Editorial

Nuggehalli M. Ravindra PhD

Professor, New Jersey Institute of Technology, Newark, NJ, USA

Carbon, with its allotropes¹ such as diamond, graphite, lonsdaleite, amorphous carbon, single-walled carbon and types of fullerene including C60, C540 and C70, continues to be at the forefront of scientific research. This is evidenced by awarding the Nobel Prize in chemistry,² in 1996, to Robert F. Curl Jr., Sir Harold W. Kroto and Richard E. Smalley for their discovery of fullerenes and, more recently, awarding the Nobel Prize in physics to Andre Geim and Kostya Novoselov, of the University of Manchester, UK, in 2010, for their discovery of graphene.³ In 2010, the total number of research publications focusing on carbon nanotubes (CNT), graphene and fullerenes exceeded 13 000 with more than 8000 publications focusing on CNT.⁴ With all this curiosity, excitement, investment and expectations, it is anticipated that, unlike the high-temperature superconductors, these carbon-related materials and structures will hit the marketplace very soon.

The first of the articles⁵ in this issue of *Emerging Materials Research* presents an 'Overview of Carbon Nanotubes' by Deepmala Gupta, Bhasker Pratap Choudhary, Nakshatra B. Singh, from the Research and Technology Development Centre, Sharda University, Greater Noida, India, and N. S. Gajbhiye, Dr. Harisingh Gour University, Sagar, Madhya Pradesh, India. The authors describe the uniqueness and opportunities that CNT offer. CNT are either single-walled or multiwalled and have been studied extensively. A large number of research articles, review articles and books have been published on this topic. However, review articles covering all the aspects of CNT are rarely found. This article gives an overview of CNT in terms of classification, synthesis, characterization, functionalization, properties, composites, applications and future directions.

Shrinking electronic device dimensions and increasing costs of energy will necessitate more advanced methods of energy storage and manipulation in the future, especially for handheld electronics such as cell phones, tablet computers and so on. This can be facilitated by the creation of novel materials with superior properties in comparison with those that are currently in use. Manganese oxide (MnO_x) nanowires offer an exciting opportunity for a number of applications relating to these needs.

The second article⁶ in this issue is on 'Rapid Synthesis and Characterization of Amorphous Manganese Oxide Nanowires'. This article by Rajen B. Patel and Zafar Iqbal of the Interdisciplinary Program in Materials Science and Engineering at the New Jersey Institute of Technology and Tsengming Chou of the Laboratory for Multiscale Imaging, Stevens Institute of Technology, focuses on the study of large amorphous MnO_x nanowires/nanofibers, consisting

of curved 1D mesoporous structures with the potential for use in electrochemical battery electrodes. They have been synthesized by a facile chemical precipitation process at room temperature. The synthesis process is adapted from one that is used to obtain nanoscale metal borides and is easily scalable. X-ray diffraction, scanning and transmission electron microscopies, Raman spectroscopy and inductively coupled plasma atomic emission spectroscopy have been performed to reveal critical details of the morphology, structure and composition of this material.

Composite materials exhibit high dielectric permittivity. Therefore, they have been considered to be potential candidates as dielectrics for capacitors with high energy density. In recent years, composite materials such as CaCu₃Ti₄O₁₂ (CCTO)^{7,8} have gained considerable importance due to their high dielectric permittivity in the radio frequency range. They also exhibit nonlinear current–voltage properties. While these ceramics are potentially promising materials for several applications, they are limited by the large loss tangent that makes them unsuitable for capacitor applications. Therefore, reduction in the loss tangent value is critical and requires detailed investigation.

'Effect of Substitution and Impurities on Dielectric Properties and Resistivity of CaCu₃Ti₄O₁₂' by Narsingh B. Singh, Margaret Gillan, David House, Ravali Yanamaddi, Vishnu Razdan and Bradley Arnold of the Department of Chemistry and Biochemistry, University of Maryland, Baltimore County, MD, USA, is the third article⁹ of this issue. The authors have performed the synthesis and grain growth of pure calcium copper titanate (CCTO) compound and its derivatives by substituting silicon CaCu₃Si_xTi_{4-x}O₁₂ (CCSTO) to determine the effect on dielectric properties and resistivity. The authors observed significant increase in the resistivity even with small concentration of silicon. Concentration above 5% did not produce any significant advantages; they also observed a similar increase in resistivity when CCSTO was doped with nickel. In a separate experiment, the authors soaked CCSTO before grain growth in an organic melt. Soaking also increased the resistivity by several orders of magnitude. The authors observed almost three orders of magnitude higher resistivity in CCSTO compared with CCTO material processed under identical conditions.

Pure titanium and its alloy counterparts have gradually grown in stature and significance to become a much-needed metal primarily because of their selection and use for a wide spectrum of applications spanning a variety of industries including aerospace, automotive, marine, civil construction, biomedical and

commercially related products. Pure titanium metal and its alloy counterpart(s) have excellent mechanical and thermodynamic properties.

In the last article of this issue,¹⁰ Kannan Manigandan, Tirumalai S. Srivatsan and Gregory N. Morscher of the Division of Materials Science and Engineering, Department of Mechanical Engineering, The University of Akron, Akron, OH, USA, discuss their results of 'The Quasi-static and Cyclic Fatigue Fracture Behavior of an Emerging Titanium Alloy'. Sustained research and development efforts culminating in the emergence of new and improved titanium alloys have provided both the impetus and interest for studying their mechanical behavior under the extrinsic influence of loading spanning both static and dynamic loads. In this article, the quasi-static and cyclic fatigue fracture behavior of a titanium alloy (Ti-Al-V-Fe-O₂) is highlighted. Test specimens of this titanium alloy were deformed both in quasi-static tension and cyclic stress amplitude-controlled fatigue. The quasi-static mechanical properties, cyclic fatigue response and microscopic mechanisms, contributing to deformation and eventual fracture, are highlighted in light of the competing and mutually interactive influences of nature of loading, intrinsic microstructural effects, deformation characteristics of the titanium alloy metal matrix and macroscopic aspects of fracture.

REFERENCES

1. See http://en.wikipedia.org/wiki/File:Eight_Allotropes_of_Carbon.png. Accessed 22/11/2013.
2. See <http://www.iucr.org/people/nobel-prize/curl>. Accessed 22/11/2013.
3. See http://www.nobelprize.org/nobel_prizes/physics/laureates/2010/. Accessed 22/11/2013.
4. Van Noorden, R. The trials of new carbon. *Nature* **2011**, 469, 14–16.
5. Gupta, D.; Pratap Choudhary, B.; Singh, N. B.; Gajbhiye, N. S. Overview of carbon nanotubes. *Emerging Materials Research* **2013**, 6, 299–337.
6. Patel, R. B.; Iqbal, Z.; Chou, T. Rapid synthesis and characterization of amorphous manganese oxide nanowires. *Emerging Materials Research* **2013**, 6, 338–343.
7. Thongbai, P.; Vangchangyia, S.; Swatsitang, E.; Amornkitbamrung, V.; Yamwong, T.; Maensiri, S. Non-Ohmic and dielectric properties of Ba-doped CaCu₃Ti₄O₁₂ ceramics. *Journal of Materials Science: Materials in Electronics* **2013**, 24, 875–883.
8. Thomas, P.; Satapathy, S.; Dwarakanath, K.; Varma, K. B. R. Dielectric properties of poly(vinylidene fluoride)/CaCu₃Ti₄O₁₂ nanocrystal composite thick films. See <http://arxiv.org/abs/1301.4056> for further details. Accessed 22/11/2013.
9. Singh, N. B.; Gillan, M.; House, D.; Yanamaddi, R.; Razdan, V.; Arnold, B. Effect of substitution and impurities on dielectric properties and resistivity of CaCu₃Ti₄O₁₂. *Emerging Materials Research* **2013**, 6, 344–347.
10. Manigandan, K.; Srivatsan, T. S.; Morscher, G. N. The quasi-static and cyclic fatigue fracture behavior of an emerging titanium alloy. *Emerging Materials Research* **2013**, 6, 348–355.