Editorial

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Silicon technology continues to evolve, and new directions toward taking advantage of the mature and inexpensive silicon are being constantly sought. For example, by integrating atoms of semiconductor materials into nanowires and structures on top of silicon surfaces, researchers at the University of California – Davis,¹ have recently demonstrated three-dimensional nanowire transistors.

In the September 2013 issue of the *Proceedings of National Academy of Sciences*, Sadeghi, Jo and Shi² of the University of Texas at Austin show that the thickness of multilayer graphene, supported on an amorphous substrate, needs to be more than 30 atomic layers to recover the graphite thermal conductivity. This finding is attributed to the long phonon mean free paths in graphite even along the cross-plane direction. Furthermore, this is used to clarify the interface leakage of phonons as an important mechanism for the observed suppression. This result has significant implications for the application of graphene in electronics, thermal management and other applications including thermoelectrics.

The first of the articles³ in this issue of *Emerging Materials Research* presents a study on the ‘Nanostructures containing boron and nitrogen’ by Tsengming Chou of the Stevens Institute of Technology, Zafar Iqbal and Rajen Patel of the New Jersey Institute of Technology. In this study, a method to grow boron nitrogen nanoheterostructures has been developed. This method is based on an alteration to a process that has been shown to be suitable for the growth of pure boron nanostructures. The technique uses the solid precursors MCM-41, NiB and MgB₂ or Mg(BH₄)₂ in combination with flowing ammonia gas. Two boron nitrogen nanoheterostructures have been found. One boron nitrogen heterostructure is a nanowire with alternating pure boron and boron nitride sections, creating an axial heterostructure. This material is reported for the first time in the literature. The other is a boron nitride nanotube filled with magnesium oxide, a radial nanoheterostructure. Additional modifications to the process have resulted in novel methods of synthesizing boron nitride nanowires, boron nanowires and boron nitride nanotubes. The boron nitrogen nanoheterostructures, found in this study, have the potential for applications in electronics and optics due to the wide band gap of boron nitride. These materials have been characterized by scanning electron microscopy (SEM), transmission electron microscopy and electron energy loss spectroscopy.

Metal matrix composites (MMCs) play a major role in materials science, particularly in the field of aerospace, marine, transportation, military and structural applications. They are

used mainly in a relatively high-temperature and wear resistance applications. Among MMCs, aluminum matrix composite (AMC), reinforced with TiC, has better potential for high-temperature applications. Production of AMC has been carried out using various methods.

The second article⁴ in this issue focuses on the ‘Processing and characterization of AA 6082/TiC composites by stir casting’. This article by Thangarasu, Murugan, Dinaharan and Thangapandi is a collaborative effort between Sri Ramakrishna Institute of Technology, Coimbatore Institute of Technology and VV College of Engineering, India. The present study focuses on the fabrication of aluminum (6082-T6) matrix composites, reinforced with TiC particulates, using stir-casting route. The composite has been successfully fabricated with the addition of 5 and 10% TiC particles. The microstructure and mechanical properties of the fabricated AMCs have been analyzed. The optical microstructure and SEM images reveal homogeneous dispersion of TiC particles in the matrix. The mechanical properties such as tensile strength, microhardness and wear resistance show improvement with the increase in weight per cent of TiC particulates in the aluminum matrix.

Multifunctionality and the demand for improving the properties of construction materials makes it necessary to leave the approach of monomaterials and combine them to fabricate composite structures, such as combinations of metals with polymers.

‘Three-layered sandwich material for lightweight applications’, by Heinz Palkowski of Clausthal University of Technology and Adele Carradò of Institut de Physique et Chimie des Matériaux de Strasbourg, is the next article⁵ in this issue of the journal. This article focuses on metal–polymer–metal sandwich sheets. Bonding is improved using adhesive layers. These sandwich sheets are designed for their mechanical and thermal properties, working capacity and so on. A short background of composite structures, to be used in the automotive and aerospace industry, is presented. Moreover, fabricating processes and forming methods for composites are briefly introduced. Finally, a study of 316L/polypropylene/316L sandwich sheets, manufactured in a roll bonding process and heating press process, is introduced. Their mechanical behavior and formability by deep drawing are discussed.

In a collaborative effort between PSS Inc., SB Microsystems and the New Jersey Institute of Technology, Peter Kaufman, Brian Jamieson and Ravindra discuss the results of ‘Coefficient of thermal

expansion-based MEMS infrared detector'.⁶ In this article, the design and performance simulation of a novel coefficient of thermal expansion-based microelectromechanical (MEMS) infrared detector is discussed. The detector design uses thermal expansion coefficient materials physically interfaced with piezoelectric resonators constructed using the MEMS process. The optics, in front of the detector, consists of an infrared lens and a band-pass filter operating in the wavelength range of 8–14 μm . By utilizing the extended blackbody calculator and thermally induced stress in the example thermal expansion coefficient material – copper, the detector and resonator performance is characterized in terms of the resonator frequency as a function of scene temperature. The performance of the detector was comparable to common infrared (IR) imaging systems currently available in the midwavelength IR and long-wavelength IR spectral ranges.

The effluent from the textile, paper and food industries containing dye is strongly colored and reveals very harmful effects on living things. Heterogeneous photocatalysis is an effective treatment method for the removal of dyes from industrial wastewaters.

Susmita Mandavgane of Sindhu Mahavidyalaya in collaboration with Nita Mohabansi of the J. B. College of Science and Yenkie of Nagpur University, India, present their study of 'Photocatalytic removal of Eosin Y by titanium dioxide (TiO_2) and zinc oxide (ZnO) catalysts'.⁷ In this study, the photocatalytic degradation of Eosin Y dyes is reported. The irradiation of aqueous solution of Eosin Y dyes in the presence of photocatalyst and ultraviolet (UV) light has been carried out in a batch photoreactor. TiO_2 and ZnO have been used as photocatalysts for the study. The rate of degradation has been estimated from residual concentration spectrophotometrically. The effects of operating conditions such as Eosin Y initial pH, $\text{H}_2\text{O}_2/\text{COD}$ ratio and the amount of catalyst loading on the removal efficiency have been evaluated. The results of these experiments indicate that the removal of Eosin Y increases with increasing the catalyst loading. Results show that maximum degradation efficiency of 99-91% occurs in 60 min with 30 mg/750 ml of TiO_2 catalyst dose.

The last study⁸ in this issue of *Emerging Materials Research* is by Nita Mohabansi of the J. B. College of Science, Susmita Mandavgane of Sindhu Mahavidyalaya and Yenkie of Nagpur University, India. In this study, 'Study of homogeneous and heterogeneous photocatalysis of benzoic acid' is presented. The

photocatalytic degradation of a hazardous and non-biodegradable compound, benzoic acid, in its aqueous solution by strong oxidizing agent, hydrogen peroxide, in the presence of UV radiation emitted from UV source is investigated. The different $\text{UV}+\text{Fe}^{2+}+\text{H}_2\text{O}_2$, $\text{UV}+\text{TiO}_2$ and $\text{UV}+\text{ZnO}$ combinations generate hydroxyl radicals having very high oxidation potential that helps in complete mineralization of the organic pollutants and are environmentally benign processes. Almost complete degradation of 97-6% and decolourization of the substrate is achieved within 90 min by $\text{UV}+\text{Fe}^{2+}+\text{H}_2\text{O}_2$ system while it takes 240 min with heterogeneous photocatalytic system. The experiments have been carried out in a batch photoreactor using 8-W low-pressure mercury vapor lamp. Substrate concentration has been determined by UV-visible spectrophotometry. The photocatalytic processes have been seen to be strongly pH dependent and adhere to first-order kinetics.

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