Science and Technology of Advanced Materials

Recent developments in inorganically filled carbon nanotubes: successes and challenges

REVIEW ARTICLE

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Issue Volume 11, Number 5

Citation Ujjal K Gautam *et al* 2010 *Sci. Technol. Adv. Mater.* **11** 054501

doi: 10.1088/1468-6996/11/5/054501

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Abstract Carbon nanotubes (CNTs) are a unique class of nanomaterials that can be imagined as rolled graphene sheets. The inner hollow of a CNT provides an extremely small, one-dimensional space for storage of materials. In the last decade, enormous effort has been spent to produce filled CNTs that combine the properties of both the host CNT and the guest filling material. CNTs filled with various inorganic materials such as metals, alloys, semiconductors and insulators have been obtained using different synthesis approaches including capillary filling and chemical vapor deposition. Recently, several potential applications have emerged for these materials, such as the measurement of temperature at the nanoscale, nano-spot welding, and the storage and delivery of extremely small quantities of materials. A clear distinction between this class of materials and other nanostructures is the existence of an enormous interfacial area between the CNT and the filling matter. Theoretical investigations have shown that the lattice mismatch and strong exchange interaction of CNTs with the guest material across the interface should result in reordering of the guest crystal structure and passivation of the surface dangling bonds and thus yielding new and interesting physical properties. Despite preliminary successes, there remain many challenges in realizing applications of CNTs filled with inorganic materials, such as a comprehensive understanding of their growth and physical properties and control of their structural parameters. In this article, we overview research on filled CNT nanomaterials with special emphasis on recent progress and key achievements. We also discuss the future scope and the key challenges emerging out of a decade of intensive research on these fascinating materials.

PACS 81.16.-c Methods of nanofabrication and processing
81.20.Vj Joining; welding
61.46.Fg Nanotubes
61.50.Lt Crystal binding; cohesive energy
81.15.Gh Chemical vapor deposition (including plasma-enhanced CVD, MOCVD, etc.)
81.65.Rv Passivation

Subjects Surfaces, interfaces and thin films
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Dates Issue 5 (October 2010)
Received 15 六月 2010 , accepted for publication 26 七月 2010
Published 27 十月 2010

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