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Editorial

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Additive manufacturing (AM),[1] commonly known as three-dimensional (3D) printing, continues to be at the forefront of research in materials science, engineering and technology. The technical meeting and exhibition of Materials Science & Technology 2016,[2] held in Salt Lake City (23 to 27 October 2016), hosted six parallel symposia on AM. While 3D printing of polymers has been well understood and is being routinely performed,[3] the ability to print metals[4,5] or ceramics[6] in a desired shape, size and geometry continues to be a challenge. The ability to print magnetic materials[7] with desired magnetic field strength using 3D printing will revolutionize this technology.

The year 2017 marks the 30th anniversary[8,9] since the inception of AM. Light-sensitive liquid polymers solidified using ultraviolet light were the first of the material candidates that were successfully demonstrated with stereolithography from 3D systems. Indeed, it can be argued that 3D printing is a technology offshoot of photolithography and has benefited from the tremendous advancements in photolithography in semiconductor device manufacturing.

For AM to become a completely scalable manufacturing technique, it will require real-time (in situ) monitoring and control with sensors tracking the spatial and temporal distribution of printed material/structure in relation to thickness, material composition, defects or dislocations, temperature, structure, shape, size, morphology, stress, and so on. Since AM is perhaps the only process that can facilitate the design and construction of very complex parts without the need for welding or other joining techniques, the expectations on the return on investment on 3D printing is immense.

The availability and implementation of sensor-based closed-loop control coupled with higher throughput will catalyze the ability to monitor 3D-printed parts to ensure regulatory compliance[10,11] while at the same time improving yield. The AM industry will also require material standards and metrology to ensure process repeatability, reproducibility and manufacturing yield.

While 3D printing has led to increased applications in rapid prototyping, the manufacturing industry has begun to transition to this technology as a way to produce, repair or replace parts. The ability to customize drugs and drug delivery services,[12] tissues and organs,[13] bones,[14] and jet engines[15] are some recent examples of 3D printing applications. The first FDA-approved 3D-printed drug – Spritam for treating epilepsy[16] – should continue to accelerate the growth of this technology in the manufacturing sector.

The paper in this issue, ‘Investigation of $CuInSe_2$thin films deposited by laser ablation method’[17] is by Kusum Rawat and Prem K. Shishodia of the Department of Electronics, Zakir Husain Delhi College, University of Delhi, New Delhi, India and Chhikara Manisha of the Department of Applied Physics, Amity University, Haryana, India. In this study, chalcopyrite copper indium diselenide ($CuInSe_2$) thin films have been deposited on Corning 7059 glass substrates by pulsed laser ablation method. Structural and optical properties of thin films deposited in vacuum conditions, varying from 10^{-3} to 10^{-6} Torr, have been investigated. The X-ray diffraction spectra revealed the chalcopyrite tetragonal structure of copper indium diselenide with (112), (220) and (312) orientations. The films were found to be highly polycrystalline in nature, which was further improved along the (112) orientation with a decrease in pressure. Lattice strain and dislocation densities in the films were also estimated using the broadening of diffraction peaks. The Raman spectra show a strong peak at 170 cm^{-1}, corresponding to the dominant A1 vibrational mode of copper indium diselenide, and shift towards 174 cm^{-1} with decreasing pressure. The optical transmittance of the films was measured in the wavelength range of 300–2200 nm. The optical bandgap of the films was found to be in the range of 1·05–1·3 eV using Tauc’s plot. The Urbach energy calculations suggest a decrease in the degree of disorder in the films deposited at low pressure.

The next paper is on ‘Nanoribbon-structured $CdWO_4$–ZnO for multiple applications’.[18] The authors, Kuppulingam Thirumalai and Subramanian Balachandran of the Department of Chemistry, Annamalai University, Annamalainagar, India, Kaliyamoorthy Selvam of Noyori Laboratory, Nagoya University, Nagoya, Japan and Meenakshisundaram Swaminathan of the Nanomaterials Laboratory, Kalasalingam University, Krishnakoil, India, report their studies on a new cadmium tungstate–zinc oxide ($CdWO_4$–ZnO) nanocomposite, prepared by a simple hydrothermal method. The nanocomposite was characterized by X-ray powder diffraction, high-resolution transmission electron microscopy (TEM), field emission scanning electron microscopy (FESEM), energy-dispersive X-ray spectroscopy, elemental colour mapping, atomic force microscopy, photoluminescence spectroscopy, X-ray photoelectron spectroscopy and Brunauer–Emmett–Teller (BET) surface area measurements. FESEM and TEM images show the heterostructure of cadmium tungstate–zinc oxide with nanoribbons and nanoparticles. The BET surface area of cadmium tungstate–zinc oxide is 2·1 times that of zinc oxide. This heterostructured material shows an enhanced photocatalytic activity on the degradation of rhodamine B and reactive orange 4 under ultraviolet irradiation. Cadmium tungstate–zinc oxide exhibits higher electrocatalytic activity than zinc oxide and cadmium tungstate for methanol electro-oxidation in alkaline medium. This coupled oxide shows increased hydrophobicity compared to cadmium tungstate or zinc oxide. A significant antibacterial activity against Gram-positive *Staphylococcus aureus* and Gram-negative *Escherichia coli* was shown by this catalyst. The results offer new insights into the performance of a coupled semiconductor oxide with multiple applications in photocatalytic, electrocatalytic, self-cleaning and antibacterial activities.

The paper 'Carboxymethyl starch as corrosion inhibitor for mild steel'[19] is by Weiming Wu of the Institute of Engineering Research, Jiangxi University of Science and Technology, Ganzhou, China, Tianyu Chen, Haiyan Du and Ding Li of the School of Metallurgical and Chemical Engineering, Jiangxi University of Science and Technology, Ganzhou, China, and Jianmei Liu of the School of Chemical Engineering, Zhejiang University of Technology, Hangzhou, China. In order to seek wider fields of application of carboxymethyl starch (CMS), in this study, the inhibition of CMS on mild steel in hydrochloric acid (HCl) solution has been investigated by polarization curves and electrochemical impedance spectroscopy. The results show that CMS has a good tendency as a corrosion inhibitor in 5% hydrochloric acid solution at room temperature, 40°C and 60°C. When CMS with a concentration of up to 2 g/l was added, the corrosion rate decreased to 11·19 mm/year and the inhibition efficiency was 80·61%. The corrosion rate increased with the increase in temperature of the medium. CMS is found to be a kind of cathode corrosion inhibitor; the inhibition efficiency increases with increasing concentration of CMS, and the inhibition efficiency is best at room temperature. Passivation will be accelerated on the surface of the electrode when mild steel electrode is in 5% hydrochloric acid solution at 40°C, which leads to good resistance to corrosion.

It has been five years since *Emerging Materials Research* was launched by ICE Science. Over these years, the journal has grown significantly. It is now cited in a large number of databases throughout the world and the number of contributors has grown exponentially.

Since 2013, the journal has been recognizing the best paper in the form of a prize. During the last three years, the following papers have won the prize

- 'Multifunctional heterostructures integrated on Si (100)'[20]
- 'Three-layered sandwich material for lightweight applications'[21]
- 'Review of polymer-based sensors for agriculture-related applications'[22]

As 2016 comes to a close, the Editor and ICE Science thank the authors, reviewers and the members of the Editorial Board for their contributions, participation and support, and wish them happy holidays and a happy New Year.

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