Editorial

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The Centre National de la Recherche Scientifique (CNRS) celebrates eighty years since its inception in 1939.¹ With a budget of €3.3 billion, 33 000 researchers and 1144 research laboratories in France and abroad, CNRS continues to be a global leader in the research and development related to science, engineering and technology.² In the early 1980s, I had the privilege of being affiliated with the CNRS-associated research laboratories in Montpellier³ and Paris.⁴

This year marks the fiftieth anniversary of the historic Apollo landing on the moon.⁵ In 1969, a major solution to meet the energy demands was proposed by setting up a moon-based array of solar cell panels and subsequent transmission to earth in the form of microwaves.⁶

Materials science and engineering continues to evolve to meet the growing demands on energy, environment, health and infrastructure. This issue of *Emerging Materials Research* presents results of twenty-one papers reported by scientists from across the world.

The first of the papers in this issue of *Emerging Materials Research* focuses on ‘Deep insight into electron transport and photovoltaic parameters in DSSCs’.⁷ This paper is by Khaled Hamdani (Division Couches Minces, Surfaces et Interfaces, Centre de Recherche en Technologie des Semi-conducteurs pour l’Énergétique, Algiers, Algeria; Laboratoire Microscope Electronique et Sciences des Matériaux, Université des Sciences et de la Technologie Mohamed Boudiaf, Oran, Algeria), Mohamed Adnane (Laboratoire Microscope Electronique et Sciences des Matériaux, Université des Sciences et de la Technologie Mohamed Boudiaf, Oran, Algeria), Sabrina Sam (Division Couches Minces, Surfaces et Interfaces, Centre de Recherche en Technologie des Semi-conducteurs pour l’Énergétique, Algiers, Algeria), Denis Chaumont (Nanoform Group, Laboratoire Interdisciplinaire Carnot de Bourgogne, Université de Bourgogne, Dijon, France), Samia Belhousse (Division Couches Minces, Surfaces et Interfaces, Centre de Recherche en Technologie des Semi-conducteurs pour l’Énergétique, Algiers, Algeria), Fatma-Zohra Tighilt (Division Couches Minces, Surfaces et Interfaces, Centre de Recherche en Technologie des Semi-conducteurs pour l’Énergétique, Algiers, Algeria), Kahina Lasmi (Division Couches Minces, Surfaces et Interfaces, Centre de Recherche en Technologie des Semi-conducteurs pour l’Énergétique, Algiers, Algeria) and Amal Hamrani (Division Couches Minces, Surfaces et Interfaces, Centre de

Recherche en Technologie des Semi-conducteurs pour l’Énergétique, Algiers, Algeria). Dye-sensitized solar cells (DSSCs), based on titanium (IV) oxide (TiO₂) nanoparticles and nanotubes (NTs), with different weight ratios and phase compositions were fabricated. The obtained nanostructures were investigated using X-ray powder diffraction (XRD), scanning electron microscopy (SEM), transmission electron microscopy (TEM) and ultraviolet–visible spectroscopy. Current–voltage measurements and electrochemical impedance spectroscopy were used to investigate the electron transport and photovoltaic performance of DSSCs. An increase of 14% in cell efficiency was achieved by introducing 10 wt% NTs. In this configuration, high dye loading is ensured and substantial improvement in electron transport efficiency is achieved by a more effective stack of the particles. Moreover, a 21 wt% rutile content is beneficial to the overall solar energy conversion by prompting highly efficient electron migration from the rutile conduction band to anatase trapping sites. When 20–100% NTs are incorporated in the structure, the photocurrent and thus the cell efficiency decrease progressively. The diminution of photocurrent is associated with a lesser amount of the adsorbed dye, owing to the small surface area of titanium (IV) oxide films with high NT content. The photocurrent decrease also correlates with the decrease in the electron lifetime, indicating that electron transport through titanium (IV) oxide film is becoming less efficient due to the diminution of the extent of interparticle connectivity.

The second paper by Weilin Shi (Suzhou University of Science and Technology, Suzhou, China), Miaoyuan Shi (Department of Electrical Engineering and Electronics, University of Liverpool, Liverpool, UK) and Xiyang Ma (Suzhou University of Science and Technology, Suzhou, China) is on ‘Tunable CdS/TiO₂ all-optical switches with defect layers’.⁸ The switching characteristics of one-dimensional photonic crystal (PC) all-optical switches of cadmium sulfide (CdS)/titanium dioxide with defect layers are investigated. The excited defect modes with high intensity, perfect symmetry and a very narrow band were found in the photonic bandgap range of the PC transmission spectrum when cadmium sulfide defect layers were inserted in the PC structure. They result from the high optical non-linearity of the cadmium sulfide defect layer and the strong localized effects of the incident light. These effects are attributed to the light localization in the defect layers of the multilayer structures. Additionally, the number and position of the defect modes are tuned

according to the number and separation of the defect layers. The steep response of on and off and the tuning properties of the perfect defect modes can be exploited for ultrafast all-optical switches in all-optical circuits. The results demonstrate that cadmium sulfide defective PCs are good candidates for the fabrication of ultrafast all-optical switching devices.

The third paper focuses on 'Electrospinning of poly(β -hydroxybutyrate) scaffolds: morphology and aging'.⁹ This paper has been reported by Angel Romo-Urbe (Polymer Nanocomposites Lab, Laboratorio de Nanopolimeros y Coloides, Cuernavaca, Mexico; R&D, Advanced Science & Technology, Johnson & Johnson, Jacksonville, FL, USA), Araceli Flores (Instituto de Estructura de la Materia, Consejo Superior de Investigaciones Científicas, Madrid, Spain) and Maraolina Dominguez-Diaz (Polymer Nanocomposites Lab, Laboratorio de Nanopolimeros y Coloides, Cuernavaca, Mexico). Fibrous polymeric scaffolds exhibit capabilities of biomimicry to the native tissue architecture and achieve functional tissue-engineered products with minimal surgical implantation. This research focused on the production of fibrous scaffolds of biodegradable microbial poly(β -hydroxybutyrate) (PHB) by electrospinning. Processing conditions were found to influence the morphology of the scaffolds, which, in turn, controlled the wettability and aging behavior, which are quite important for medical applications. Commercial and biosynthesized PHB from a mutant *Azotobacter vinelandii* OP strain were investigated. The morphology and wettability of the fibrous scaffolds were characterized using optical microscopy, atomic microscopy and SEM. Tuning the voltage and the solution concentration (at constant flow rate) produced either a filamentous morphology or aggregates of filaments. The wettability correlated with the degree of porosity, and predominantly a hydrophobic behavior was attained in an otherwise hydrophilic material. Aging, monitored at room temperature for up to 11 months by degree of crystallinity, showed that scaffolds with filamentous morphology exhibited an increase in crystallinity, leading to brittleness. However, scaffolds with aggregated filaments were quite stable as the degree of crystallinity remained constant over the 11 month period. Applications are envisioned for PHB biomimetic scaffolds in cell growth and bone tissue regeneration.

The fourth paper, 'Green synthesis of glycerol monostearate-modified cationic waterborne polyurethane',¹⁰ has been reported by Zakia Sultana (School of Chemistry and Chemical Engineering, Wuhan Textile University, Wuhan, China), Sakil Mahmud (Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo, China), Md. Nahid Pervez (School of Chemistry and Chemical Engineering, Wuhan Textile University, Wuhan, China), K. M. Faridul Hasan (School of Textile Science and Engineering, Wuhan Textile University, Wuhan, China) and Quan Heng (School of Chemistry and Chemical Engineering, Wuhan Textile University, Wuhan, China). In this research, a novel class of glycerol monostearate (GMS)-modified cationic waterborne polyurethane (CWPU) dispersions has been successfully synthesized by using isophorone diisocyanate as a raw material under the action of a catalyst and cosolvent. The CWPU dispersion has been

characterized by Fourier transform infrared spectroscopy, and the effects of GMS on the particle size distribution, solid content, surface tension, viscosity and stability were investigated as well. Then, a new type of transparent and high-performance film was prepared by casting the CWPU dispersion onto a glass substrate. The performance of the films was studied using SEM, dynamic light scattering, XRD, thermogravimetric analysis and measurements of mechanical properties, water contact angle and weight gained in different solvents (water, acid and alkali). The resulting CWPU films have an adequate level of transparency and sufficient folding flexibility, are thermally stable up to 550°C and exhibit high tensile stress-strain behavior. This work proposes a new route for utilizing value-added CWPU with superior properties that will help maintain balance in the sustainable chemical industry.

'Magnetoelectric hysteresis of a bilayered magnetoelectric composite'¹¹ is the fifth paper in this issue of *Emerging Materials Research*. Yun Zhou (College of Science, China Jiliang University, Hangzhou, China), Su-Su Wang (College of Science, China Jiliang University, Hangzhou, China), Tian-Xiang Gao (College of Science, China Jiliang University, Hangzhou, China), Jian-Feng Wang (College of Science, China Jiliang University, Hangzhou, China), Miao-Gen Chen (College of Science, China Jiliang University, Hangzhou, China), Zhi-Wei Jiao (College of Science, China Jiliang University, Hangzhou, China) and Liang Wu (College of Science, China Jiliang University, Hangzhou, China) are the coauthors of this paper. A bilayered magnetoelectric composite has been fabricated by bonding a magnetostrictive layer Terfenol-D and a piezoelectric layer $\text{Pb}(\text{Zr}_{0.52}\text{Ti}_{0.48})\text{O}_3$ together. The magnetoelectric hysteresis behavior of the magnetoelectric composite has been investigated. The results show that the magnetoelectric voltage coefficients of the composite are strongly affected by the bias magnetic field and test period. The magnetoelectric voltage coefficients with the bias magnetic field exhibit hysteresis over a test period, forming hysteresis loops with an anticlockwise direction sweep. The test time hysteresis, caused by a fast-varying bias magnetic field, can be reduced by prolonging the test period. The observed coercive field, remanence and ratio of the remanence of the magnetoelectric hysteresis loops with the test period obey an exponential decay law. In addition, the bias magnetic field dependence of magnetoelectric hysteresis loops is found to be associated with magnetic hysteresis loops. These findings provide some ideas not only for practical applications, but also for the magnetoelectric effect examinations in these composites.

Palash Chandra Karmaker (Department of Electrical and Electronic Engineering, University of Information Technology and Sciences, Dhaka, Bangladesh), Mohammad Obaidur Rahman (Department of Physics, Jahangirnagar University, Dhaka, Bangladesh), Nguyen Huy Dan (Institute of Materials Science, Vietnam Academy of Science and Technology, Hanoi, Vietnam), Samia Islam Liba (Materials Science Division, Atomic Energy Center, Dhaka, Bangladesh), Per Nordblad (Solid State Physics, Department of Engineering Sciences, Uppsala University, Uppsala, Sweden) and Sheikh Manjura Hoque (Materials Science Division, Atomic Energy Center, Dhaka, Bangladesh) report their studies on 'Characterization of Nd

(Tb)–Fe–B-based exchange-spring nanocomposite magnets¹². The authors attempt to optimize for performance the composition of $R_2\text{Fe}_{14}\text{B}/\text{Fe}_3\text{B}$ -based hard nanocomposite alloys with R = neodymium (Nd) and terbium (Tb) by optimizing phases in order to develop hysteresis parameters such as maximum magnetization, coercivity and maximum energy product through variation in composition and heat treatment. The samples were prepared from arc-melted ingots with different compositions. The crystallization temperatures were obtained from the differential scanning calorimeter traces of the samples with the composition $\text{Nd}_{4-x}\text{Tb}_x\text{Fe}_{71}\text{Co}_5\text{Cu}_{0.5}\text{Nb}_1\text{B}_{18.5}$ ($x = 0.0, 0.2, 0.4, 0.6, 0.8$ and 1.0). Depending on their crystallization temperatures, the samples were annealed at 600, 625, 650, 675 and 700°C for 10 min. Amorphosity and crystallization behavior were studied by XRD using copper (Cu) $K\alpha$ radiation ($1.5418 \text{ \AA}$). The Mössbauer spectra of all the samples were recorded at room temperature by using iron-57 (^{57}Fe) Mössbauer spectrometry in transmission geometry with a constant-acceleration spectrometer. Magnetic properties were determined by a vibrating-sample magnetometer in the as-cast and annealed conditions. Although the highest values of coercivity and remanent ratio were found to be 4.18 kOe and 0.72, respectively, for the sample of composition $\text{Nd}_3\text{Tb}_1\text{Fe}_{71}\text{Co}_5\text{Cu}_{0.5}\text{Nb}_1\text{B}_{18.5}$ annealed at 650°C with a higher concentration of terbium, the highest maximum energy product was determined to be 12.67 MGOe for the sample of $\text{Nd}_{3.8}\text{Tb}_{0.2}\text{Fe}_{71}\text{Co}_5\text{Cu}_{0.5}\text{Nb}_1\text{B}_{18.5}$.

‘Photocatalytic activity of hierarchical Ti–Zr–ZSM-5 catalysts from attapulgite by MRS’¹³ by Hong-Ji Li (College of Town Planning and Municipal Engineering, Xi’an Polytechnic University, Xi’an, China), Jian-Min Zhang (College of Town Planning and Municipal Engineering, Xi’an Polytechnic University, Xi’an, China), Jing Yang (College of Town Planning and Municipal Engineering, Xi’an Polytechnic University, Xi’an, China), Jing-Hua Song (College of Town Planning and Municipal Engineering, Xi’an Polytechnic University, Xi’an, China) and Chen-Hui Yu (College of Environmental and Municipal Engineering, Lanzhou Jiaotong University, Lanzhou, China) is the seventh paper in this issue of *Emerging Materials Research*. Hierarchical architectures of titanium (Ti)–zirconium (Zr)–zeolite Socony Mobil-5 (ZSM-5) nanocrystalline aggregates were synthesized in a microwave-assisted rapid system. The micro–mesoporous structure and single-site photocatalytic activity of the nanocrystals were developed by using acidized attapulgite (microwave-treated acidized attapulgite) in the precursor solution. The morphology, crystallinity, surface area and porosity of the samples were characterized by Fourier transform infrared spectroscopy, XRD, SEM, TEM and nitrogen gas (N_2) adsorption–desorption. Results demonstrate that titanium–zirconium–ZSM-5 single-site heterogeneous catalysts persist on the typical framework of mordenite framework inverted structure and present a new spherical aggregate morphology made-up of hexagonal nanocrystals. The synthesis time required is reduced from 12 h to 180 min. The hierarchical nanocrystals have a Brunauer–Emmett–Teller surface area ($349.51 \text{ m}^2/\text{g}$) similar to and a mesopore volume larger than ($0.23 \text{ cm}^3/\text{g}$) those of commercial zeolites. The tetrahedrally coordinated metal oxide (titanium and

zirconium) moieties were implanted and isolated in the silica matrices of micro–mesoporous ZSM-5, which had significant photocatalytic activity and reusability for degrading methylene blue dye in wastewater. As a micro-reactor, the nanocrystals, with single-site photocatalytic activity, are worthy of further investigation for potential applications in catalysis for dyeing and wastewater treatment.

Zhi Li (National Key Laboratory of Science and Technology on Unmanned Aerial Vehicle, Northwestern Polytechnical University, Xi’an, China; School of Aeronautics, Northwestern Polytechnical University, Xi’an, China; School of Mechanical Engineering, Shaanxi Institute of Technology, Xi’an, China), Sheng-Li Lv (National Key Laboratory of Science and Technology on Unmanned Aerial Vehicle, Northwestern Polytechnical University, Xi’an, China), Wei Zhang (National Key Laboratory of Science and Technology on Unmanned Aerial Vehicle, Northwestern Polytechnical University, Xi’an, China; School of Aeronautics, Northwestern Polytechnical University, Xi’an, China), Xiaosheng Gao (Department of Mechanical Engineering, University of Akron, Akron, OH, USA) and Tirumalai S. Srivatsan (Department of Mechanical Engineering, University of Akron, Akron, OH, USA) report their studies on ‘Influence of environment on response characteristics of a high-strength aluminum alloy’.¹⁴ This paper presents the results of a study aimed at understanding the stress corrosion cracking behavior of aluminum (Al) alloy 2219 with specific reference to understanding the mechanisms governing initiation of cracks and their progressive growth through the alloy microstructure. The influence of stress level on the initiation of stress corrosion cracks was determined. Results of this study revealed pitting to be the main type of corrosion that occurred during the early stages of exposure of the chosen aluminum alloy to an acidic environment. After the formation and presence of a pit, the applied stress was found to induce local stress concentration, promoting the early initiation of one or more microscopic cracks, while concurrently enabling fine microscopic cracks to expand and grow through the alloy microstructure. The cracks were observed to propagate along the grain boundaries, with few of the cracks growing through the crystals. With appropriate selection of electrochemical parameters, the influence of applied stress, coupled with the use of a solid mechanics module in synergism with an electrochemical corrosion module, on the stress corrosion behavior of the chosen aluminum alloy 2219 was studied using an iterative approach, and numerical prediction of corrosion was made possible.

‘Status of laser transformation hardening of steel and its alloys: a review’¹⁵ is the ninth paper in this issue of *Emerging Materials Research*. Purushothaman Dinesh Babu (School of Mechanical Engineering, Sastra Deemed University, Thanjavur, India) and Ponnusamy Marimuthu (School of Mechanical Engineering, Sastra Deemed University, Thanjavur, India) are the coauthors of this paper. The status of laser transformation hardening in surface modification of steel and its alloys is reported in this review paper. The laser hardening process involves the use of high-intensity laser radiation to rapidly heat the surface of steel into the austenitic region. Due to the high rates of heat transfer, steep temperature gradients result in rapid

cooling by conduction. This causes the transformation from an austenite to a martensite microstructure without the need for external quenching and generates a hard wear-resistant surface. The introduction of high-power lasers, such as neodymium-doped yttrium aluminum garnet (Nd:YAG), diode and fiber lasers, has made laser-assisted hardening an attractive candidate for surface-hardening processes. Recently, fiber lasers have appeared as a competitor to Nd:YAG and diode lasers for material processing. This review paper is a synopsis of the fundamentals of laser hardening, outlining some of its benefits compared with those of conventional hardening techniques and its industrial applications. A selective review of the experimental and numerical research carried out on steel in this area is also presented. Finally, it is concluded that the overall state of research on laser hardening in surface engineering of steel is well developed, and a still-growing number of industrial applications is observed.

Zhi Li (National Key Laboratory of Science and Technology on Unmanned Aerial Vehicle, Northwestern Polytechnical University, Xi'an, China; School of Aeronautics, Northwestern Polytechnical University, Xi'an, China), Shengli Lv (National Key Laboratory of Science and Technology on Unmanned Aerial Vehicle, Northwestern Polytechnical University, Xi'an, China), Xiaosheng Gao (Department of Mechanical Engineering, University of Akron, Akron, OH, USA) and Tirumalai S. Srivatsan (Department of Mechanical Engineering, University of Akron, Akron, OH, USA) report their studies on the 'Influence of surface quality on the pitting corrosion behavior of an aluminum alloy'.¹⁶ Surface quality is an important factor that exerts a profound influence on both the extent and severity of damage due to corrosion that is experienced by an aircraft structure. In this study, a quantitative method was used to determine the surface quality and the roughness of the surface was analyzed by scanning selected specimens of the chosen aluminum alloy with the aid of a scanner. Accelerated corrosion experiments on the chosen aluminum alloy, namely 2A12, were performed in the laboratory air environment to analyze the influence of surface quality on both the initiation and growth of damage due to pitting corrosion. Results of the experiments revealed that, during the early stages of corrosion, a rough surface is more susceptible to the initiation and onset of corrosion by pitting and has a higher resultant corrosion rate. The corrosion rate gradually increases with time. With increased exposure to an aggressive environment, the influence of surface quality on environment-induced degradation, or corrosion, was found to disappear.

The fifth International Conference on Computational and Experimental Science and Engineering was held in Antalya, Turkey.¹⁷ The first of the papers from this conference, 'Synthesis and mechanical properties of $(\text{Ni}_{70}\text{Si}_{30})_{100-x}\text{Fe}_x$ ($x = 0, 5, 10$) alloys',¹⁸ appears in this issue of *Emerging Materials Research*. Celal Kursun (Department of Physics, Faculty of Arts and Sciences, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Turkey) and Ahmet Muslim Aksoy (Department of Physics, Faculty of Arts and Sciences, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Turkey) report their studies on the synthesis of $(\text{Ni}_{70}\text{Si}_{30})_{100-x}\text{Fe}_x$ ($x = 0, 5, 10$) alloys by utilizing the

arc-melting technique in a vacuum/argon (Ar) atmosphere. The microstructural properties and microhardness of the nickel (Ni)–silicon (Si)–iron alloys were characterized. These alloys were investigated by XRD, optical microscopy, SEM and Vickers microhardness measurements. The XRD results showed that all the alloys have some intermetallic phases such as Ni_2Si , Fe_2Si , $\text{Ni}_{74}\text{Si}_{26}$ and Fe_3Ni . These phases were confirmed by SEM–energy-dispersive X-ray spectroscopy (EDX) analyses. From optical microscopy images, planar and dendritic growths were observed. The obtained phases affected positively the microstructures of the alloys. Thus, the microhardness values of the alloys improved and were determined to be in the range 866–1024 HV. Moreover, these microhardness values revealed that the iron content in the nickel–silicon alloy system was a very significant factor in determining the change in the microhardness of the alloys.

Serajul Haque (Mechanical Engineering Department, B.S. Abdur Rahman Crescent Institute of Science and Technology, Chennai, India) and Narayanaswamy Srirangarajulu (Madras Institute of Technology, Anna University, Chennai, India) report their studies on 'Effect of manufacturing process parameters on the wear rate of Al 6061–Cu–SiCp alloy composites'.¹⁹ In selecting the raw material for the production of machine parts, its wear resistance is considered to be a key parameter. Stir casting is a highly economical and effective technique for the manufacture of metal matrix composites. In the present research work, the tribological characteristics of an aluminum 6061 alloy composite, reinforced with varying particle sizes of silicon carbide (SiC) (45, 53 and 63 mm), were investigated using a pin-on-disk wear-testing machine. Apart from this, the influence of pouring temperature and stirring speed during stir casting is also taken into account while characterizing the composite's wear behavior. The analysis of variance test results indicate that the particle size of the silicon carbide reinforcement affects the wear rate of the composite samples. It was observed that the combined effect of stirring speed and pouring temperature significantly influences the wear rate of the test samples. Nevertheless, the combined effect of stirring speed and particle size of the ceramic reinforcement, as well as the pouring temperature and particle size of silicon carbide, has no significance as far as the wear rate is concerned. The microstructural study of the worn samples was conducted using SEM analysis.

'Roughening of film fabricated by ultrasonic microarc oxidation on Ti–13Nb–13Zr',²⁰ by Fengbiao Wang (School of Mechanical Engineering, Shenyang Ligong University, Shenyang, People's Republic of China) and Yongqing Wang (School of Mechanical Engineering, Dalian University of Technology, Dalian, People's Republic of China), is the next paper in this issue of *Emerging Materials Research*. The fracture toughness of brittle biofilms, prepared by microarc oxidation process, on Ti–13Nb–13Zr alloy needs to be improved. Ultrasonic technology was successfully incorporated into the process. The indentation test and its analysis method were adopted to measure the fracture toughness of the films. The properties of the film such as surface morphology and phase composition were compared with those of a film prepared without using the ultrasonic technology, the toughening factors

were analyzed and a calculation model of fracture mechanics was established. The results show that the films prepared by composite process has higher fracture toughness than the single-process film with a different film porosity, and the toughness of the former can reach $2.65 \text{ MPa m}^{1/2}$ for higher duty cycles. Parts of titanium dioxide phase transformation toughening, reduction in the main-crack stress concentration by microcracks and the densification of the microstructure caused by ultrasonic cavitation effect are the main reasons for improvement in fracture toughness. Similar results of measurement and calculations show the validity of the model. The composite process can achieve the purpose of toughening titanium alloy biofilms.

'Modeling and optimization of TAM in turning of Inconel 718 superalloy using RSM and PSO',²¹ by Venkatesh Ganta (Department of Mechanical Engineering, Rajeev Gandhi Memorial College of Engineering and Technology, Nandyal, India) and Chakradhar Dupadu (Department of Mechanical Engineering, Indian Institute of Technology Palakkad, Palakkad, India), presents optimization and modeling studies of thermally assisted machining (TAM) process parameters for machining Inconel 718 superalloy with a titanium aluminum nitride (TiAlN) nano-multilayer carbide insert by using response surface methodology and particle swarm optimization (PSO) technique. Machining parameters such as cutting speed, feed rate, depth of cut and workpiece temperature were considered as control factors. Experiments were conducted based on central composite rotatable design and the output responses were cutting force, surface roughness, tool wear and metal removal. From the experimental results, it was found that the cutting speed and workpiece temperature were the most influencing factors of cutting force, surface roughness and metal removal rate. The relation between control factors and output responses is developed by the multiple regression approach, and good agreement is found between them. Henceforth, PSO has the ability to yield appropriate machining parameters while turning Inconel 718 superalloy under TAM conditions.

Shaofei Jiang (College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou, China), Hangchao Zhou (College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou, China) and Jiquan Li (College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou, China) report their studies on 'Heating properties of ERHCM molds based on heating cell units'.²² A thermal analysis method was developed based on heating cell units to study the thermal response of electrical rapid heat cycle molding (ERHCM) molds. Heating efficiency, mold strength and uniformity of temperature distribution on the mold cavity surface were studied as a function of the distance from the center of heating rods to the mold cavity surface, which is one of the most important parameters for mold design. In this paper, the height/diameter value was employed to describe the distance from the center of the heating rods to the mold cavity surface. Additionally, the maximum von Mises stress, after heating, was determined to describe the mold strength, and the temperature difference was applied to characterize the temperature distribution uniformity of

the cavity surface. The results showed that electrical rapid heat cycle injection molds obtain reasonable heating efficiency, mold strength and cavity surface temperature uniformity when the distance from the center of heating rods to the mold cavity surface is approximately 1–1.5 times their diameter.

The next paper in this issue of *Emerging Materials Research* is 'A quantitative evaluation of the appearance quality of weld lines in RHCM parts'.²³ This paper is by Jiquan Li (College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou, China), Taidong Li (College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou, China), Fuyu Xu (College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou, China) and Shaofei Jiang (College of Mechanical Engineering, Zhejiang University of Technology, Hangzhou, China). The appearance quality of plastic parts in weld lines can be improved significantly through the rapid heat cycle molding (RHCM) process. However, there is no evaluation method for measuring the appearance quality of weld lines to determine whether they are in a good or bad condition. In this study, RHCM parts were molded with electric heating and the total color difference (dE) of the Commission Internationale de l'Eclairage (CIE) Lab system was employed as the quantitative evaluation method for the appearance quality of weld line. The dE of weld lines under different heating temperature conditions was analyzed. The results indicate that the mold heating temperature significantly influences the appearance quality of weld lines and the CIE Lab system accurately assesses the appearance quality of weld lines. Moreover, the experimental results further demonstrate that the lightness difference has a significant influence on the dE of weld lines in plastic parts, whereas the color differences have only a slight influence.

The next paper, 'Dynamic shear rheology of nanocomposite propellant suspension',²⁴ is reported by Rohit Lade (Advanced Separation and Analytical Laboratory, Department of Chemical Engineering, Visvesvaraya National Institute of Technology, Nagpur, India), Kailas Wasewar (Advanced Separation and Analytical Laboratory, Department of Chemical Engineering, Visvesvaraya National Institute of Technology, Nagpur, India), Rekha Sangtani (Solid Rocket Propellants Division, High Energy Materials Research Laboratory, Pune, India), Arvind Kumar (Solid Rocket Propellants Division, High Energy Materials Research Laboratory, Pune, India), Diwakar Shende (Advanced Separation and Analytical Laboratory, Department of Chemical Engineering, Visvesvaraya National Institute of Technology, Nagpur, India) and Dilip Peshwe (Department of Metallurgical and Materials Engineering, Visvesvaraya National Institute of Technology, Nagpur, India). Composite propellants are highly filled polymer suspensions containing 84–90% solids, which makes the rheological behavior very complicated. The present study deals with the viscoelastic behavior of a composite suspension consisting of 11–17% aluminum, 0–6% aluminum nanoparticles, 67% ammonium perchlorate and 16% hydroxyl-terminated polybutadiene by performing experiments under oscillatory shear. In addition, the Cox–Merz rule was applied to the experimental data. The suspension has prominently exhibited a viscous behavior and

could be graded as a weakly structured material where sedimentation may occur. The suspension containing 2% nanoparticles featured a substantially weak structure, a short linear viscoelastic region and a low critical stress. Both complex moduli show a consistent increase in the range 10–1000 strain value. The $\tan \delta$ value obtained was <5 , which indicates viscous suspension in nature. The suspension with 2% nanoparticles observed the maximum change in $\tan \delta$ for the analyzed range of frequencies. The composite propellant suspension did not obey the Cox–Merz rule.

Ceren Ince (Civil Engineering Department, Center for Sustainability, Middle East Technical University Northern Cyprus Campus, Guzelyurt, North Cyprus) reports a study on ‘Effectiveness of treatment methods on polypropylene fibres incorporated in cement mortars’.²⁵ Fiber reinforcements are often used in cementitious materials to provide enhanced strength. However, the surface smoothness and inert chemical nature of polypropylene fibers result in an insufficient fiber–matrix bonding interface and hence lead to poor mechanical properties of these materials. Two distinct treatment methods – namely porofication method and sulfuric acid–dichromate treatment method – are adopted to assess the effectiveness of these techniques on fiber–matrix interface properties. The paper begins with an investigation on the effectiveness of these methods on polypropylene fibers. The wetting characteristics of these fibers are determined using the water absorption test, contact angle measurements and SEM analysis. The study then focuses on the mechanical properties and durability of cement mortars incorporating treated polypropylene fibers. The void ratio, flexural and compressive strengths and split tensile strength are studied, and microstructural analyses are also carried out to support these measurements. The resistance to impact, freeze and thaw and carbonation of cement mortars incorporating treated polypropylene fibers is investigated. The treatment methods, adopted in this study, lead to improvement in the interface between the hydrated cement product and fibers and also significantly enhance the mechanical properties and durability of these mortars incorporating polypropylene fibers.

The paper ‘Mechanical and microstructural properties of metakaolin geopolymer’²⁶ is reported by A. R. R. Kalaiyarrasi (Department of Civil Engineering, St Peter’s Institute of Higher Education and Research, Chennai, India) and P. Partheeban (Department of Civil Engineering, St Peter’s College of Engineering and Technology, Chennai, India). Fly ash (FA) is a commonly used aluminosilicate raw material for the synthesis of geopolymers. Metakaolin (MK) is also an aluminosilicate-rich material that is relatively pure and has a huge potential as a geopolymer precursor. In this research, FA is replaced with MK in 0, 25, 50 and 75% by mass (MK0, MK25, MK50 and MK75, respectively). The silicon/aluminum ratio of the MK precursor is significant in strength development. For a silicon/aluminum ratio of 0.86 (M1), the compressive strength of geopolymer concrete decreased by 57% for MK75 at 120 d. For a silicon/aluminum ratio of 1.11 (M2) of the MK75 mix, the compressive strength is almost the same as that of MK0 at 120 d, and for a silicon/aluminum ratio of 1.21 (M3), the compressive strength increases by 16% for MK75 at 120 d. Nevertheless, the

volume of permeable voids (VPV) is reduced to 0.638 for MK75 (M3) compared to 18.58 for MK0. SEM images of hardened MK-modified geopolymer concrete support the result showing reduced VPV compared to that FA-geopolymer concrete. EDX analysis of the hardened MK50 mix of M3 geopolymer concrete confirms the presence of Si–O–Si bonds, resulting in higher strength.

Benan Shu (State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan, People’s Republic of China), Shaopeng Wu (State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan, People’s Republic of China), Chao Li (State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan, People’s Republic of China), Yongshuang Long (State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan, People’s Republic of China) and Quantao Liu (State Key Laboratory of Silicate Materials for Architectures, Wuhan University of Technology, Wuhan, People’s Republic of China) report their studies on ‘Inhibition effect and mechanism of mesoporous silica hollow nanospheres on asphalt VOCs’.²⁷ In this study, mesoporous silica hollow nanospheres (MSHSs) with continuously distributed pore diameters were synthesized through the hydrothermal method. Then, the effect of MSHSs on the inhibition of asphalt volatile organic compounds (VOCs) was studied by using pyrolysis–gas chromatography/mass spectrometry (GC–MS). In addition, SEM, TEM, Fourier transform infrared spectroscopy and the Brunauer–Emmett–Teller method were conducted to analyze the inhibition mechanism. GC–MS results showed that the addition of MSHSs could significantly reduce the emission of asphalt VOCs. Temperature influenced the emission amount of asphalt VOCs. The adsorption efficiencies of MSHSs for alkanes, hydrocarbon derivatives and polycyclic aromatic hydrocarbons were different. The inhibition mechanism indicated that the reduction of emissions of asphalt VOCs is a result of physical adsorption, rarefied concentration adsorption and chemical adsorption caused by MSHSs.

‘Application of coal-powder borehole-sealing material in borehole-sealing engineering’²⁸ is reported by Hui Li (School of Safety Science and Engineering, Henan Polytechnic University, Jiaozuo, People’s Republic of China; State Key Laboratory Cultivation Base for Gas Geology and Gas Control, Henan Polytechnic University, Jiaozuo, People’s Republic of China; Collaborative Innovation Center of Coal-bed Methane and Shale Gas for Central Plains Economic Region, Jiaozuo, People’s Republic of China), Shaoshuai Guo (School of Safety Science and Engineering, Henan Polytechnic University, Jiaozuo, People’s Republic of China), Haidong Chen (School of Safety Science and Engineering, Henan Polytechnic University, Jiaozuo, People’s Republic of China; State Key Laboratory Cultivation Base for Gas Geology and Gas Control, Henan Polytechnic University, Jiaozuo, People’s Republic of China; Collaborative Innovation Center of Coal-bed Methane and Shale Gas for Central Plains Economic Region, Jiaozuo, People’s Republic of China). In order to perform the scientific analysis of the material of the coal-powder borehole-sealing technology and verify its actual

sealing performance, the authors performed studies involving laboratory experiments and field tests. The results of this research are as follows.

- (a) the borehole-sealing material has good micro-expansion properties. With increase in additive proportion, the expansion and strength of the sealing material increase. In addition, properties such as thermal expansion are also affected by the water/material ratio of the slurry. The smaller the water/material ratio, the greater is the degree of deformation.
- (b) Considering the expansion properties of coal-powder borehole-sealing material, strength characteristics and application cost determine the optimum composition ratio of the coal-powder borehole-sealing material; the volume of coal powder accounts for 70% and the additive volume accounts for 30%. In this condition, the expansion rate and maximum compressive strength of the sealing material are 6% and 7·30 MPa, respectively.
- (c) The gas concentration extracted out of the borehole, sealed by using the coal-powder sealant, is slightly higher than that for the borehole sealed by using expansive cement (72·50 and 69·65%, respectively).

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