

Editorial

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The American Physical Society (APS)¹ and The Minerals, Metals & Materials Society (TMS)² held their annual meetings in March and February 2014, respectively. Some of the highlights of the March Meeting of the APS included presentations of over 9000 abstracts, the observed increase in coercivity in vanadium (III) oxide/nickel bilayers³ and continued interest in Graphene.⁴ Over 4300 attendees participated in the TMS Annual Meeting. The highlights of the Meeting included the 2014 TMS RF Mehl Medal Symposium on Frontiers in Nanostructured Materials and Their Applications⁵ and Comic-Tanium, an exhibit linking materials science and comic book superheroes.

Self-assembly and energy continue to represent challenging and exciting areas of research in materials science, engineering and technology. Natalie A. Wasio and collaborators of the Department of Chemistry and Biochemistry, University of Notre Dame, report their studies of self-assembly of hydrogen-bonded two-dimensional quasicrystals⁶ of ferrocenecarboxylic acid. Andreas Pospischil, Marco M. Furchi and Thomas Mueller of the Institute of Photonics, Vienna University of Technology, report a p–n junction as a solar cell, a photodiode and a light-emitting diode based on an electrostatically doped tungsten diselenide monolayer.⁷

Phosphate glasses have several advantages over conventional silicate and borate glasses. In the last few decades, they have gained greater interest due to several possible applications and superior properties such as large thermal expansion coefficients, solubility, low melting and softening temperatures and high-ultraviolet and far-infrared (IR) transmission.

The first of the articles⁸ in this issue of *Emerging Materials Research* presents a study on the ‘Barium Oxide–Doped Silver Phosphate Glass’ by Bhasker Pratap Choudhary and N. B. Singh of Sharda University, India. In this study, silver phosphate glasses doped with 0, 5, 10, 15 and 20wt% barium oxide have been synthesized and characterized. X-ray diffraction (XRD) studies confirm the amorphous nature of the glasses. IR spectral studies show the presence of characteristic P–O–P linkages of linear phosphate chains, presence of O–P–O units in the phosphate tetrahedral and the formation of P–O–Ba bonds in the doped glass. It is also confirmed that, due to doping of barium oxide, loosening of glassy structure occurs and the glass becomes more disordered. Differential scanning calorimetric (DSC) studies reveal that the glass transition temperature increases with barium oxide concentration. Scanning electron microscopy studies show that barium oxide doping modifies the microstructures of the glass.

Electrical conductivity measurements, between 303 and 373 K, in the frequency range from 0.1 to 10 KHz, indicate that all glasses are ionic conductors with Ag⁺ ions as the charge carrier. The electrical conductivities of the doped silver phosphate glass are found to be higher than that of the undoped silver phosphate glass. Results show that the dielectric constants increase with increase in temperature at all frequencies and decrease with increase in frequency.

Currently, proton-exchange membrane fuel cells (PEMFCs) are of great interest for a variety of applications. A variety of membranes based on polymer blends, cross-linked polymers and polymer–ceramic composites are available. However, the high cost of perfluorinated polymers limits large-scale commercialization of PEMFCs. The necessity to reduce the cost of PEMs is thus stimulating a large body of research, which aims at rationalizing the remarkably efficient combination of characteristics of the perfluorinated ionomers and at developing new polymers with similar properties by a less-expensive chemistry.

The second article⁹ in this issue focuses on the ‘Influence of Glutaraldehyde Cross-linking With Polymer/Heteropolyacid Membranes’. This article by Uma Thanganathan and Masayuki Nogami is a collaborative effort between Okayama University and Nagoya Institute of Technology. In this article, a class of materials that are composed of a combination of glutaraldehyde, phosphotungstic acid and poly(vinyl alcohol) have been fabricated and their structural, thermal and pore-size properties are studied. The obtained results confirm that the composites have the potential to be promising electrolytes for PEMFCs operating at low/intermediate temperatures.

Polymers have a wide range of applications due to their versatile properties. However, the majority of conventional synthetic polymers are petroleum based, which is a depleting resource and they are non-degradable in nature. Hence, their disposal has created a serious environmental problem. Many researchers have made efforts on the development of environmentally benign biodegradable polymers. Among the various biodegradable polymers, polyurethanes are one of the most versatile materials due to their excellent physical properties, relatively good biocompatibility and biodegradability. Hence, they are extensively applied in the field of elastomers, foams, adhesives, coatings and sealants.

‘Synthesis, Characterization and Biodegradation Studies of Poly(ester-urethane)s’, by G. S. Bhusari and S. S. Umare

of Visvesvaraya National Institute of Technology and A. S. Chandure of Metlok Pvt. Ltd, Nagpur, India, is the next article¹⁰ in this issue. The authors have used a series of aliphatic poly(ester-urethane)s (PEUs) with different NCO/OH ratio that have been synthesized by a two-step bulk polymerization process from aliphatic poly(neopentyl-succinate) (PNSu), 4,4'-dicyclohexylmethane diisocyanate and 1,3-propanediol as a chain extender in the presence of dibutyltindilaurate as a catalyst. PNSu has been prepared by the transesterification polycondensation from diethyl succinate and neopentyl glycol in the presence of titanium isopropoxide as a catalyst. The effect of the NCO/OH ratio on the structural, physical and thermal properties of PEUs has been studied by Fourier transform IR spectroscopy, XRD, proton nuclear magnetic resonance spectroscopy, gel permeation chromatography, density measurement, DSC, thermogravimetric analysis/differential thermal analysis and optical microscopy. The density and number-average molecular weight of PEUs are found to be in the range of 1.175–1.180 g/cm³ and 55 137–56 947 g/mol, respectively. The biodegradability of the PEUs has been investigated by hydrolytic and enzymatic degradation at 37°C.

It is well known that c-Si solar cells fabricated on Czochralski (CZ) wafers exhibit light-induced degradation of the cell parameters. Generally, this effect is ascribed to boron–oxygen-defect complex that is formed in the wafer itself due to prolonged exposure of CZ wafers to light. As a finished silicon solar cell has a multilayered structure, it is also possible to have some degradation at various interfaces on light illumination. The study of degradation mechanism is, therefore, important in silicon solar cell devices. The antireflection coating of SiN:H layer on n⁺ region, an integral part of silicon solar cells, can contribute to the degradation process. In particular, it is recognized that the SiN:H/Si interface states have a strong-positive-charge accumulation at the interface that can be affected by light exposure.

In a collaborative effort between National Renewable Energy Laboratory and New Jersey Institute of Technology, Santosh K. Sahoo, Bhushan L. Sopori, Durga Misra, Rene Rivero and Nuggehalli M. Ravindra discuss the results of 'Impact of Interface Trap Density at Metal/SiN_x/n⁺ MOS Capacitor in Multilayered Si Solar Cells'.¹¹ Impact of the SiN_x/n⁺-Si interface on the silicon solar cell performance has been investigated, where SiN_x is used as a passivation layer. Significant shifts in capacitance, conductance and leakage current characteristics have been observed for metal/SiN:H/n⁺-Si MOS capacitor when it is subjected to a constant voltage stress at room temperature. A direct correlation between the degradation of SiN:H/Si interface and the solar cell performance is observed.

Thin-film solar cells are made from a variety of semiconductors including amorphous and polycrystalline silicon, gallium arsenide, cadmium telluride and copper indium diselenide, as well as organic semiconductors. A limitation in all thin-film solar cell technologies

is that the near-band gap absorptance is small. Therefore, structuring the thin-film solar cell, so that light is trapped inside to increase the absorptance, is very important.

P. R. Kharangarh, G. E. Georgiou and K. K. Chin of the New Jersey Institute of Technology present their studies¹² of 'Impact of Copper Back Contact in CdTe Solar Cells by Using C-V-T Measurements'. This study analyzes the impact of copper as a function of annealing temperatures during back-contact formation. The observed defect levels, formed after copper diffusion, have been identified by using the temperature-dependent capacitance–voltage (C-V) characteristics at reverse bias in the dark. Theoretical background involving recombination centers, defect density and the role of impurity defects (copper-related defects) suggests that the temperature-dependent C-V profiling is a suitable technique to investigate the copper-related defects.

The last section¹³ in this issue, by Patrick K. Bowen of Michigan Technological University, presents a book review on *Magnesium Biomaterials: Design, Testing, and Best Practice* by Nicholas Travis Kirkland and Nick Birbilis, published by SpringerBriefs in Materials. The exploration of degradable metallic biomaterials is a key area of inquiry in modern biomaterials research, and research has never been more intense than in the last decade. The authors have compiled *Magnesium Biomaterials: Design, Testing, and Best Practice*, the second volume, in the 'SpringerBriefs in Materials' series to address progress in absorbable magnesium and its alloys.

REFERENCES

1. March Meeting 2014, Denver, Colorado, USA. See <http://www.aps.org/meetings/march/index.cfm> for further details. Accessed 10/3/2014.
2. TMS 2014 143rd Annual Meeting and Exhibiton. San Diego Convention Center, San Diego, CA, USA. see <http://www.tms.org/TMSHome.aspx> for further details. Accessed 10/3/2014.
3. Venta, J. D. L.; Wang, S.; Saerbeck, T.; Ramirez, J. G.; Valmianski, I.; Schuller, I. K. Coercivity enhancement in V₂O₃/Ni bilayers driven by nanoscale phase coexistence. *Applied Physics Letters* **2014**, *104*, 062410–062405.
4. Session L30: Graphene Devices: Fabrication, Characterization and Modeling: Nanomechanics. see <http://meetings.aps.org/Meeting/MAR14/Session/L30> for further details. Accessed 10/3/2014.
5. Nanomaterial - 2014 TMS R. F. Mehl Medal Symposium on Frontiers in Nanostructured Materials and Their Applications. see http://www.tms.org/meetings/annual-14/AM14tech_Nanomaterials.aspx for further details. Accessed 10/3/2014.
6. Wasio, N. A.; Quardokus, R. C.; Forrest, R. P.; Lent, C. S.; Corcelli, S. A.; Christie, J. A.; Henderson, K. W.; Kandel, S. A. Self-assembly of hydrogen-bonded two-dimensional quasi crystals. *Nature* **2014**, *507*, 86–89.

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7. Pospischil, A.; Furchi, M. M.; Mueller, T. Solar-energy conversion and light emission in an atomic monolayer p–n diode. *Nature Nanotechnology Letters* **2014**, DOI: 10.1038/NNANO.2014.14.
 8. Choudhary, B. P.; Singh, N. B. Barium oxide–doped silver phosphate glass. *Emerging Materials Research* **2014**, 3(2).
 9. Thanganathan, U.; Nogami, M. Influence of glutaraldehyde cross-linking with polymer/heteropolyacid membranes. *Emerging Materials Research* **2014**, 3(2).
 10. Bhusari, G. S.; Umare, S. S.; Chandure, A. S. Synthesis, characterization and biodegradation studies of poly(ester-urethane)s. *Emerging Materials Research* **2014**, 3(2).
 11. Sahoo, S. K.; Sopori, B. L.; Misra, D.; Rivero, R.; Ravindra, N. M. Impact of interface trap density at metal/SiN_x/n⁺ MOS capacitor in multilayered Si solar cells. *Emerging Materials Research* **2014**, 3(2).
 12. Kharangarh, P. R.; Georgiou, G. E.; Chin, K. K. Impact of copper back contact in CdTe solar cells – study of defects by temperature dependent capacitance voltage measurements. *Emerging Materials Research* **2014**, 3(2).
 13. Bowen, P. K. Book review: Magnesium Biomaterials: Design, Testing, and Best Practice, Nicholas Travis Kirkland and Nick Birbilis, SpringerBriefs in Materials. *Emerging Materials Research* **2014**, 3(2).