Carbon Nanotube and Graphene Hybrid Materials Systems for Multifunctional Applications

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Due to their exceptional stiffness, strength, thermal and electrical conductivity, carbon nanotubes and graphene have the potential for the development of nano hybrid materials for a wide variety of applications. In order to achieve the full potential of carbon nanotubes and for structural, thermal and electrical applications, carbon nanotubes and grapheme need to be developed into bulk fully integrated hybrid materials. Full integration of nanotubes and graphene requires their development beyond conventional composites so that the level of the non-nanotube material is designed to integrate fully with the amount of nanotubes and graphene. Here the carbon nanotubes are part of the matrix rather than a differing component, as in the case of conventional composites. In order to advance the development of multifunctional materials integrating nanotubes and graphene, this research is focused on the simultaneous control of nanoarchitecture, structural properties, thermal and electrical conductivity of fully integrated hybrid materials. These are hybrid materials systems designed to surpass the limits of rule of mixtures engineering and composite design. The goals are to implement multifunctional designs to fully mimic the properties of carbon nanotubes and grapheme on larger scales for enhanced thermal and electrical management in addition to the control of other properties such as strength, toughness energy and power. These new approaches involve exfoliation, functionalization, dispersion, stabilization, alignment, polymerization, reaction bonding and coating in order to achieve full integration. Typical examples of structural applications of polymeric and ceramic matrices and applications in energy systems such as capacitors and batteries as well as other material systems are presented and discussed.

1. Marquis, F.D.S. "Carbon Nanotube Nanostructured Hybrid Materials Systems for Renewable Energy Applications" *JOM*, Vol 63, 1 (2011) 48
2. Marquis, F.D.S. and L.P.F. Chibante "Improving the Heat Transfer of Nanofluids and Nanolubricants with Carbon Nanotubes" *JOM*, 12 (2005) 32-44.
3. Functional *Composites of Carbon Nanotubes and Applications*", Lee, K-P, Gopalan, A.I. and Marquis, F.D.S. Marquis, Research Signpost (2009), ISBN 978-81-7895-413-4.
4. Marquis, F.D.S. "*The Nanotechnology of Carbon Nanotube Nanofluids*" in "Functional Composites of Carbon Nanotubes and Applications", Lee, K-P, Gopalan, A.I. and Marquis, F.D.S. Marquis, ISBN 978-81-7895-413-4, (2009).