Editorial

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With the rapid technological advancements in the 21st century, industries relating to materials science and engineering will continue to play a significant role in various sectors of the global economy. These sectors include the following: aeronautics, space and transportation, civil, construction and infrastructure engineering, communications, electronics, energy, environment and sustainability, and health care. While many of the applications of two-dimensional materials are in their infancy, material properties such as self-assembly, self-repair and self-healing are still to be explored. Applications will continue to drive technology and materials will enable technology and the resulting products. Manufacturing methods and practices will continue to address climate control and energy savings in addition to return on investment, reliability and yield. Scaling down at the materials, device and structure level, while addressing low-power needs, high-frequency response and optimal thermal management, will continue to be the drivers in device/systems integration, electronics, photonics and telecommunications.

The first issue of *Emerging Materials Research* for 2018 contains eight peer-reviewed papers representing various inter-disciplinary subjects in materials science and engineering.

The first of the papers focuses on ‘Modeling on magnetoelectric effect of functional piezoelectric dielectric’.¹ This paper is by Jia-Wei Zhang (Northeast Electric Power University, Jilin City, China; Key Laboratory of Engineering Dielectric and Its Application of Ministry of Education, Harbin University of Science and Technology, Harbin, China; Key Laboratory of Silicon Device Technology, Chinese Academy of Sciences, Beijing, China), Hong-Yan Guo (Northeast Electric Power University, Jilin City, China), Wei-Xing Geng (State Grid Ningxia Electric Power Corporation, Maintenance Company, Ningxia, China), Chun-Ling Liu (State Grid Ningxia Electric Power Corporation, Maintenance Company, Ningxia, China) and Rui-Tong Liu (State Grid Liaoning Province Power Company Limited, Power Research Institute, Shenyang, China). In the context of wireless magnetoelectric devices based on functional dielectrics, this paper focuses on investigating the magnetoelectric response of a magnetic actuator by comparing the results of simulation with those of experiments. Multiphysics modeling of the magnetic actuator – composed of a piezoelectric bender

coated with silver electrodes, a lock-in amplifier and magnetic poles – is carried out using the finite-element method and Multiphysics modules. Due to the direct coupling of the piezoelectric layer and the Lorentz force induced by eddy currents in the silver electrodes, a magnetoelectric voltage was generated on the suspended piezoelectric bender. The good agreement between the experimental data and the simulation results demonstrates the coupling between eddy-current-induced Lorentz forces in the silver electrodes and the piezoelectric layer. The proposed prototype is based on the magnetoelectric functional dielectric without the magnetic phase and also without applying a power source, so that it could be low cost, have linear feedback and be practical. These features make it a candidate prototype for a new type of magnetoelectric actuators and sensors.

The second paper by R. Arul Jothi, R. U. Mullai, E. Vinoth, T. Suresh, S. Gopinath and S. Vetrivel of the Research Department of Physics, Government Arts College, Tiruvannamalai, India, is on ‘Growth and characterization of succinic acid-mixed KHP crystal for NLO applications’.² In this study, semi-organic single crystals of succinic acid-mixed potassium hydrogen phthalate (KHPSA) are grown from an aqueous solution by the slow evaporation method at room temperature. The structural properties of the grown crystals have been studied by single-crystal X-ray diffraction, powder X-ray diffraction and Fourier transform infrared spectral analysis. Ultraviolet (UV)–visible spectral analysis shows that the mixed crystal has a lower UV cutoff wavelength of 226 nm combined with good transparency of about 55% in a very wide range. The second harmonic generation efficiency test has been carried out and the results are discussed. Thermogravimetric–differential thermal analyses are carried out to characterize the melting behavior and thermal stability of the mixed crystal. The hardness profile of the sample is investigated by using the Vickers microhardness test. The electrical properties have been studied by carrying out dielectric constant studies. Determination of the microstructure and composition of the KHPSA crystal has been carried out by scanning electron microscopy with energy-dispersive spectroscopy.

The third paper focuses on ‘Application of TTSP to non-linear deformation in composite propellant’.³ This paper has been reported by Jinsheng Xu, Hongli Wang, Xiaohong Yang, Long

Han and Changsheng Zhou of the School of Mechanical Engineering, Nanjing University of Science and Technology, Nanjing, China. A series of constant-rate tensile tests and relaxation tests were conducted to assess the mechanical properties of the hydroxy-terminated polybutadiene (HTPB) propellant. The relaxation modulus master curve was acquired using relaxation tests at the linear viscoelastic segment, and stress-reduced time master curves at different strain levels were established to determine whether the time-temperature superposition principle (TTSP) could be used to assess the non-linear mechanical property of the HTPB propellant. Results showed that the mechanical properties of HTPB propellant strongly depend on temperature; the extent of this dependence is enhanced with decrease in temperature, and the TTSP can be used in non-linear segments. With the application of the TTSP, the ultimate strength and the stress-strain curves of constant-rate tensile tests can be predicted at any temperature and strain rate, and the predicted σ - ϵ responses matched the test results closely, but led to some errors at high temperatures. This was because of some errors in the time-temperature shift factors.

The fourth paper 'Arcing failure analysis of miniature circuit breaker using nano-W-Cu material'⁴ has been reported by Dezhi Xiong (Key Laboratory of Fiber Optic Sensing Technology and Information Processing, Ministry of Education, Wuhan University of Technology, Wuhan, China; Metering Center of State Grid Hunan Electric Power Company, Changsha, China), Xiangqun Chen (Metering Center of State Grid Hunan Electric Power Company, Changsha, China), Jie Yang (Key Laboratory of Fiber Optic Sensing Technology and Information Processing, Ministry of Education, Wuhan University of Technology, Wuhan, China), Yi Zuo (Energy and Power Engineering College, Changsha University of Science and Technology, Changsha, China), Junhua Hu and Jinbo Li (Metering Center of State Grid Hunan Electric Power Company, Changsha, China). In order to solve the problem of frequent failures of miniature circuit breakers and the resulting short arcing, research on nano-tungsten-copper (nano-W-Cu) material in arcing failure analysis of miniature circuit breakers was carried out by the authors. Ordinary pure copper material – which is widely used in electrical power distribution – exhibits major limitations such as low melting point and metal vapor, which causes frequent failure of the miniature circuit breaker. In this way, on the basis of analyzing the mechanism of miniature circuit breaker arcing and using nano-W-Cu material, this paper makes provisions for the 10 kA tolerance test process and conditions of short-circuit current and extracts the commonly used test for a certain type of miniature circuit breaker combined with nano-W-Cu material. The test results show that miniature circuit breaker arcing can be reduced by using nano-W-Cu material to replace the ordinary pure copper alloy. This could significantly enhance the performance of miniature breaker arcing and its breaking capacity and reduce the miniature circuit breaker arc time as well as the breaking time, which could effectively improve the reliability, security and stability of miniature circuit breakers and effectively solve the problem of miniature circuit breaker arcing failure.

'Response of copper's microstructure to laser shock peening'⁵ is the fifth paper in this issue, presented by Yujie Fan, Erbin Guo and Yibin Dai of the School of Mechanical Engineering, Jiangsu University of Science and Technology, Zhenjiang, China. The response of copper's microstructure to laser shock peening (LSP) was investigated in this study. LSP experiment was conducted with a Spotlight neodymium (Nd)-doped yttrium aluminum garnet laser. Then microstructural observations in the affected zone and substrate were conducted by means of cross-sectional optical microscopy and transmission electron microscopy. The experimental results indicated that the distribution of grain size becomes more uniform near the top surface after LSP treatment, and the average grain size in the top surface is about 5 μ m. There are four typical microstructural features along the depth direction due to the ultrahigh plastic strain in the affected zone, and the microstructure changes with the number of LSP impacts. The movement of and interaction between dislocations plays an important role in the evolution of the dislocation structure. Additionally, the grain refinement mechanism of copper along the depth direction, induced by the plastic deformation during multiple LSP impacts, was proposed based on the microstructural observations.

Paul Arindam, Tirumalai S. Srivatsan (Division of Materials Science and Engineering, Department of Mechanical Engineering, The University of Akron, Akron, OH, USA) and Gary L. Doll (Timken Engineered Surfaces Laboratory, Akron Engineering Research Center, Department of Civil Engineering, The University of Akron, Akron, OH, USA) report their study on 'Effects of surface treatment on tensile properties and fracture behavior of two high-strength steels'.⁶ In this paper, the extrinsic influence of high-energy mass finishing surface treatment, referred to as 'HEMF', on the tensile properties and resultant fracture behavior of two high-strength steels (that are viable candidates for both selection and use in a spectrum of high-performance applications) is presented and discussed. HEMF is essentially a surface-treatment process wherein fine objects, microscopic in dimension, are made to impact the surface of the chosen specimen at a very high speed and force. Test results reveal that the innovative surface treatment did increase the yield strength, tensile strength and ductility of the chosen stainless steel 17-4 PH. For alloy steel 300M, both the yield strength and tensile strength decreased in the longitudinal orientation but revealed an increase in the transverse orientation. Surface preparation was observed to have a detrimental influence on the ductility of alloy steel 300M. The kinetics governing tensile response and fracture behavior, at both the macroscopic and fine microscopic levels, are presented in light of the nature of loading, the presence of surface treatment and intrinsic microstructural effects.

'Preparation and properties of controlled compacting filling material based on admixture technique'⁷ by Xuesong Zhang, Rangang Yu and Jinping Chen (College of Pipeline and Civil Engineering, China University of Petroleum, Qingdao, China) is the seventh paper in this issue. Using fly ash as the main raw

material with a certain amount of cement, polycarboxylate superplasticizer and the admixture such as slump retaining agent and thickening agent, a type of controlled low-strength material is developed that can be used to fill the discarded oil pipeline. Controlled compacting filling materials exhibit good fluidity and low compressive strength. These materials can take advantage of waste efficiently. With the aid of some admixtures, such as polycarboxylic, high-performance, water-reducing agents DW-I and DWB01, and thickening agent carboxymethyl cellulose, fly ash (as a raw material) is mixed with 10–15 wt% cement to prepare a low-cost controlled compacting filling material that meets the fluidity and compressive strength required to fill an unused oil pipeline. Given the local elevation difference along the wasted pipeline, this material can rely on gravity transportation to fill in the terminal position of the pipeline and self-compact, which can reap economic and environmental benefits.

‘Dynamic splitting tensile test of hybrid-fiberreinforced reactive powder concrete’⁸ is the eighth and last paper in this issue. Shaojun Cao, Xiaomeng Hou and Qin Rong of the Key Lab of Structures Dynamic Behavior and Control, Ministry of Education, Harbin Institute of Technology, Harbin, China, and Gang Li of the Harbin Institute of Technology, Harbin, China, are the authors of this paper. In order to investigate the dynamic splitting tensile strength of reactive powder concrete (RPC) under high strain rates, split Hopkinson pressure bar experiments are conducted on hybrid-fiber-reinforced (2% steel fiber and 0.2% polypropylene fiber) RPC. The results show that the dynamic splitting tensile strength of RPC increases with an increase in nominal strain rate from 100 to 350 s⁻¹. The splitting tensile strength dynamic increasing factor (SDIF) of RPC is lower than that of ordinary concrete with the same compressive strength. This is mainly because the compactness of RPC is higher than that of normal concrete. Further, considering that it is not safe to apply the

calculation method of SDIF to RPC in the European code Comité Européen du Béton, empirical relations of SDIF and strain rate for RPC with hybrid fibers are proposed. The proposed SDIF–strain rate relations for RPC can be used in computer programs for evaluating the dynamic response of RPC structures.

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