(EAM-P010-2018) Samaria-doped ceria with impregnation of molten lithium/potassium carbonate for application as CO_2 separation membranes

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Composite membranes for carbon dioxide separation were obtained with vacuum infiltration of an eutectic mixture of potassium and lithium molten carbonates into a samaria-doped ceria (SDC) porous matrix at high temperature. Porous SDC were obtained by thermal removal of LiF sacrificial pore former. Scanning electron microscopy and scanning probe microscopy micrographs allowed for estimating pore volume and molten carbonate percolation through porous SDC. Impedance spectroscopy measurements at temperatures below and above the melting temperature of the carbonates show the contributions of oxide and carbonate ions to the total electrical conductivity of the ceramic membranes, which is dependent on the pore volume.

(EAM-P011-2018) Freeze casting of LAGP electrolyte for textured 3D all-solid-state lithium-ion battery multifunctional composites

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In this study, all-solid-state structural lithium-ion batteries, a type of load bearing electrochemical energy storage that provides systems-level weight savings, is being pursued for the realization of inherently safe next generation hybrid-electric and all-electric green aerospace propulsion systems. Currently investigated all-solid-state batteries do not meet the requirements for specific power and mechanical stability. To address these issues, freeze casting of lithium aluminum germanium phosphate (LAGP) electrolyte material has been explored for the creation of a textured 3D electrolyte scaffold with large interfacial surface area for high power discharge and hierarchical porosity for accommodation of active material volume changes during electrochemical cycling. We report the effects of freeze casting processing parameters on the microstructural development and mechanical performance of the scaffolds, characterized through scanning electron microscopy and ring-on-ring mechanical testing. Slurry composition and casting parameters such as solids loading, casting speed, tape angle, and temperature gradients have been modified to determine the impact on density, lamellar morphology, and final load bearing performance.

(EAM-P012-2018) Shape and size dependent phase transformations and field-induced behavior in ferroelectric nanoparticles

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Composite materials made up of ferroelectric nanoparticles dispersed in a dielectric matrix are being actively investigated for a variety of novel electronic and energy harvesting applications. However, the dependence of their functional properties on shapes, sizes, orientation and mutual arrangement of ferroelectric particles is currently not fully understood. We utilize a time-dependent Ginzburg-Landau approach combined with coupled-physics finite-element-method based simulations to study the effects of shape, size and mutual arrangement of ferroelectric nanoparticles on their polarization topology, both equilibrium and under applied electric and elastic fields. Perovskite $PbTiO_3$ and $BaTiO_3$ are employed as generic ferroelectric materials, while air and $SrTiO_3$, are used as the dielectric matrix. Particle shapes considered involve members of the superellipsoidal series, i.e., octahedron, sphere, cube and intermediate shapes. We observe a rich variety of polarization textures and interesting transitions between them, as the particle shape and size are being changed. We also find that the composite system response to an applied field, i.e., the shape of its P vs E loop, is tunable by controlling the particle size and orientation. In particular, multistage switching is possible in particles with vortex-like polarization textures, which may be useful for memory applications.

(EAM-P013-2018) Mesoscale modeling of stress induced band-gap attenuation in ZnO NanowiresMesoscale modeling of stress induced band-gap attenuation in ZnO Nanowires

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Semiconducting zinc oxide (ZnO) is a highly attractive material for nanoscale applications, since it can be easily shaped into a wide variety of different shapes, including nanopillars and nanowires. Here, we have utilized a mesoscale finite-element based modeling approach to study stress induced band-gap changes in monolithic ZnO nanowires with diameters ranging from 100 to 800 nanometers. Obtaining good agreement with experimental results for the monolithic wires, we have also investigated core/shell Zn/ZnO nanowire geometries. Size, shape, morphology, core/shell volume ratio and core protrusion beyond the shell were optimized for maximum band-gap downshifts. For the core/shell nanowire arrangements we predict downshifts in excess of 0.25 eV, as compared to the 0.1 eV maximum downshift measured in monolithic wires, which, in combination with other band-gap manipulation techniques, can greatly expand the utility of such nanostructures for optoelectronic applications.

(EAM-P014-2018) Dielectric Properties of Ferroelectric Materials on Aerospace Alloys

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The current trend of additive manufacturing aerospace components made from high-temperature alloys has led to the consideration of integrated functionality such as sensors and actuators. The combination of ferroelectric oxides and aerospace alloys to be manufactured in a single process step provokes interest over the compatibility of such materials with its different physical parameters. In this theoretical work, the effects of coefficients of thermal expansion mismatch on materials properties are examined for PZT 20/80 thin films on four conventional, aerospace alloys: Inconel 718, Ti-6Al-4V, Al6061, and stainless steel 17-4 PH. A non-linear thermodynamic model is employed to calculate dielectric, pyroelectric and piezoelectric properties as a function of growth temperature for these systems. It is found that there are shifts in the ferroelectric phase transition to higher temperatures due to compressive thermal strains. As a result, the dielectric constants of PZT 20/80 on Ti-6Al-4V, stainless steel 17-4 PH and Inconel 718 with a growth temperature (T_G) of 700 °C all surpass that of bulk PZT 20/80. The former two also have higher pyroelectric and piezoelectric coefficients than bulk, which indicate its suitability for potential applications. PZT 20/80 on Ti-6Al-4V deposited at T_G=700 °C displays the largest response of p=0.0412 $\mu C\ cm^{-2}\ {}^{\circ}C^{-1}$ and d33=97.439 pC/N at room temperature.

(EAM-P015-2018) Effect of Gd_2O_3 additives on the electrical properties of ZnO varistor at different temperatures

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The influence of Gd_2O_3 (0, 0.2, 0.5, 1, 1.5) mol% additives on electrical properties of ZnO – Pr_6O_{11} – Co_3O_4 – Cr_2O_3 – Gd_2O_3 (ZPCCG) – based varistors were studied. Samples were prepared by using the standard ceramic technique (traditional thermal chemistry method). The grain size of prepared samples was obtained by SEM.