Editorial

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As the year comes to a close, research on two-dimensional (2D) materials continues to progress^{1,2} at a rapid pace. Examples of this include graphene-based smart textiles¹ and large-area single-crystal sheets of borophene on surfaces of copper.² Like black gold³ and black silicon,⁴ black silver⁵ has entered the arena to join materials that permit significant enhancement in optical absorption in the visible and infrared range of wavelengths, and thus could be useful in a variety of energy-related applications.

The first of the papers in this issue of *Emerging Materials Research* focuses on ‘Bioimaging based on antibody-conjugated amphiphilic polymer-core@shell quantum dots’.⁶ This paper is by Amir-Hassan Zamani (Reproductive Immunology Research Center, Avicenna Research Institute, ACECR, Tehran, Iran; Immunology Research Center, Iran University of Medical Sciences, Tehran, Iran), Mohammad-Reza Nejadmoghaddam (Nanobiotechnology Research Center, Avicenna Research Institute, ACECR, Tehran, Iran; Nanotechnology Research Center, Faculty of Pharmacy, Tehran University of Medical Sciences, Tehran, Iran), Mojtaba Mirhosseini Moghaddam (Microinova Engineering GmbH, Allerheiligen bei Wildon, Austria), Fereshteh Mohammadi (Nanobiotechnology Research Center, Avicenna Research Institute, ACECR, Tehran, Iran), Mohammad Eskandari (Nanobiotechnology Research Center, Avicenna Research Institute, ACECR, Tehran, Iran) and Ramin Ghahremanzadeh (Nanobiotechnology Research Center, Avicenna Research Institute, ACECR, Tehran, Iran). Quantum dots (QDs) are one of the most important achievements in the fast-growing nanotechnology field. Their unique optical properties make them superior to conventional fluorophores and essential in many applications. They have been successfully applied in various fields such as optics, electronics and biology. The ability to make QDs water soluble and use them to label specific biomolecules has led to promising applications such as high-resolution cellular imaging. In this study, the authors present procedures for the synthesis and coating of cadmium selenide (CdSe) nanoparticles and their surface modification with an amphiphilic polymer for biological conjugation. The effectiveness of biological functionalization has been assessed through cadmium selenide conjugation to an amine-reactive anti-human CD4 monoclonal antibody. The results show that the fabricated QD cores have a size distribution of about 2.5–3 nm with the first exciton

absorption peak and maximum emission wavelengths of 518 and 525 nm, respectively. Coating with zinc sulfide (ZnS) markedly increases the emission intensity of QDs. Fourier transform infrared analysis confirms the surface modification of core@shell QDs with the polymer. Intense specific fluorescent signals have been observed when the QD-conjugated antibody is electrophoresed. The procedure introduced in this investigation could be viewed as a platform for functional and efficient synthesis of QD nanoparticles.

The second paper by Qiannan Yu (School of Petroleum Engineering, Northeast Petroleum University, Daqing, China; Daqing Oilfield Personnel Development Institute, Daqing Oilfield Limited Company, Daqing, China), Zhengshun Zhao (School of Chemical Engineering, Sichuan University, Chengdu, China) and Shuai Tan (School of Chemical Engineering, Sichuan University, Chengdu, China) is on ‘Preparation and proton conduction in liquid crystals containing sulfonic acid moiety’.⁷ A series of novel biphenyl benzoate-based liquid crystals (**1**) containing terminal sulfonic acid moieties have been prepared through the etherification reaction for anhydrous proton conduction. The chemical structures of **1** have been characterized by nuclear magnetic resonance, Fourier transform infrared spectroscopy and high-resolution mass spectrometry. Differential scanning calorimetry measurements and polarizing optical microscopic observations indicate that **1** exhibits a thermotropic smectic A phase in a temperature range of 188–226°C. X-ray diffraction measurements suggest that the molecules of **1** in the smectic phase form bilayer nanostructures, wherein the sulfonic acid moieties are lamellar aggregated within the layers to form 2D pathways for proton conduction. Electrochemical impedance spectroscopy measurements suggest that the lamellar assembly of the sulfonic acid moieties in the smectic phase benefit the anhydrous proton conduction of the sulfonic acid derivatives, and proton conductivities on the order of 10^{−4} S/cm are achieved. The proton conductivity of **1** in the smectic A phase is higher than that in the crystal state and isotropic liquid state.

The third paper focuses on ‘Size-dependent surface energy of Ar and Si nanovoids’.⁸ This paper has been reported by Shuai Zhang (School of Materials Science and Engineering, Jilin Jianzhu University, Changchun, China) and Hui Li (College of Materials

Science and Engineering, Taiyuan University of Technology, Taiyuan, China). In this investigation, a simple model for the size dependence of liquid–vapor surface energy of a liquid drop, free of any adjustable parameter, has been extended to the size dependence of the surface energy of nanovoids. Considering nanovoids, there is a negative curvature on the void surface, which is completely different from nanoparticles or liquid drops, which have positive curvature surfaces. Thus, curvature has an important effect on the material properties. Moreover, by introducing negative curvature into the model for deduction of liquid–vapor surface energy, a successful prediction of the behavior of the surface energy of argon (Ar) and silicon (Si) on the surface of nanovoids is obtained, which further confirms the role of curvature. Furthermore, it is shown that the surface energy of nanovoids increases as the size of the void is reduced, suggesting a greater difference in energy between surface atoms and interior atoms, especially when the size of the void is smaller than 4 nm. This is because the surface energy gradually approaches that of the bulk when the size of the void is larger than 4 nm. Thus, the effect of size on the surface energy of voids is significant when the voids are of small dimensions.

The fourth paper, ‘Equal-channel angular extrusion of Al 5083 covered with copper shielding’⁹ has been reported by Ananda Babu Varadala (Department of Mechanical Engineering, Vignan’s Institute of Engineering for Women, Visakhapatnam, India), Swami Naidu Gurugubelli (Department of Metallurgical Engineering, Jawaharlal Nehru Technological University Kakinada – University College of Engineering Vizianagaram, Vizianagaram, India) and Sateesh Bandaru (Department of Mechanical Engineering, Vignan’s Institute of Information Technology, Visakhapatnam, India). The microstructural homogeneity, hardness and tensile strength of aluminium (Al) alloy 5083, with and without copper shielding (CS), processed by equal-channel angular extrusion (ECAE) are investigated in this work. The two opposite longitudinal faces of the rectangular billets are shielded with copper sheets of various thicknesses (1.0, 1.5, 2.0 and 2.5 mm) and ECAE’d at room temperature in route A (no rotation of billet) up to four times. The required extrusion load is drastically reduced due to the smaller coefficient of friction between the CS and channels of the steel die. The CS reduces the effect of the dead metal zone as well as the microcracks and improves strain uniformity in the extruded alloy. The hardness and tensile strength of the extruded alloy with CS are increased extensively due to the newly formed submicron-size grains in the homogeneous structure. Also, the ductility of ECAE’d alloy with CS is higher compared to that of the alloy extruded without shielding. It is noticed that the increase in the thickness of CS does not have a noteworthy effect on the structural and mechanical behavior of the extruded alloy.

‘Mechanical and microstructural properties of GGBFS–RHA geopolymer concrete’¹⁰ is the fifth paper in this issue of *Emerging Materials Research*. Seyed Mahmoud Zabihi and Hamid Reza Tavakoli from the Department of Civil Engineering, Babol Noshirvani University of Technology, Babol, Iran, are the coauthors

of this paper. Their study aims to evaluate the suitability of ground-granulated blast-furnace slag (GGBFS)- and rice husk ash (RHA)-based geopolymer concrete for construction of structural elements using large amounts of industrial and agricultural solid wastes as raw materials. Compressive and splitting tensile strength, shrinkage and rapid chloride permeability tests have been performed to investigate the properties of the geopolymers. The test results show that replacement of cement with GGBFS–RHA-based geopolymer improves the mechanical properties of concrete and 100% replacement with the geopolymer can be considered as having the best results from the environmental, structural and economic points of view. Furthermore, the curing time affects the compressive strength significantly. In addition, carbon dioxide (CO₂) emissions will be significant with the construction of the studied sustainable GGBFS–RHA-based geopolymer composites. From a microstructural point of view, the total incorporation of GGBFS–RHA-based geopolymer in composites leads to pore refinement in both the matrix and the interfacial zones and a reduction in the width of the interfacial transition zone between the paste and the aggregate, which could efficiently reduce water permeability.

Yan-Fei Chen (School of Innovation and Entrepreneurship, Guizhou Normal University, Guiyang City, People’s Republic of China), Dong-Sheng Yang (School of Materials and Architectural Engineering, Guizhou Normal University, Guiyang City, People’s Republic of China), Li-Lan Xie (School of Materials and Architectural Engineering, Guizhou Normal University, Guiyang City, People’s Republic of China), Xiao-Song Yang (School of Materials and Architectural Engineering, Guizhou Normal University, Guiyang City, People’s Republic of China), Yi-Ru Wu (School of Materials and Architectural Engineering, Guizhou Normal University, Guiyang City, People’s Republic of China) and Yan-Jia Huang (School of Materials and Architectural Engineering, Guizhou Normal University, Guiyang City, People’s Republic of China) report their studies on ‘Activity of sedimentary-fly-ash-aerated concrete’.¹¹ The key technology for the production of aerated concrete, using sedimentary fly ash to replace the new fly ash, is of enormous interest to the concrete industry. The chemical composition, mineral composition and microstructure of the sedimentary fly ash in Qian-Xi, Gui-Yang and Qing-Zhen power plants are presented. The activity of the sedimentary fly-ash-aerated concrete was tested in detail by employing grinding, mineral admixtures and chemical admixtures. The results show that the sedimentary fly ash is essentially low-calcium fly ash. The mineral composition of the sedimentary fly ash is basically the same as that of the new fly ash. The compressive strength and flexural strength of the ground fly ash specimens are larger than that of untreated fly ash. The use of mineral admixtures SH1 and SH2 for sedimentary fly-ash-aerated concrete can increase the compressive and flexural strength. The excitation effects of SIII activator, SIV activator and SV activator are better than those of other activators. The best chemical admixture is calcium oxide (CaO)–SIV activator. These studies are of significance for the use of sedimentary fly ash in aerated

concrete. This investigation provides a new way to eliminate sedimentary fly ash.

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