred electrons and the charge transfer density along the SWCNT axis are estimated from the Raman spectra. These data on charge transfer are required for the application of terbium iodide-filled SWCNTs in nanoelectronics, thermoelectric power generation, and sensors. The obtained quantitative data reveal the high doping efficiencies of SWCNTs with terbium iodide. This is one of the most effective dopants for SWCNTs. The data show a strong p-doping of SWCNTs with the charge transfer from SWCNTs to terbium iodide. The data from Raman spectroscopy testify to the shift of the Fermi level to the valence band of the SWCNTs. The Fermi level shifts are estimated from these data. They are in the range of 0.3–0.4 eV and are comparable to the values for SWCNTs filled with other rare earth metals using environment-friendly processes.

Keywords: single-walled carbon nanotube; filling; environment-friendly process; terbium iodide; electronic properties

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