Editorial

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It has been fifteen years since graphene was discovered by Andre Geim and Kostya Novoselov.¹ Its global market size is expected to reach US\$552.3 million by 2025.² Graphene will continue to play a major role in various sectors of the global economy including composites/coatings, electronics and energy. Its attributes, such as high electrical conductivity, electron mobility, permeability and thermal conductivity, coupled with its excellent mechanical properties at the sub-nanometer thickness, are the prime drivers for this long-term expectation. A scalable manufacturing process of graphene for use in ultrathin membranes has been successfully demonstrated.³ Grolltex, a graphene and two-dimensional materials producer, has released production of 30 000 8 in. (203 mm) wafer equivalents per year at its chemical vapor deposition (CVD) monolayer fabrication facility.⁴

Emerging developments in materials and device manufacturing include three-dimensional (3D) printing (digital light processing, electron beam melting, fused deposition modelling, selective laser sintering and stereolithography) and atomic layer deposition/area selective deposition. The ability to tailor/scale these processes to suit the material/device requirements, along with minimizing the number of process steps, increasing yield and reducing manufacturing costs, are some of their inherent advantages.

Materials science and engineering encompasses a very wide variety of topics and applications. This issue of *Emerging Materials Research* presents results of interdisciplinary research focusing on biomaterials, composites, construction materials, metals and polymers and their applications.

The first paper by Hong-Bing Shi (School of Stomatology, Beihua University, Jilin, China), Yong-Seok Jang (Department of Dental Biomaterials and Institute of Biodegradable Materials, School of Dentistry, Chonbuk National University, Jeonju, South Korea), Thuy-Duong Thi Nguyen (Odonto-stomatology Faculty, Hue University of Medicine and Pharmacy, Hue, Vietnam), Tae-Ju Oh (Department of Periodontics and Oral Medicine, School of Dentistry, University of Michigan, Ann Arbor, MI, USA), A-Lum Han (Department of Family Medicine, College of Medicine, Wonkwang University, Iksan, South Korea), Min-Ho Lee (Department of Dental Biomaterials and Institute of Biodegradable Materials, Chonbuk National University, Jeonju,

South Korea), Seung-O Ko (Department of Oral and Maxillofacial Surgery, School of Dentistry, Chonbuk National University, Jeonju, South Korea) and Tae-Sung Bae (Department of Dental Biomaterials and Institute of Biodegradable Materials, School of Dentistry, Chonbuk National University, Jeonju, South Korea) is on 'Effect of the surface treatment and hole size of pure titanium mesh on new bone formation'.⁵ The purpose of this study is to investigate the effect of surface modification and hole size of pure titanium (Ti) mesh on the enhancement of bioactivity and new bone formation for the dental application of guided bone regeneration. Three types of titanium mesh with different hole sizes and distributions were used for surface treatments, which were anodization, silicate pretreatment, cyclic precalcification and heat treatment. Improvement of bioactivity as a result of the surface modifications and the tendency to new bone regeneration by the different designs of titanium mesh were identified through an immersion test in simulated body fluid and an in vivo test using the rat calvarial defect model, respectively. It was confirmed that the bioactivity of the titanium mesh was enhanced through the formation of multiple layers by anodization and precalcification treatments at the initial stage after implantation of the titanium mesh, and the hole size and distribution of the titanium mesh affected the new bone formation in the bone defect with implantation period differently.

The second paper focuses on 'Advanced machining of TiNiCo shape memory alloys for biomedical applications'.⁶ This paper has been reported by Soni Hargovind (Department of Mechanical Engineering, National Institute of Technology Karnataka, Mangalore, India), Sannayellappa Narendranath (Department of Mechanical Engineering, National Institute of Technology Karnataka, Mangalore, India) and Motagondanahalli Rangarasaiah Ramesh (Department of Mechanical Engineering, National Institute of Technology Karnataka, Mangalore, India). Wire electro discharge machining (WEDM) is one of the most productive non-traditional machining processes. Complex shapes can be cut using the WEDM process. In the present study, attempts have been made to study the effects of various process parameters of WEDM such as pulse on time (T_{on}), pulse off time (T_{off}), servo voltage (SV), wire speed (WS) and servo feed (SF) on the material removal rate (MRR) and surface roughness (SR) for machining of titanium–nickel–cobalt (TiNiCo) shape memory

alloys, traditionally used as bone staple material. Grey-relational-analysis-based entropy measurement methods were used for formulating a hybrid combination of optimization methods in order to investigate the input parameters of WEDM on the comprehensive performance of a bone staple material's SR and MRR. Experiments were carried out by using response surface design (L-33), and the input parameters were ranked based on the grey relational grade. An experimental run was conducted using the optimal combination of input parameters of WEDM, which was obtained from the analysis. T_{on} of 125 μ s, T_{off} of 42 μ s, SV of 40 V, SF of 2180 machine units and WS of 4 m/min were obtained as the best combination of input process parameters for TiNiCo alloy.

The third paper 'A novel approach to achieving a low Young's modulus in titanium-based metallic glasses'⁷ has been reported by Jia-Peng Luo (Southern University of Science and Technology, Shenzhen, China; Harbin Institute of Technology, Harbin, China), Xiao Jia (Southern University of Science and Technology, Shenzhen, China), Dong-Lai Zheng (Southern University of Science and Technology, Shenzhen, China; Harbin Institute of Technology, Harbin, China), Gang Wang (Shanghai University, Shanghai, China), Jian-Fei Sun (Harbin Institute of Technology, Harbin, China) and Ming Yan (Southern University of Science and Technology, Shenzhen, China). Titanium-based materials are favorable for biomedical implant applications because of their unique biocompatibility, good corrosion resistance and moderate overall mechanical properties. Furthermore, amorphous titanium-based metallic glasses can take a decent share of the market as a result of their excellent properties. Developing low-modulus titanium-based metallic glasses is of both scientific and practical interest. In this study, the authors have analyzed more than 40 different types of titanium-based metallic glasses and introduced two modified parameters that are based on a molecular orbital approach but are better in the prediction of the Young's modulus of metal implants, which should be about 30 MPa. Alloying elements are categorized and compared accordingly. Zirconium (Zr), hafnium (Hf), niobium (Nb), tantalum (Ta), tin (Sn) and molybdenum (Mo) are proposed to be effective in designing low-Young's-modulus biomedical titanium-based metallic glasses.

Allu Venkat Pradeep (Department of Mechanical Engineering, Jawaharlal Nehru Technological University, Kakinada, India; Department of Mechanical Engineering, Vignana's Institute of Engineering for Women, Visakhapatnam, India), Lingaraju Dumpala (Department of Mechanical Engineering, Jawaharlal Nehru Technological University, Kakinada, India) and Shinagam Ramakrishna (Department of Mechanical Engineering, Gayatri Vidhya Parishad College of Engineering, Visakhapatnam, India) report their studies on 'Effect of MQL on roughness, white layer and microhardness in hard turning of AISI 52100'.⁸ The influence of turning parameters on the surface integrity of the workpiece in hard turning of AISI 52100 steel, using the minimum quantity of lubrication, was investigated in this work. The cutting parameters considered were cutting speed, feed, depth of cut and tool nose

radius, at three levels each. Response surface methodology was employed to study the influence of factors on surface roughness, microhardness, topography, white layer thickness and elemental composition. From model analysis, the microhardness and surface roughness were best predicted by quadratic regression models, whereas white layer thickness was best evaluated by a linear model. The variance analysis revealed that surface roughness was significantly affected by nose radius (33.83%), followed by feed (32.5%). It was observed that the surface defects were reduced with an increase in cutting speed. Microhardness was majorly affected by feed (36.64%), followed by nose radius (32.88%). The white layer thickness ranged from 4.3 to 15.9 mm for all experiments. White layer thickness was significantly influenced by nose radius (82.24%), cutting speed (9.78%) and feed (1.23%). Energy-dispersive X-ray spectroscopy analysis of the machined workpiece at a cutting speed of 150 m/min validated that oxidation was instigated and the weight percent of carbon (C) was augmented in the base metal.

The fifth of the papers in this issue focuses on 'Pnipam-covered gold nanodots for reversible adsorption of biomolecules'.⁹ This paper is by Mai Thi Tuyet Nguyen (Department of Physical Chemistry, School of Chemical Engineering, University of Science and Technology, Hanoi, Vietnam). Thermoresponsive polymer poly (*N*-isopropylacrylamide) (Pnipam) can undergo a phase transition from a hydrophilic, water-swollen state to a hydrophobic, collapsed state when heated above its lower critical solution temperature, around 32°C in water. A temperature-induced change in the hydration of Pnipam can render its surface adhesive or non-adhesive to biomolecules. The author has thus exploited a hybrid plasmonic nanostructure including a lithographic gold nanodots array covered with Pnipam brushes for reversible adsorption of protein molecules. Microscopic and spectroscopic analysis (e.g. scanning electron microscopy, atomic force microscopy and far-field extinction microspectroscopy) have been performed on prepared hybrid nanomaterial to characterize the morphology and the optical properties. This thermoresponsive, hybrid nanostructure was demonstrated to be able to efficiently switch the adsorption/desorption of bovine serum albumin proteins by convenient temperature stimuli. This work represents an important step toward the use of thermosensitive plasmonic structures in biomedical and biological applications, such as enzyme immobilization, cell sorting, protein adsorption and purification.

'Preparation of two novel Schiff base polymers and their Eu (III)/Yb (III) complexes'¹⁰ is the sixth paper in this issue. Dingjun Zhang (Lanzhou University of Technology, Lanzhou, China), Youzhi Wu (Lanzhou University of Technology, Lanzhou, China), Caixia Huo (Lanzhou City University, Lanzhou, China), Ling He (Lanzhou University of Technology, Lanzhou, China), Wenjiang Lu (Lanzhou University of Technology, Lanzhou, China) and Zhaoxuan Feng (Lanzhou University of Technology, Lanzhou, China) are the coauthors of this paper. A series of novel Schiff base photosensitive polymers with coordination property were synthesized through a condensation reaction. Then, using the

Schiff base photosensitive polymers as macromolecular ligands, a series of polymer rare-earth complexes were prepared through a coordination reaction. The structure of the polymer and their corresponding complex was performed by means of Fourier transform infrared and ultraviolet spectroscopy; the fluorescence properties of the complex were mainly investigated by fluorescence spectroscopy, and the thermal property was investigated by differential scanning calorimetry and thermogravimetric analysis. The luminescence properties of the europium (Eu) (III)/ytterbium (Yb) (III) complex in dimethylformamide solutions were investigated. The experimental results show that the complexes have fine thermal stability and all the europium (III)/ytterbium (III) complexes exhibit characteristic photoluminescence peaks in the visible region. The results indicate that the complexes are promising in the field of light-emitting materials and can be further mixed with a suitable polymer to form functional rare-earth polymers.

Hongyan Li (School of Materials Science and Engineering, Tianjin Chengjian University, Tianjin, People's Republic of China; Tianjin Key Laboratory of Soft Soil Characteristics and Engineering Environment, Tianjin, People's Republic of China; Tianjin Building Materials Academy, Tianjin, People's Republic of China), Ruyi Li (School of Materials Science and Engineering, Tianjin Chengjian University, Tianjin, People's Republic of China), Hongli Liu (School of Materials Science and Engineering, Tianjin Chengjian University, Tianjin, People's Republic of China; Tianjin Key Laboratory of Soft Soil Characteristics and Engineering Environment, Tianjin, People's Republic of China), Dongmei Wang (Tianjin Building Materials Academy, Tianjin, People's Republic of China), Pengyu Zhang (Tianjin Building Materials Academy, Tianjin, People's Republic of China), Tong Liu (Tianjin Building Materials Academy, Tianjin, People's Republic of China) and Aiwu Yang (Tianjin Key Laboratory of Soft Soil Characteristics and Engineering Environment, Tianjin, People's Republic of China; School of Civil Engineering, Tianjin Chengjian University, Tianjin, People's Republic of China) report their studies on 'Thermal behavior of silica aerogel/PMMA composite reinforced by non-covalent interaction'.¹¹ A silica aerogel (SA)/poly(methyl methacrylate) (PMMA) hybrid composite with a non-covalent interaction phase interface was prepared by introducing γ -aminopropyltriethoxysilane and acrylamide. The effects of the non-covalent interaction phase interface on the performance of SA/PMMA hybrid composites have been investigated by performing scanning electron microscopy, energy-dispersive X-ray spectrometry, Fourier transform infrared spectrometry, nitrogen gas (N_2) adsorption-desorption, thermogravimetric analysis, gel permeation chromatography and mechanical bending strength test. The results indicated that a SA/PMMA hybrid composite with a non-covalent interaction phase interface and a nanoporous structure was obtained. The strong interface bond strength of the non-covalent interaction phase interface between SA phase and polymer phase facilitated the coupling effect for phonon transmission, which could improve the thermal stability and the thermal conductivity of the composites. The strong interface bond strength of the non-

covalent interaction phase interface also restricted the movement of the molecular chains of the polymer, which could improve the mechanical properties of the composites.

'Effect of surface roughness on sealing performance of silicone rubber'¹² is the eighth paper in this issue of *Emerging Materials Research*. Jian Wu (Center for Rubber Composite Materials and Structures, Harbin Institute of Technology at Weihai, Weihai, China), Jiye Dong (Shanghai Aerospace Equipments Manufacturer Co., Ltd, Shanghai, China), Chuncai Xu (Goertek Inc., Weifang, China) and Youshan Wang (Center for Rubber Composite Materials and Structures, Harbin Institute of Technology at Weihai, Weihai, China) are the coauthors of this paper. Silicone rubber seals are widely used in the aerospace industry and the microscopic roughness of the metal surface has a significant effect on sealing performance. In this paper, a sinusoidal profile is used to describe the microscopic topography of the metal surface. Then, a static sealing contact model is developed for analyzing the influence of surface roughness parameters R_a and R_{sm} on sealing performance. Results show that the sealing clearance, the maximum contact pressures and the maximum Mises stress increase when R_a increases. In contrast, R_{sm} has the opposite effect. With the decrease in R_a , the contact ratio in the contact interface increases. When R_{sm} increases, the contact ratio in the contact interface increases. The contact pressure and the stress concentration increase when the surface roughness increases. Thus, it is important to consider the effect of the microscopic roughness in rubber seal design.

'Composite hydrate salt $Na_2HPO_4 \cdot 12H_2O$ – $Na_2SO_4 \cdot 10H_2O$ and its thermal storage properties'¹³ by Maosheng Zheng (School of Chemical Engineering, Northwest University, Xi'an, China), Chaochao Xie (School of Chemical Engineering, Northwest University, Xi'an, China), Jia Liu (School of Chemical Engineering, Northwest University, Xi'an, China) and Hao Jin (School of Chemical Engineering, Northwest University, Xi'an, China) is the ninth paper in this issue. Phase change thermal storage materials store and release thermal energy through changes in their physical state at the phase transition temperature, which is widely used in thermal utilization applications. The main problems with inorganic phase change thermal storage materials are phase separation and supercooling phenomena. In this paper, the preparation of composite phase change material (disodium hydrogen phosphate dodecahydrate ($Na_2HPO_4 \cdot 12H_2O$)–sodium sulfate decahydrate ($Na_2SO_4 \cdot 10H_2O$)) is conducted by using the co-melting method in order to reduce the phase separation and supercooling. The evaluation of the thermal storage properties of this composite material is performed as well. The results show that the phase separation phenomenon is eliminated in the composite material with a mass ratio of 9:1 for disodium hydrogen phosphate dodecahydrate:sodium sulfate decahydrate, which has the highest crystallizing temperature of 28.2°C , excellent heat storage performance and lowest supercooling degree of about 4.8°C . The heating-cooling cyclic tests indicate that the composite material is stable for up to 200 heating-cooling

cycles. The X-ray diffraction result shows that the composite material consists of the components disodium hydrogen phosphate dodecahydrate and sodium sulfate decahydrate only.

Xiaojie Li (Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun, China) and Kai Zhao (Northeast Institute of Geography and Agroecology, Chinese Academy of Sciences, Changchun, China) report their studies on 'Rapid surface roughness testing method and instrument'.¹⁴ Surface roughness presents microsurface topographic variances and irregularities; it is an important characteristic in many experiments and model construction. A quick testing method and an instrument for surface roughness measurement were developed in this study. A laser beam was emitted onto the test subject, the reflected light was directed to the camera and the images were then captured through a linear scanning process. The 3D coordinates of the measurement area were then obtained after image processing and coordinate transformation, and multiple surface roughness levels were calculated by employing the 3D coordinates. The precision experiment and field experiment showed that the instrument has a maximum average comparative error of 2.93%, and the instrument was able to replicate the 3D structure of the test subjects precisely. A series of surface roughness parameters were calculated as the final measurements. The instrument and the controlling/post-processing software are available by contacting the authors.

Next comes 'Wear and frictional behavior of composites filled with agro-based waste materials'¹⁵ by Kishore Debnath (Department of Mechanical Engineering, National Institute of Technology Meghalaya, Shillong, India), Vikas Dhawan (College of Engineering, Chandigarh Group of Colleges, Punjab Technical University, Mohali, India), Inderdeep Singh (Department of Mechanical and Industrial Engineering, Indian Institute of Technology Roorkee, Roorkee, India) and T. S. Srivatsan (Department of Mechanical Engineering, University of Akron, Akron, OH, USA). The authors report their studies on the tribological performance of glass/epoxy filled with agro-based waste materials. Three different types of agro-based waste materials were chosen. These were (a) rice husk, (b) wheat husk and (c) coconut coir. The waste materials were randomly distributed during fabrication of the glass/epoxy composites. The intrinsic influence of sliding parameters – that is, sliding speed and applied load – on both the wear and friction behavior of the engineered composites was experimentally investigated, and an attempt was made to compare these with each other. The morphologies of both the worn test specimens and the sliding disc were examined to establish the specific mechanism governing wear. The rice-husk-filled glass/epoxy was revealed to have the maximum wear resistance among the developed composites.

Wei Gong (Department of Civil Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China), Hongfa Yu (Department of Civil Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China), Haiyan Ma

(Department of Civil Engineering, Nanjing University of Aeronautics and Astronautics, Nanjing, China), Hongxia Qiao (Key Laboratory of Disaster Prevention and Mitigation in Civil Engineering of Gansu Province, Lanzhou University of Technology, Lanzhou, China) and Guangfeng Chen (School of Earth and Space Sciences, Peking University, Beijing, China) appear next with 'Study on corrosion and anticorrosion of rebar in magnesium oxychloride cement concrete'.¹⁶ In order to solve the rapid corrosion problem associated with rebar in magnesium chloride ($MgCl_2$) cement concrete, an experiment on the corrosion and anticorrosion of rebar is designed. The corrosion and anticorrosion effects of rebar are evaluated through the corrosion current density. A time-varying model of rebar corrosion in magnesium chloride cement concrete is proposed. Based on the time-varying model for rebar corrosion, the initial cracking time with magnesium oxychloride cement reinforced concrete is calculated. The results show that the test environment has little effect on the exposed rebar corrosion. The corrosion current density of the coated rebar in a water-soaking environment is greater than that for coated rebar in an indoor natural environment. Greater concrete cover depths cause more severe rebar corrosion. All cases of exposed rebar corrosion conform to the exponential-type time-varying model, whereas coated rebar corrosion conforms to the logarithmic-type time-varying model. The corrosion degree of the magnesium oxychloride cement exposed rebar concrete is much greater than that for magnesium oxychloride cement coated rebar concrete by two orders of magnitude, showing the feasibility, long-term stability and effectiveness of using coated rebar in magnesium oxychloride cement concrete.

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