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Editorial

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This year marks the 100th anniversary since Albert Einstein proposed the idea of stimulated emission of radiation.[1] While this concept is critical to the understanding of the equilibrium of black-body radiation,[2] it has led to the invention of the maser (microwave amplification by stimulated emission of radiation)[3–5] and the modern day laser (light amplification by stimulated emission of radiation).[6,7]

Coincidentally, the US Defense Advanced Research Projects Agency announced a program – *Enabling Extreme New Designs for Optics and Imagers* – that aims to develop highly portable, miniaturized and efficient devices for advanced imaging applications.[8] It is anticipated that this program will lead to enhanced two- (2D) and three-dimensional (3D) optoelectronic and photonic structures with multi-function capability of operation in the desired range of wavelengths. This project is an excellent case of design–optimization–process–properties–performance in band-gap engineering, optical and photonic materials, structures and networks and should help to transition devices such as photonic crystals[9,10] and quantum dots[11,12] from fundamental research and design to prototyping and manufacturing.

In recent years, the progress in the integration of materials and devices to form structures, circuits and systems has been occurring at a rapid pace. Examples include application-specific integrated circuits (ASICs),[13] application-specific coating technologies (ASpeCT)[14,15], nano/micro electronic/opto mechanical structures (NEMS/MEMS/MOMS)[16] and optoelectronic integrated circuits (OEICs)[17,18]. The International Technology Roadmap for Semiconductors (ITRS 2.0, see http://www.itrs2.net/itrs-reports.html) calls for '3D Power Scaling' as the next phase of silicon integrated circuit technology. These technologies, coupled with recent advances in 3D printing[19,20] and surface mounting technologies (such as magnetic field assisted assembly)[21] are anticipated to be the next enabler of manufacturing systems-on-a-chip, XYZ-on-a-chip, lab-on-a-chip, etc.

The first of the papers in this issue presents 'Structural and optical properties of Cr-doped ZnO thin films'.[22] This paper is a collaborative effort between the Department of Electronics at Zakir Husain Delhi College, University of Delhi (New Delhi, India), the Department of Electronic Science at the University of Delhi South Campus (New Delhi, India) and the Department of Applied Physics at Amity University (Noida, India). The authors, Dhruvashi Singh, Kusum Rawat, Punisha Pal and Prem K. Shishodia, present their studies on chromium (Cr)-doped zinc oxide (ZnO) thin films prepared on silicon and glass substrates by using sol–gel spin-coating technique. The influence of chromium doping on the structural and optical properties of zinc oxide films has been investigated. The X-ray diffraction (XRD) results reveal that the films are polycrystalline in nature with hexagonal Wurtzite structure. The absence of secondary diffraction peaks, other than those for zinc oxide, suggests that the chromium ions successfully replaced zinc (Zn) ions and were incorporated into the crystal lattice positions. The average grain size and the strain arising due to the introduction of chromium ions in the lattice were obtained by using Williamson–Hall analysis. The surface morphology of the films was observed by field emission scanning electron microscopy (SEM). The Raman spectra of the films show a peak at 434 cm^{-1} corresponding to E_2 (high) mode of crystalline zinc oxide Wurtzite structure, and the intensity of this mode decreases with increase in chromium doping. The films are highly transparent (~90%) in the visible region, which reduces with chromium doping.

The second paper in this issue focuses on the 'Surface potential decay of functional dielectrics after polarization'.[23] This paper is a collaborative effort between the School of Electrical Engineering, Northeast Dianli University (Jilin City, China), the Key Laboratory of Engineering Dielectrics and Its Application, Ministry of Education, Harbin University of Science and Technology (Harbin, China), the State Grid Liaoning Province Power Co., Ltd, Power Research Institute (Shenyang, China) and the State Grid Information & Telecommunication Group Co., Ltd (Beijing, China). The authors, Jia-Wei Zhang, Chao Yin, Rui-Tong Liu and Yong-Sheng Zhao, present their results on the high-voltage polarization domains in functional dielectrics and the ability to orient them with an external applied electric field, with an emphasis on the development of a variety of applications for energy conversion from energy harvesting to information storage and reading. Voids are often generated at the bond interface during the production process of polymer films, which can break down easily in the process of polarization with high voltage, but the voids inside the dielectric materials play an important role in charge storage and maintenance if the materials are oriented towards the application of electrostatic generator, sensor, actuator and transducer, etc. Meanwhile, a polymer matrix doped with a small amount of nanoparticles can suppress charge formation and increase surface charge decay rate. Results obtained in this paper show that polymer materials with microvoids have better maintenance properties of space charge compared with nanocomposite polymer materials. The results, in this research, are important reference values and have practical significance in the field of insulation and applications of functional dielectric materials.

'Study of wear-corrosion resistance of Co-based biomaterial'[24] by Yanling Yang, Lijie Qiao, Ziyuan Gao and Yu Yan is a report of the results of a collaborative effort between the Corrosion and Protection Center, Key Laboratory for Environmental Fracture (Ministry of Education, Harbin University of Science and Technology), the School of Materials Science and Engineering, University of Science and Technology Beijing (Beijing, People's Republic of China) and the Department of Chemical Engineering, Weifang Vocational College (Shandong, People's Republic of China). The longevity and safety of artificial joint implants are determined by wear and corrosion properties. For many clinical cases, the released metallic ions and wear debris can cause adverse tissue reactions. Eventually, failure of such medical devices can be induced. Therefore, it is of great interest to increase the wear-corrosion resistance of implant materials. The release of metallic ions is related to the damage on the passive film, which can spontaneously form on the surface of the cobalt–chromium–molybdenum (CoCrMo) alloy. In order to prevent the tribocorrosion reaction (the interaction between tribology and corrosion), a titanium nitride (TiN) film was applied on the surface by magnetron sputtering technology. The tribocorrosion behaviors of the titanium nitride and cobalt–chromium–molybdenum combination were studied. It has been shown that titanium nitride can greatly increase tribocorrosion resistance. However, if the titanium nitride film is damaged by tribological contact or the impact of the contact, the corrosion rate would increase significantly.

The paper 'Mechanical properties of woven glass fiber-reinforced polymer composites'[25] is by Guangfa Gao and Yongchi Li of the School of Mechanical Engineering, Nanjing University of Science and Technology (Nanjing, China), the Department of Mechanical Engineering, National University of Singapore (Singapore) and the Department of Modern Mechanics, University of Science and Technology of China (Hefei, China). In this study, the mechanical properties of a woven glass fiber-reinforced polymer composite were investigated in quasi-static compression and tension tests. With the composite being regarded as a transversely isotropic material, compression tests in the normal and tangent directions and tension tests in the tangent direction were conducted. The investigation indicates that the composite is an elasto-brittle material, and its compressive failure strength is significantly greater than its tensile strength. A positive strain rate effect on the compressive behavior in the normal direction was discovered. The experimental results show that failure stresses and strains of the composite in the normal direction are all significantly greater than those in the tangent direction at different strain rates. For the polymer, shear failure is the dominant failure mode in quasi-static uniaxial compressive loading. In the process of compressive loading in normal direction, the interaction strengthened gradually. The fiber with greater tensile strength contributed more to compressive strength in the normal direction than that in the tangential direction. However, in the elastic stage, the deformation was so small that the polymer played a dominant role in this process. Thus, the Young's moduli of the composites in the two directions were similar.

The next paper is on 'Dyeing of ramie yarn with Reactive Blue 19 in liquid ammonia'[26] by Yingjie Cai, Shu Wen, Chi Yuan, Fan Liu, Linwei He and Lina Lin of the Engineering Research Center for Clean Production of Textile Dyeing and Printing and the School of Textile Science and Engineering, Wuhan Textile University (Wuhan, China). Liquid ammonia dyeing is an anhydrous dyeing process that uses liquid ammonia instead of water. There are reports that the liquid ammonia dyeing performance is unsatisfactory due to problems of low exhaustion and poor fixation. In this work, ramie yarn was cationically modified using 2,3-epoxypropytrimethylammonium chloride. The original and cationic yarns were dyed with Reactive Blue 19 in liquid ammonia. The dyeing time varied from 10 to 600 s with 10% dye on mass of fiber (OMF), and the dye mass ranged from 1 to 100% dye OMF for 600 s at −35°C at a liquor-to-goods ratio of 1:35. After dyeing, the dyed samples were dried at 100°C for 10 min, followed by a soaping-off treatment. The results indicated that the dyeing equilibrium time for the original ramie yarn was 60 s and that for the cationic yarn was 300 s. Thus, the cationic treatment improved both dye exhaustion and fixation.

The paper 'Thermal analysis of montmorillonite modified by imidazolium'[27] is by Jingjie Zhang, Qilin Mei, Long Chen, Xia Chen and Lei Zu of the Key Laboratory of Advanced Technology for Special Functional Materials of Ministry of Education, School of Materials Science and Engineering, Wuhan University of Technology (Wuhan, China). In order to improve the performance of sodium (Na) montmorillonite (MMT), in this study, 1-hexadecyl-2,3-dimethylimidazolium bromide was synthesized and used as a cationic surfactant for the organic modification of sodium MMT. The modification effect of pH was investigated and the structure of the imidazole organic modifier was characterized by nuclear magnetic resonance and Fourier transform infrared spectroscopy (FTIR). In addition, the modified sodium MMT was systematically confirmed by FTIR and XRD. The results showed that the imidazolium surfactant successfully intercalated into the galleries of MMT and enlarged the (001) d spacing of MMT. It was observed that the $d_{(001)}$ peaks largely shift to the left with decreasing pH, indicating low pH-facilitated intercalation, and its effect reached the best at pH 3, where the interlayer distance between MMT platelets increased from 1·31 to 3·52 nm. Thermogravimetric analysis showed that the modified sodium MMT exhibited excellent thermal stability; the onset and the maximum decomposition temperature were 343°C and 406°C, respectively.

Zou Fang-Li, Hu Jian-Hua, Huang Shang-Yu, Lei Yu, Zhou Meng-Cheng and Xu Zhi-Kun of the School of Materials Science and Engineering, Wuhan University of Technology (Wuhan, China) and the School of Electrical and Mechanical Engineering, Wuhan Institute of Technology (Wuhan, China) report their studies on the ‘Preparation of Ag-based solder foils by low-voltage magnetic pulsed compaction’.[28] In this study, Cd-free Ag-based solder foils were fabricated using mechanically alloyed powders containing 56% Ag, 22% Cu, 17% Zn and 5% Sn by low-voltage magnetic pulsed compaction (LV-MPC), followed by liquid-phase sintering. The effects of processing parameters – such as discharge voltage, capacitance, coil turns, diameter–height ratio and compacting times – of LV-MPC on both the green density and the sintered density of compacts were analysed. Results showed that the green density increased with increasing discharge voltage, capacitance and coil turns. Green density also increased with increasing compacting times and diameter–height ratio, but the effect was relatively small because of the small filling height of the powder. The minimum thickness of solder foils fabricated by LV-MPC was approximately 0·2 mm. After sintering for 0·5 h at 480°C, the changing tendency of sintered density with different processing parameters was similar to that of green density with the same processing parameters. However, anti-densification occurred and the sintered density declined slightly. The maximum relative densities of the samples after LV-MPC and liquid sintering were approximately 89% and 87%, respectively.

Fei-Shuo Hung of the Department of Travel Industry Management, Far East University (Tainan, Taiwan) reports studies on ‘Multilayered effects of Fe on EMI shielding of Sn–Al architectural powder’.[29] No evident effect on shielding efficiency was observed when electromagnetic wave-absorbing coating materials were applied in single layers because of the dispersing nature of the powder. When coating was increased to two layers, shielding effects were evident at both high and low frequencies, with greater shielding efficiency at low frequencies than at high frequencies. It is worth noting that when the coating was increased to three layers, as the weight percentage of powdered iron (Fe) increased from 5 to 8%, the shielding efficiency of the powdered iron composite material was raised to −35 dB. This shows that, as the weight percentage becomes higher, the powder shows the resonance phenomenon of the permeability spectrum, and at high frequencies the electromagnetic wave shielding efficiency of the composite materials was greatly increased. As the weight percentage of the powdered iron was increased to 8%, the powder could not be spread evenly in the epoxy because of the dispersing characteristic of the electromagnetic properties of iron and the anisotropic and heterogeneous nature of the powdered composite material. During production, the powder aggregates often resulted in greater heterogeneity in the materials and, consequently, lowered shielding efficiency at 3 GHz.

The paper ‘Synthesis of meso-SAPO-37 materials using neutral surfactant’[30] is presented by Rekha Yadav, Arvind Kumar Singh and Ayyemperumal Sakthivel of the Department of Chemistry, University of Delhi (Delhi, India) and the Department of Chemistry, Central University of Kerala (Nileshwar, India). The electrostatic interaction between the inorganic precursor and the organic surfactant plays a major role in the assembly of mesoporous materials; hence, the authors believe that the use of a neutral surfactant against a cationic surfactant might help to produce long-range-ordered mesoporous materials with better thermal stability. The current work focuses on the synthesis of mesoporous silicoaluminophosphate-37 materials using a neutral surfactant (hexadecyl amine) by a two-step procedure. The synthesized materials were characterized by various spectroscopic and analytical techniques, namely FTIR, powder XRD, SEM and nitrogen (N_2) sorption. The mesoporosity of the samples was evident from XRD and nitrogen sorption analysis. FTIR spectra support the presence of microporous structural building units on the mesoporous surface. The SEM images showed the presence of a flower-like morphology with hexagonal petals. The resulting material showed promising activities for *trans* alkylation of naphthalene using 1,3-diisopropylbenzene.

‘Hemp concrete: carbon-negative construction’ is a study[31] by Tarun Jami, Deepak Rawtani and Yadendra K. Agrawal of the Institute of Research and Development, Gujarat Forensic Sciences University (Gandhinagar, India). The onset of heavy greenhouse gas emissions from conventional construction practices has led to research on several plausible low-carbon dioxide footprint construction materials that are either carbon dioxide-neutral or carbon dioxide-negative. One such ‘green’ construction material is lime hemp concrete (LHC), also referred to as hemp concrete or hempcrete, which are some of the many names of this novel construction material. LHC is essentially a composite made of lime and hemp shivs. This paper presents a literature review of the various studies carried out on hemp concrete to understand its properties, drawbacks and advantages in construction. The review dwells on discussion of hemp, use of lime as a binder material and the mechanical, thermal and hygric properties of LHC. The salient features of LHC with regard to mechanical, thermal and hygric properties and ecological impact are discussed in the paper. It is observed that further research on LHC is required to be able to establish mix design principles, improve the compressive and flexural strengths of LHC and its use as a load-bearing structural material for high-rise constructions, and establish cradle-to-death greenhouse gas emissions, recyclability and reusability, which seem to be promising propositions with hemp concrete.

The next paper in this issue is an ‘Experimental study on magnesium oxychloride cement concrete’[32]. This study is reported by Hong-Xia Qiao, Wei Gong, Ying-Ying Shi, Mugure Elizabeth Wanjiru and Jin-Mei Dong of the Key Laboratory of Disaster Prevention and Mitigation in Civil Engineering of Gansu Province and the Literature School of International Education, Lanzhou University of Technology (Lanzhou, China), and the Qinghai Institute of Salt Lakes, Chinese Academy of Sciences (Xining, China). Magnesium oxychloride cement concrete specimens can be produced in different ratios by experimental design and analysis using the Taguchi method. The significant sequences of strength and water resistance of the selected controllable factors were studied under dry and flooding conditions respectively, and the sensitivity sequence and the most robust set level of the factors were analyzed. The results show the following: the significant sequences are consistent under different conditions. The selected controllable factors were phosphate, fly ash, molar ratio of activated magnesium oxide (MgO) to magnesium chloride ($MgCl_2$) of 5·4 and phosphoric acid. The maximum sensitivity factor under both conditions is phosphate; the most robust levels are consistent for a molar ratio of activated magnesium oxide to magnesium chloride of 5·4, without ash and without phosphoric acid. However, the results for phosphate are inconsistent. The amount of phosphate, added at the most robust level under dry conditions, is more than the amount under flooding conditions, so that the most robust set level of the factor under dry conditions will reduce its water resistance.

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