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Editorial

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Research in materials science and engineering is progressing rapidly. The global emphasis, education and awareness have been focusing on the intensification of applications, recycling and reuse of materials for the benefit of humanity. This is leading to a new culture of enhanced creativity and increased respect for the world we live in. Thus, the gaps between fundamental research in materials science and engineering, research and development, and manufacturing are beginning to narrow.

Due to the unique set of characteristics that include mechanical, optical, electronic and structural properties, scientists are exploring graphene for device applications. Researchers have shown that graphene can be used to improve the performance of a broad range of devices. By incorporating graphene into a silicone encapsulant, scientists have demonstrated increase in thermal conductivity, decrease in thermal expansion coefficient, improvement in chemical resistance and enhancement in the long-term stability of inorganic white light–emitting diodes (LEDs).[1] Graphene has been a boon for applications in optoelectronics. The applications include polarizers, ultrafast lasers, transparent electrodes and photodetectors. However, a low absolute absorption observed in a single layer of graphene, ~2·3% of the incident photon, needs to addressed. In an attempt, Pirruccio *et al*.[2] studied a multilayer structure of graphene in an attenuated total reflectance configuration. They found an enhanced absorption over the entire visible spectrum as a consequence of coherent absorption resulting from controllable interference and dissipation. Recent research has also shown that graphene materials are useful for capacitive energy storage. Yang *et al*.[3] have integrated graphene sheets with a non-volatile liquid electrolyte forming an electrochemical capacitor (EC) with energy density of ~60 Wh/l, which is much greater than for most commercially available ECs (5–8 Wh/l). In a separate research, Mousavi *et al*.[4] has studied metamaterial tuning, a topic of extreme importance in modern science and technology, in which the resonance frequency of metamaterials shifts to blue – this has been made possible by coating them with a graphene layer. Now, with the help of both blue shifting and red shifting of the resonant frequency, the metamaterials working in the broader frequency range are discovered day by day, which has a wide range of applications from 'super lens' to cloaking devices.

Research on biosensors has recently been updated with the discovery of a glass-based chip, instead of silicon-based electrochemical arrays.[5] Limitations inherent in the complexity of the integrated circuit in the existing device have been addressed in this research by designing solution-based circuits. This not only enables highly multiplexed sensing but also provides rapid detection at lower cost. Similarly, a new probing device used in the fluorescence studies of biological system has been designed by Yang *et al*.[6] This device has an advantage over commonly used organic fluorophores, such as cyanine fluorophore (Cy5), in which it has reduced blinking emission, desirable brightness, longer-lasting fluorescence emission and is more stable. This device is intended for use in optical imaging of a single molecule and is hence a powerful tool for understanding complex biological systems.

Significant interest in materials research is focused on developing magnetic refrigerants for liquid-helium temperatures utilizing the magnetocaloric effect (MCE), that is, change in temperature due to the change in applied magnetic field. This is the basis for efficient refrigeration, but it requires careful compromise between maximum magnetic density and weakly coupled magnetic ion (zero magnetic order at zero field). Lorusso *et al*.[7] have studied a metal organic framework, the gadolinium formate ($Gd(HCOO)_3$), which shows 'unprecedently large' MCE at low temperatures. This has been attributed to the light and compact structural framework having very weak magnetic correlations between gadolinium ions.

The first article[8] of this issue in *Emerging Materials Research* focuses on a 'Review of Polymer-Based Sensors for Agriculture-Related Applications'. This article is by Vinay S. Palaparthy, Maryam S. Baghini and Devendra N. Singh, from the Department of Electrical Engineering, Indian Institute of Technology (IIT)-Bombay, Mumbai, India. Advancements in micro-electro-mechanical systems (MEMS) and nano-electro-mechanical systems (NEMS) technologies are changing the way integrated systems interact with nature by providing a variety of physical and chemical sensing technologies. For emerging markets, cost of new technologies, aimed at applications such as environmental monitoring and agriculture, is an important factor for deployment. This article provides a review of low-cost polymers, used for sensing environmental parameters such as humidity and temperature, and soil-related substances such as pH, nitrogen, phosphorus and potassium. Polymer-based MEMS and NEMS sensors take advantage of simple low-temperature spin-coating process for depositing various sensitive polymer layers on a variety of sensing devices. Review of materials, specifications and preparation methods of the polymers along with their molecular structures are presented in this article. A brief review of the associated devices such as ISFET (ion-sensitive field-effect transistor) with reported results are also presented.

The second article of this issue,[9] 'Integration of Indium Micromirrors for Biosensing Applications' is by Rafael Gómez Bule, Raul Broto Cervera, Chun-Mou Hsiao and Raquel Perez-Castillejos, of the Department of Biomedical Engineering at the New Jersey Institute of Technology. The authors report their studies of indium mirrors as components of opto-microfluidic systems due to their ability to reflect light efficiently. Their use, however, has been limited by the challenges of their integration to microfluidic devices. They describe the fabrication of indium micromirrors integrated to microfluidic devices and successfully demonstrate their application to the determination of fluorescence concentration in aqueous solutions by absorbance measurements. The technological route, presented in this study, for integrating metallic mirrors to microfluidic devices is fast, simple and inexpensive.

'Oleic Acid–Capped CdTe Quantum Dots and Their Applications as Nano-LED' by Lalit Baruah of the Department of Physics, Assam University, India and Siddhartha S. Nath of Central Instrumentation Laboratory, Assam University, India,[10] discusses a simpler and cost-effective approach, in particular with the use of oleic acid and liquid paraffin, to prepare CdTe quantum dots at relatively low temperatures (150–200°C). Compared with other solvents (capping agents), oleic acid is cheaper, more environment friendly and stable in air. The as-prepared CdTe quantum dots exhibit cubic crystallite with size in the range of 3–11 nm. This proposed new route reduces the material costs and permits to obtain CdTe quantum dots with a narrow emission (fluorescence) spectra ranging from 602 to 617 nm at room temperature. In order to investigate the application of the prepared samples as nano-LED, electroluminescence spectroscopy is studied and shows the emission to be almost at the similar wavelength as that of fluorescence. This study infers possible application of CdTe quantum dots as nano-LED with emission in the range of 605–620 nm.

The article 'Synthesis and Magnetic Properties of Fergusonite Structured $La(NbVMn)O_4$' by Shunsuke Kawakami, Naoya Takeda, Shigemi Kohiki, Fuki Tsutsui, Juri Harada, Masao Arai, Masanori Mitome, Kazuyo Ohmura, Kunio Yubuta and Toetsu Shishido, is a collaborative study between the Department of Materials Science, Kyushu Institute of Technology, Kitakyushu, Japan; National Institute for Materials Science, Tsukuba, Japan and Institute for Materials Research, Tohoku University, Sendai, Japan.[11] In this investigation, the authors have synthesized fergusonite-structured $La(Nb_{0.71}V_{0.04}Mn_{0.25})O_4$ samples. The samples, consisting of La^{3+}, Nb^{5+}, V^{5+}, Mn^{4+}, and oxygen ions, demonstrated temperature-dependent magnetization that increased with lowering the temperature below ≈200 K, and almost saturated below ≈100 K. At 75 K, the field-dependent magnetization demonstrated sigmoidal curve and reached 3 μB/Mn at 1 T. Such a magnetic behavior can be ascribed to exchange interaction between $Mn^{4+}Nb_2O_{11}$ nanoclusters. The Mn^{4+} substitution for the V^{5+} sites of the crystal resulted also in the occupied state above the valence-band maximum.

Kannan Manigandan and Tirumalai S. Srivatsan of The University of Akron, Ohio and Andrew M. Freborg of Deformation Control Technology, Inc., Cleveland, Ohio, report their studies[12] on the 'Influence of Finish and Notch on Flexural Strength and Fracture of a Steel'. In this article, the extrinsic influence of surface finish and notch on both flexural strength and fracture behavior of the alloy steel Pyrowear 53 when subjected to quasi-static bending is presented and discussed. The influence of surface finish on bevel-shaped samples of this alloy steel revealed the isotropic surface finish to carry a higher maximum load during a flexural test. However, from the standpoint of extension, the micro-machined process samples revealed observable improvement in extension (mm) capability when subjected to static bending. Samples of this alloy steel having a funnel notch had a lower maximum load-carrying capability when compared one-on-one with the bevel-shaped sample. The macroscopic fracture mode and the microscopic features on the fracture surface are presented and discussed in light of shape of the test specimen. The key microscopic mechanisms governing fracture behavior of this novel steel are discussed in light of the role played by intrinsic microstructural features, deformation characteristics of the microstructural constituents and nature of loading.

L. A. Maltseva, T. V. Maltseva, V. A. Sharapova, N. N. Ozerets, K. D. Khramtsova and M. P. Tretnikova from the Ural Federal University, Yekaterinburg, Russia, report their studies on the 'Corrosion-Resistant Austenitic Steels For Elastic Elements'.[13] The features of the formation of the structure and physical and mechanical properties of 1 and 5% cobalt-containing austenitic steels, at high plastic strains, have been investigated. Mechanical and relaxation properties of corrosion-resistant metastable austenitic steel (03Kh14N11K5M2YuT) have been investigated as function of the pretreatment and the temperature–time treatment conditions. These studies should be useful in the development of new tools for use in microsurgery and elastic elements and springs for precision engineering and instruments that are made of thin or fine wire.

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