Editorial

Nuggehalli M. Ravindra PhD

Professor, New Jersey Institute of Technology, Newark, NJ, USA

The abundance of silicon, the scalability at the wafer, device and circuit level maturity, know-how, repeatability, reproducibility, yield and reliability of its device technology and the associated low costs will continue to support the use of silicon, for many more years, as the prime semiconductor of choice for a variety of device and circuit applications. In spite of its indirect bandgap, the ability to fabricate silicon-based light emitting diodes (LEDs) continues to challenge material scientists^{1,2} and excite device engineers³. If high-efficiency silicon LEDs can be manufactured, it will lead to silicon-based lasers. The motivation for this continued interest in silicon LEDs is its compatibility with the silicon Ultra Large Scale Integration (ULSI) technology. In a recent issue of *Applied Physics Letters*, Cheng *et al.*⁴ report their studies of ‘phonon-assisted transient electroluminescence in silicon’. The authors find that an increase in injection current density leads to a broadening of the electroluminescence spectrum and a reduction in the bandgap due to Joule heating.

Utilising the scattering of high-energy photons to low-energy photons, optically pumped silicon ‘Raman’ lasers have been demonstrated in the past^{5–8}. However, these lasers need to interface with electronic components and systems and the modulation of the laser should be driven by electrical signals. Intel has been working on the silicon ‘Raman’ laser for some time⁸.

Recently, Intel has teamed up with Lawrence Berkeley National Lab to design and develop new photoresists^{9,10} that will have improved light sensitivity and mechanical stability. As the semiconductor industry focuses on manufacturing processes at the 10-nm node, it is anticipated that these new photoresists will meet the demands of short-range patterning capabilities in the 2–20 m range¹⁰ and thus facilitate in extreme-ultraviolet lithography (wavelength = 13.5 nm).

With the summer months in progress, a number of recently published books in materials science and engineering^{11–17} have caught my attention. Reviews of these books are currently in progress and will be published in the upcoming issues of *Emerging Materials Research*.

The first of the papers¹⁸ in this issue of *Emerging Materials Research* presents a study on the ‘Extrinsic influence of environment on the corrosion behaviour of enamel-coated steel dowel bars’. This paper by Srikanth Bajaj, Anil Patnaik, J. Payer, R. L. Liang, K. Manigandan and T. S. Srivatsan of The University of Akron, Akron, Ohio, presents a study on a new type of enamel-coated dowel bars for use as concrete pavements. In this study, the authors find that

a gradual deterioration of such bars can occur due to corrosion occurring at locations of fine microscopic cracks and other defects in the coating. The results of the study aimed at evaluating and understanding the corrosion resistance of such dowel bars are presented and comparisons are made with corresponding epoxy-coated dowel bars. Identical defects were introduced onto the surface of the dowel bars with the two types of coatings. The extrinsic influence of the environment and the resultant corrosion based on type, location and severity of the defects was carefully examined. Test results reveal the corrosion resistance of enamel-coated dowel bars to be as good as that of the corresponding epoxy-coated dowel bars. The presence of the corrosion products was essentially confined to locations of the defects in the test specimens when the steel was exposed to concrete and subject to induced current to accelerate corrosion, thereby demonstrating the enamel coating on the surface of the dowel bars to be effective in isolating the steel from the surrounding concrete and concurrently providing enhanced resistance to corrosion. Also, the enamel-coated dowel bars did not reveal peeling of the coating at the interface. The epoxy-coated dowel bars revealed peeling of the epoxy coating from the surface that eventually got stuck to the inner surface of the surrounding concrete. This demonstrated that the enamel-coated dowel bars would perform better under prevailing service conditions in concrete pavements where relative free sliding is both essential and required.

The second paper¹⁹ in this issue focuses on the ‘Test and regression analysis on tribological properties of locomotive traction gear materials’. In this paper by Ying Shi and Yu-Peng Yao of the Dalian Jiaotong University, Dalian, China, the authors discuss the effect of load and relative sliding velocity on the tribological properties of locomotive traction gear materials 42CrMo and 17CrNiMo6 on the basis of pin-on-disk reciprocating friction and wear tests. Their research shows that load and relative velocity have significant effects on the tribological properties of locomotive traction gear materials. The friction coefficient between friction surfaces decreases and then tends to be stable with increase in load and relative sliding velocity. An expression for the friction coefficient has been proposed by regression analysis and significant tests. This lays a theoretical basis for research on the tribological properties of locomotive traction gears. The correctness of the expression has been verified by tests.

‘Thermomechanical behaviour, light and X-ray scattering of polylactic acid’ by Adriana Reyes-Mayer and Angel Romo-Uribe of the Universidad Nacional Autonoma de Mexico, Cuernavaca, Morelos, Mexico, is the third paper²⁰ in this issue of *Emerging*

Materials Research. This paper reports a study on the thermal properties, microstructure and mechanical behaviour of extruded films of biodegradable polylactic acid (PLA) and compares these properties with those of polyethylene. Thermal properties showed poorer thermal stability of PLA (some 100°C lower than the polyolefins), and poorer ability of PLA to crystallise, exhibiting a pronounced cold crystallisation exothermic peak, which is not present in the extruded polyolefins. Poor crystallisation in PLA films was corroborated by wide-angle and small-angle X-ray scattering, and hot-stage optical microscopy. Uniaxial deformation showed that the mechanical properties of PLA film along and orthogonal to the extrusion direction (determined under uniaxial testing at room temperature) are significantly larger than the polyolefins, by a factor of 2–6. Moreover, the mechanical properties along and orthogonal to the extrusion direction revealed significant anisotropic mechanical properties of PLA. Furthermore, the mechanical modulus of PLA was a decreasing function of strain rate thus suggesting a strain rate softening behaviour.

Deepti B. Patle of the Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur, India, and Wasudeo B. Gurnule of the Kamla Nehru Mahavidyalaya, Nagpur, India, report their studies on ‘Antimicrobial studies and ion exchange properties of copolymer resin derived from p-HBBF’. This paper²¹ describes the synthesis of p-hydroxybenzaldehyde–biuret–formaldehyde (p-HBBF) copolymer resin through the condensation of p-hydroxybenzaldehyde and biuret with formaldehyde in the presence of hydrochloric acid as a catalyst and with various molar ratios of the reacting monomers. The resulting copolymer was characterised with UV-visible, FTIR, ¹H-NMR and C¹³ NMR spectral data, which were employed to determine the reactivity of monomers. The average molecular weight of this resin was determined with conductometric titration in a nonaqueous medium. The chelating ion-exchange properties were also studied with the batch equilibrium method. The chelating ion-exchange properties of this copolymer were studied for seven metal ions (Cu²⁺, Ni²⁺, Cd²⁺, Co²⁺, Zn²⁺, Pb²⁺ and Fe³⁺). The study was carried out over a wide pH range and in media of various ionic strengths. The copolymer showed a higher selectivity for Fe³⁺ ions than that for Cu²⁺, Ni²⁺, Cd²⁺, Zn²⁺ and Pb²⁺. The surface morphology of the copolymer resin was examined by scanning electron microscopy, and it establishes the transition state between crystalline and amorphous phases. The p-HBBF copolymer resin was tested for its inhibitory action against pathogenic bacteria and fungi. The resin shows potent inhibitory action against bacteria, such as *Escherichia coli*, *Klebsiella* sp (NCIM 2719) and *Pseudomonas aeruginosa*, and fungi, namely, *Candida albicans* and *Penicillium* sp.

The last paper²² in this issue of *Emerging Materials Research*, ‘Simulation of spectral emissivity of vanadium oxides (VO_x)-based microbolometer structures’, is by Chiranjivi Lamsal and Nuggehalli M. Ravindra of the New Jersey Institute of Technology,

Newark, New Jersey. In this paper, a simulation of the room temperature spectral emissivity of an industry standard VO_x-based microbolometer structure, with *x* equal to 1.8, is presented. The simulation is based on Multi-Rad, a package that implements thin film optics in the form of matrix method of multilayers and assumes the layers to be optically smooth, parallel to each other and optically isotropic. The simulated results are shown to be in good accord with the available experimental data in the literature. The calculations show that bare VO_x, that is VO₂, V₂O₃ and V₂O₅, with different thicknesses, exhibits wavelength-dependent emissivity that scales almost linearly with thickness. In the wavelength range of 8–14 μm, the spectral emissivity of bare VO_x, consisting of the stacked layers of the thin films of VO₂, V₂O₃ and V₂O₅, of total thickness of 500 Å, behaves as a mixed system. The Si₃N₄ overlayer does not change the spectral emissivity of Al/Si while it decreases the spectral emissivity of the VO_x/Si₃N₄/Air/Al/Si system. Calculations show that the Si₃N₄ layer provides the much-desired linear performance of the VO_x-based microbolometer.

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