Editorial

Nuggehalli M. Ravindra PhD

New Jersey Institute of Technology, Newark, NJ, USA

The anomalous physical and thermodynamic properties of water persist in exciting scientists^{1–3} from across the world. In the energy sector, physicists report a ‘large, non-saturating thermopower in a quantizing magnetic field’.⁴ Flexible solar cells are back in the news.^{5,6} A magnetic field-assisted milli-scale robotic assembly machine has been demonstrated as an approach to parallel robotic automation systems.⁷ Materials will continue to play a major role in energy, healthcare, infrastructure and manufacturing. The second issue of *Emerging Materials Research* for 2018 contains ten peer-reviewed papers representing these critical areas of the global economy.

The first of the papers focuses on ‘Determination of flow stress of magnesium alloy sheet AZ31B by reverse analysis method’.⁸ This paper is by Xinwu Ma (Key Laboratory for Liquid–Solid Structural Evolution and Processing of Materials (Ministry of Education), Shandong University, Jinan, China), Wang Fang (College of Mechanical and Electronic Engineering, Shandong Jianzhu University, Jinan, China) and Wenjian Zang (Key Laboratory for Liquid–Solid Structural Evolution and Processing of Materials (Ministry of Education), Shandong University, Jinan, China). In this paper, the reverse analysis method is presented to determine the flow stress of magnesium alloy sheet AZ31B based on limiting dome height tests. The determination of flow stress is treated as an optimization problem by the reverse analysis technique. The unknown coefficients in the flow stress equation are regarded as design variables, and the difference between experimental loads and corresponding predictions by the finite-element method is calculated as an objective function. The response surface method is used to solve this optimization problem, and the flow stress of the material is determined by optimal values of design variables. The flow stress of an AZ31B sheet is determined at 250°C by reverse analysis. The limiting dome height tests for AZ31B sheet are carried out and sampling points are chosen from load against stroke curve. The finite-element analysis model for sheet forming is set up in accordance with the test condition. The numerical simulations are performed with sample values of design variables and objective functions are calculated. The response surface equation is formulated by the regression analysis and the optimal values of design variables are obtained by minimizing the equation.

The second paper by Y.M. Zhang, Y.Y. Qiao, K.X. Song and S.D. Yang of the School of Materials Science and Engineering, Henan

University of Science and Technology, Luoyang, China and Henan Key Laboratory of Advanced Non-ferrous Metals, Luoyang, China, is on ‘Effect of composition design (Cu, Ti and Mg) and optimization on deformed Zn–Cu–Ti alloy’.⁹ The influence of various ratios of copper (Cu), titanium (Ti) and magnesium (Mg) elements on the properties of the deformed zinc (Zn)–copper–titanium alloy has been investigated by the orthogonal design experiment in this work. The results show that copper has a significant impact on the microhardness of the alloy, while titanium has an effect on the elongation, and both copper and titanium have equal influence on the tensile strength. Within the range of experiments, 2.0, 0.05 and 0.001% are the most optimal concentrations of copper, titanium and magnesium, respectively, which makes the alloy have high tensile strength, microhardness and elongation. The optimum ratio of the alloy was Zn–2.0 Cu–0.05 Ti–0.001 Mg, which was verified; the microhardness of the alloy attained a value of 88 HV, the tensile strength reached 255 MPa and the elongation was 63% after extrusion.

The third paper focuses on ‘Study of protective coatings and their optimization using a plasma spray technique’.¹⁰ This paper has been reported by Ming-San Xu and Ming-Der Jean of the School of Mechanical and Automotive Engineering, Fujian University of Technology, Fuzhou, China. This study reports the use of second-order function on the basis of Taguchi method for plasma-based spray processes to enhance the surface wear resistance of zirconia ceramic coatings. The L18 orthogonal array with eight control factors is used, and the antiwear properties of the deposits are implemented. Small granules are distributed evenly and closely in the fully melted coatings, while surface features show porous structures, cavities, macropores and unmelted zirconium dioxide particles in the partially melted coatings. A dense texture in the coatings is found, which provides good wear resistance, and the polynomial model for the surface wear-resistant properties is constructed. The results of the present study show that the proposed quadratic model, based on orthogonal array design, can obtain the conditions for process optimization and predict wear volume losses to yield the desired results. These results provide useful information for the control of wear volume losses for plasma-sprayed coatings and ensure good wear-resistant properties.

The fourth paper ‘Preparation of SiCp/Al–Si composites’¹¹ has been reported by Wang Aiqin (School of Materials Science and

Engineering, Henan University of Science and Technology, Luoyang, China; Non-ferrous Metal Generic Technology Collaborative Innovation Center of Henan Province, Luoyang, China), Tian Hanwei (School of Materials Science and Engineering, Henan University of Science and Technology, Luoyang, China) and Xie Jingpei (School of Materials Science and Engineering, Henan University of Science and Technology, Luoyang, China; Non-ferrous Metal Generic Technology Collaborative Innovation, Center of Henan Province, Luoyang, China). In this study, billets of silicon carbide particle (SiCp)/aluminum (Al)–silicon (Si) composites were prepared by the one-way press method. The cold billets were sintered in nitrogen atmosphere and hot extruded. The effect of different holding pressures and holding times and the duration of different applied pressure on cold-press billet were studied. Moreover, the influence of the different extrusion ratios and extrusion speeds on the composite bars was studied. The microstructure and tensile strength of materials were affected by the heat treatment temperature. The composites were characterized by scanning electron microscopy and tensile stress measurements. Results show that the cold-press billet is most intact when it is pressed at 500 MPa for 30 min and incubated for 30 min. In the process of hot extrusion, the surface of composite bar is smoothest when the extrusion temperature, ratio and speed are, respectively, 480°C, 15:1 and 1 mm/s. Compared with cold-press billet, the density of the composite is increased significantly from 78.84 to 98.86% after hot extrusion. As solid solute at 500°C for 4 h and then aging at 190°C for 6 h, the tensile strength of the composite is best, reaching up to 280.42 MPa.

‘Conductivity modification of gum acacia-based gel electrolytes’¹² is the fifth paper in this issue of *Emerging Materials Research*. Narinder Arora (Post Graduate Department of Physics, DAV College, Amritsar, India), Viney Sharma (Department of Physics, Panjab University, Chandigarh, India), Rajesh Kumar (Post Graduate Department of Physics, DAV College, Amritsar, India) and Rajiv Kumar (Department of Physics, Goswami Ganesh Dutt Sanatan Dharam College (GGDSD), Haryana, India) are the authors of this paper. Gum acacia (GA) is a natural gum with a high molecular weight; it is a polysaccharide material that is acidic in nature and the least viscous among hydrocolloids. The ion-conducting behavior of water-dissolvable GA-based gel electrolytes has been studied with salt (ammonium chloride (NH₄Cl)) concentration, GA content and temperature enhancement. The conductivity of GA-based gel electrolytes without salt has been found to increase with the increase in GA content at low concentrations and reaches a maximum value of 4.99×10^{-3} S/cm at 40 wt.% of GA and then shows a small decrease at higher concentrations of GA. GA-based gel electrolytes show ionic conductivity decrements and indicate negative activation energy with increase in temperature, which contradicts the theoretical explanation – that is, $\sigma = \sigma_0 \exp(-E_a/K_bT)$. An ionic conductivity on the order of 10^{-1} S/cm has been observed for varying weight percentages of GA-based gel electrolytes containing 5M ammonium chloride and does not

show much change with temperature enhancement from 10 to 70°C, which makes it suitable for their use in fuel cells and other device applications.

Sunil K. Saxena (Department of Chemistry, Sharda University, Greater Noida, India; Research and Development Centre, JK Lakshmi Cement Ltd, Jhajjar, Haryana, India), Mukesh Kumar (Research and Development Centre, JK Lakshmi Cement Ltd, Jhajjar, Haryana, India) and Nakshatra B. Singh (Department of Chemistry, Sharda University, Greater Noida, India) report their studies on ‘Electrical conductivity and dielectric constant of geopolymer cement mortar’.¹³ In the last few decades, increasing efforts have been made towards the utilization of fly ash, especially in an efficient and green fashion. The geopolymer technology provides a green solution to the utilization of fly ash, avoiding its negative impact on the environment and ecology. Geopolymer cement was made by activating pond fly ash with 14M sodium hydroxide (NaOH) and sodium silicate solutions. Natural sand was used to make the mortar. Alccofine powder, a substitute of silica fume, was also added during the geopolymerization process. Curing was done at 80°C for 12 h. It is reported that the geopolymer exhibits high electrical conductivity at room temperature. This can play an important role in fast ionic conduction in solid-state batteries and other solid-state electrochemical devices. In this paper, electrical conductivity and dielectric constant, compressive strength and scanning electron microscopy studies were performed to characterize the geopolymer. The energy of activation for conduction was found to increase with frequency.

‘Thermal and mechanical coupling effects on permeability of weakly cemented sandstone’¹⁴ is the seventh paper in this issue. Shuang You, Hongguang Ji, Tao Wang and Zhaoyang Song of the School of Civil and Resource Engineering, University of Science and Technology Beijing, Beijing, China, are the authors of this paper. The weakly cemented sandstone is the host rock in the Cretaceous and Jurassic strata with low intensity, high water-bearing capacity and sensitivity to disturbance. In order to investigate the influence of temperature and confining pressure on the permeability of weakly cemented sandstone, scanning electron microscopy was used to characterize the microstructure of the particles; a series of triaxial creep tests were performed on coarse, medium and fine sandstone separately, and the effect of particle size on the permeability of sandstone was also analyzed. The results indicate that the increase of confining pressure led to the plastic deformation between the rock particles, that permeability was irreversible as the confining pressure changed, and the permeability reduction rate of coarse sandstone was lower than that of fine sandstone. The sensitivity of weakly cemented sandstone to temperature and confining pressure increased as the sizes of the particles decreased, and the effect on permeability was more obvious.

‘Minor defect correlation with dynamic elastic properties of polypropylene fiber-reinforced concrete’¹⁵ by Rishi Gupta, Adham El-Newihy and Mandeep Shah of the University of Victoria, Victoria, BC, Canada, is the eighth paper in this issue of

Emerging Materials Research. The efficient rehabilitation of aging civil infrastructure requires innovative and emerging materials along with the proper implementation of structural health monitoring (SHM). Prior to identifying a strategic SHM technique, the understanding of defects in structures is vital. Common defects in concrete include consolidation problems and the development of microcracks during consolidation or stress induction. Monitoring the dynamic characteristics of concrete can play an essential role in detecting real-time and early stages of deterioration. Much research is focused on detecting large defects; however, not much information is available on the detection of minor defects in composites such as fiber-reinforced concrete. This study focuses on testing and monitoring of the dynamic elastic behavior of concrete using a non-destructive resonant frequency approach. The change in dynamic elastic properties of normal concrete under flexural and compression loading is analyzed. Moreover, an initial attempt to monitor the change in the elastic behavior, when polypropylene fibers are added as reinforcement, is also investigated. Experimental results show a decrease in the dynamic modulus of elasticity when minor defects are present and when polypropylene fibers are added to plain concrete mixture.

The ninth paper ‘Consequences of dewatering cement mortars incorporated with ground Bayburt stone’¹⁶ is by Ceren Ince and Shahram Derogar of the Department of Civil Engineering, Faculty of Engineering, European University of Lefke, Lefke, Northern Cyprus, Mersin, Turkey. The detrimental effects of the rapid dewatering of cement mortars due to the interaction of wet mortar and brick substrate at the freshly mixed state in masonry construction are often addressed in the literature. The desorptivity and hence very high water-releasing ability of cement mortars result in a great water loss during dewatering, which significantly affects the fresh and hardened state properties of the end product. This paper, therefore, investigates the possible role of ground Bayburt stone incorporation in cement mortars on dewatering characteristics and the consequences of this effect at the hardened state properties of these mortars in construction practice. The paper begins with the measurement of the parameters of water transport kinetics and individually reports the effect of dewatering on the mechanical properties and durability characteristic of cement mortars incorporated with ground Bayburt stones. The results reported in this paper strongly suggest that ground Bayburt stone incorporation in cement mortars significantly compensate the degree of dewatering, and this vital feature not only decreases the influence of dewatering on mechanical properties but also results in enhanced durability characteristics of cement mortars.

‘A CFD simulation of CLSM filling with piping on Herschel–Bulkley rheological model’¹⁷ by Xuesong Zhang, Rangang Yu and Jinping Chen of the College of Pipeline and Civil Engineering, China University of Petroleum, Qingdao, China, is the last paper in this issue of *Emerging Materials Research*. In order to study and predict the flowing behavior of controlled low-strength material (CLSM) slurry filling with piping

transportation, a three-dimensional computational fluid dynamics simulation is carried out based on the Herschel–Bulkley (H–B) rheological model. The simulation is validated by L-pipe flow experiments of CLSM on the flow time and flow pattern. The analysis results show that it is reliable to use the H–B model to simulate the flow of the CLSM slurry. On this basis, simulations are performed to predict the dynamic characteristics of CLSM slurry filling with piping transportation and analyze the velocity distribution and pressure variation in pipeline. The simulation results are consistent with the basic law of power flow, which demonstrates the rationality and effectiveness of the method. The study on the filling characteristics of CLSM slurry pipeline lays a theoretical foundation for the realization of low-cost, safe and efficient filling of abandoned pipelines.

The Editor is thankful to the authors, readers, reviewers and the members of the Editorial Board for their contribution, participation and support.

REFERENCES

1. Sanderson K (2018) H₂O! Water is actually two liquids disguised as one. *New Scientist*, 30 May: pp. 26–29.
2. Woutersen S, Ensing B, Hilbers M, Zhao Z and Angell CA (2018) A liquid–liquid transition in supercooled aqueous solution related to the HDA-LDA transition. *Science* **359**: 1127–1131.
3. Lamsal C, Mishra DR and Ravindra NM (2014) Equilibrium configuration of (H₂O)_n, for n = 1–3. *Nanomaterials and Energy* **3**(4): 129–138, <https://doi.org/10.1680/nme.14.00005>.
4. Skinner B and Fu L (2018) Large, nonsaturating thermopower in a quantizing magnetic field. *Science Advances* **4**(5): eaat2621, <https://doi.org/10.1126/sciadv.aat2621>.
5. Wires Authors (2018) Mass-production of flexible solar cells: challenges in durability and environmental impact. *Wiley Advanced Science News*, 3 June.
6. Miettunen K, Vapaavuori J, Poskela A, Tiitonen A and Lund PD (2018) Recent progress in flexible dye solar cells. *Wiley Interdisciplinary Reviews: Energy and Environment*, <https://doi.org/10.1002/wene.302>.
7. Liu Y and Ravindra NM (2018) A magnetic-field-assisted milli-scale robotic assembly machine: an approach to parallel robotic automation systems. *Micromachines* **9**(4): 144, <https://doi.org/10.3390/mi9040144>.
8. Ma X, Fang W and Zang W (2018) Determination of flow stress of magnesium alloy sheet AZ31B by reverse analysis method. *Emerging Materials Research* **7**(2): 62–67, <https://doi.org/10.1680/jemmr.16.00081>.
9. Zhang YM, Qiao YY, Song KX and Yang SD (2018) Effect of composition design (Cu, Ti and Mg) and optimization on deformed Zn–Cu–Ti alloy. *Emerging Materials Research* **7**(2): 68–72, <https://doi.org/10.1680/jemmr.16.00108>.
10. Xu MS and Jean MD (2018) Study of protective coatings and their optimization using a plasma spray technique. *Emerging Materials Research* **7**(2): 73–81, <https://doi.org/10.1680/jemmr.16.00105>.
11. Aiqin W, Hanwei T and Jingpei X (2018) Preparation of SiCp/Al–Si composites. *Emerging Materials Research* **7**(2): 82–88, <https://doi.org/10.1680/jemmr.16.00047>.
12. Arora N, Sharma V, Kumar R and Kumar R (2018) Conductivity modification of gum acacia-based gel electrolytes. *Emerging Materials Research* **7**(2): 89–94, <https://doi.org/10.1680/jemmr.17.00011>.
13. Saxena SK, Kumar M and Singh NB (2018) Electrical conductivity and dielectric constant of geopolymer cement mortar. *Emerging Materials Research* **7**(2): 95–99, <https://doi.org/10.1680/jemmr.17.00038>.

-
14. You S, Ji H, Wang T and Song Z (2018) Thermal and mechanical coupling effects on permeability of weakly cemented sandstone. *Emerging Materials Research* **7(2)**: 100–108, <https://doi.org/10.1680/jemmr.16.00082>.
 15. Gupta R, El-Newihy A and Shah M (2018) Minor defect correlation with dynamic elastic properties of polypropylene fiber-reinforced concrete. *Emerging Materials Research* **7(2)**: 109–117, <https://doi.org/10.1680/jemmr.15.00068>.
 16. Ince C and Derogar S (2018) Consequences of dewatering cement mortars incorporated with ground Bayburt stone. *Emerging Materials Research* **7(2)**: 118–127, <https://doi.org/10.1680/jemmr.17.00007>.
 17. Zhang X, Yu R and Chen J (2018) A CFD simulation of CLSM filling with piping on Herschel–Bulkley rheological model. *Emerging Materials Research* **7(2)**: 128–137, <https://doi.org/10.1680/jemmr.17.00065>.