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EDITORIAL

Materials Properties and Manufacturing Processes

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Materials properties highly depend on the manufacturing processes. In this issue, nine recent studies reported on how to understand and improve the (i.e., optical, mechanical, thermal, piezoelectric, etc) with the manufacturing processes for different applications. Sun *et al*. (doi: 10.30919/esmm5f605) provided a comprehensive review on the recent progress in hot embossing of polymer materials for micro/nanoscale manufacturing, including plate-to-plate, roll-to-plate, and roll-to-roll forms. Research in simulation and mold fabrication for hot embossing were discussed, the various applications of polymer processing were highlighted with systematic catalogs, and challenges and future directions were outlooked.

In the area of piezoelectrics, polyvinylidene fluoride (PVDF) attracts much attention for energy harvesting because of its superior elastic properties, high flexibility and low cost. In the work by Han *et al*. (doi: 10.30919/esmm5f612), they developed a novel approach to increase the β-phase concentration of electrospun PVDF nanofibers during the manufacturing process. With comprehensive materials characterizations with SEM, Energy Dispersive X-ray, and infrared spectroscopy, they found that high-quality PVDF fibers can be obtained by high molecular weight with electrospinning, and confirmed the improved polarization of PVDF fibers with zinc oxide nanoparticle dopants. Wu el al. (doi: 10.30919/esmm5f601) demonstrated the improved interlaminar shear strength by 28.4% and impact toughness by 53.3% of carbon fibers unsaturated polyester composites by a vinyl ester sizing agent containing vinyl-functional carbon nanotubes. After studying the surface characteristics and interfacial properties of the composites before and after treated with the sizing agent, the improved wettability, chemical bonding and mechanical interlocking were found to be associated with the enhanced interfacial adhesion by the sizing agent.

In the communication by Tian *et al*. (doi: 10.30919/esmm5f603), the microwave dielectric properties of $Li_6Mg_7Zr_3O_{16}$ ceramics prepared with the pure cubic phase using the traditional solid state method were studied, which are important for microwave communication applications. It was found that the sintering temperatures of 1500 °C yielded the best properties of high quality factor $Q{\cdot}f$ value of 81,284 GHz (at 8.94 GHz), dielectric constant of 14.22, and a near-zero temperature coefficient of the resonant frequency (τ_f) of -21.56 ppm/°C. By doping with different LiF additives, the ceramics samples with 5 wt% LiF achieved a lower densification temperature of 1100 °C, with improved above properties of 132,600 GHz (at 9.26 GHz), 13.67, and -18.89 ppm/°C.

Moving from microwave to optical frequencies, Taylor *et al*. (doi: 10.30919/esmm5f607) investigated the temperature-dependent optical properties of phase-change VO_2 thin films on quartz substrate prepared by two-step furnace oxidation method within visible and near-infrared regime. In-situ temperature dependent spectroscopy was used to measure the dramatic change in transmission due to VO_2 phase transition, and more importantly, in a wide temperature range from 77 K to 750 K that revealed the excellent thermal stability of both insulating and metallic phases at cryogenic and high temperatures. The findings are important for VO_2 in many applications in particular for space thermal control and optical propulsion.

The thermal effect on the nanostructured materials is also critical for high-temperature solid-state applications like thermoelectric power generation. In the study by Hao *et al*. (doi: 10.30919/esmm5f608), the annealing effect at temperatures above 1073 K on the nanoporous silicon thin films prepared by electron beam lithography followed by deep reactive ion etching was studied. With various annealing conditions and careful inspections with SEM, they found that the pore size can greatly shrink for suspended thin films, while it can be kept intact with the mechanical protection of SiO_2/Si substrate from the thermal strain.

By loading phase change material as temperature management agent into the lightweight sand with surface pores sealed by water for internal curing, Liao *et al*. (doi: 10.30919/esmm5f606) demonstrated a multifunctional aggregate for mitigating the damage of concrete due to thermal cracking. A mortar prepared from this aggregate achieved

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comparable 28-day strength to the reference mortar with 63% lower autogenous shrinkage. The semi-adiabatic temperature rise was 7 ℃ lower, along with slowed peak temperature occurrence and smoother cooling curve. Cai *et al*. (doi: 10.30919/esmm5f611) employed a method of chemical reaction along with freeze-drying and high-temperature annealing and successfully synthesized the reduced graphene oxide/amino multi-walled carbon nanotubes aerogel. Materials characterizations verified the strong chemical bonding with enhanced hydrophobic properties. They demonstrated that the manufactured aerogel could separate oil and water within 25 s with good promise for oil spill treatment.

In addition to materials characterizations and manufacturing processes, numerical methods are also important for optimizing many processes. Wang *et al*. (doi: 10.30919/esmm5f615) studied a new self-adaptive differential evolution algorithm based on machining learning to optimize the reduced mechanism of 2-Butanone and its superior performance was verified by the comparison of commonly used generic algorithm and particle swam algorithm.

In summary, manufacturing processes play a vital role in achieving enhanced materials properties for energy harvesting, thermal control, optical communication, construction, oil spill treatment, while novel manufacturing processes and exotic materials properties along with new numerical methods are to be fully explored for many other areas of applications.