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REACTIVITY OF SOLIDS

Editorial

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Every reaction facilitated by a solid catalyst, the fabrication of advanced materials, and many geological processes are a function of the reactivity of solids. The International Symposium on the Reactivity of Solids (ISRS) provides a forum for the discussion of all aspects of this broad and fundamentally very important topic. One of the foci for the sixteenth meeting, held in Minneapolis, was the exploration of reactive materials for clean technology applications.

As we begin to address the challenge of moving beyond fossil fuels, either because of the reality of global climate change or because of diminishing supplies and rising prices, we are looking at the role of advanced materials, often nanomaterials, in enabling a low cost and abundant supply of energy to satisfy global demand.

The paper by Perry et al. examines the properties of nanocrystalline yttria-stabilized zirconia (YSZ). Fast oxygen ion conduction at high temperatures in YSZ has been known for some time. Unfortunately the technology is not presently commercially viable, in large part, because of the high temperatures required and the problem of interfacial reactions. Using nanocrystalline YSZ (grains less than 100 nm) may improve transport properties at lower temperatures. Kang et al. describe first cycle irreversibility in lithium oxides, which are used as cathodes in lithium-ion batteries. Their study provides an understanding of the origin for this irreversibility and also a means for recovering the lost cell capacity. Vanadium oxide nanostructures have been studied as possible alternatives for cathode materials in lithium-ion batteries. Roppolo et al. from SUNY Binghamton present a synthesis method for novel vanadium oxide nanostructures. The experimental conditions needed to control the morphology are described.

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Currently hydrogen is produced on an industrial scale through steam reforming of natural gas. Developing diverse cost–competitive sources for hydrogen is one of the challenges for the hydrogen economy. Miller et al. and Gstoehl et al. describe thermochemical water-splitting cycles for hydrogen.

Kohlstedt and Mackwell have studied the role of hydrogen on diffusion in oxides and silicates. These studies are very relevant in the earth sciences because of the abundance of hydrogen. There may be significant implications of these studies on minerals in understanding how hydrogen behaves in materials designed for hydrogen storage: another challenge for the hydrogen economy.

Wilding et al. report the use of neutron and high-energy X-ray diffraction to study the structure of magnesium silicate liquids. These liquids dominate the early history of the earth, and their properties such as viscosity and diffusions are considered important in the evolution of our planet. These studies are also changing how we view glass structures.

Many of the processes used to make materials involve reactions between a solid and a gas (e.g., in chemical vapor deposition of thin films), a solid and a liquid (e.g., in flux growth of gemstones), or between two or more solids (e.g., in solid-state synthesis of ceramics). The process to create a solid often involves both nucleation and growth. Favergeon et al. describe a two-dimensional model for nucleation during thermal decomposition of solids. The model seeks to address questions related to critical size of a nucleus and its shape. The model was compared to experimental data obtained by the dehydration of lithium sulfate hydrate single crystals. Kurokawa and Senna describe how to control the aspect ratio of acicular goethite particles obtained from solution. Both nucleation and growth processes are shown to be important in obtaining high aspect ratio crystals. Ishigaki et al. describe the melt synthesis of oxide phosphors. Related multi-component oxides have applications as sensors and catalysts.