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GUEST EDITORIAL

Sol–Gel Chemistry and Materials

The sol–gel synthesis of materials based on the hydrolysis and condensation of molecular precursors is used to prepare a wide range of inorganic materials. This procedure gives sols, colloidal particles suspended in a liquid that progress through a gelation process to finally form two interpenetrating networks—the solid phase and the solvent phase. Although the roots of sol–gel chemistry can be traced to the 19th century, only during the past 30 years has the field witnessed remarkable growth in sophistication and applications. Increased interest in sol–gel materials has paralleled the emergence of materials chemistry and the recognition of the vast common ground between the chemistry and materials science communities.

It is tempting to consider the 1970s as the era of the rise of the sol–gel materials field, but there were a number of earlier contributions that demonstrated some of the types of materials available with this synthesis approach. The sol–gel synthesis of colloidal particles and the deposition of thin films date back to the 1950s. Thus, sol–gel approaches were used to prepare nanodimensional inorganic materials well before the terms nanoscience and nanotechnology were popularized. Beginning in the late 1970s, researchers active at the interface between chemistry and materials science recognized the possibilities provided by sol–gel methods. Much of this interest evolved from glass science, since the ability to form inorganic glasses without melting, the synthesis of glass compositions that could not be achieved by melting, and the ability to exploit the solution nature to form glasses as fibers, films, or bulk materials (termed monoliths) represented an extraordinary combination of potential opportunities. The renewed interest in sol–gel materials occurred at a time when noncrystalline solids were being widely investigated for uses in optical communications. Multiple contributions to this special issue show the continuing active interest in sol–gel methods for optical applications, but emphasis has evolved from the scientific understanding of optical properties to the design of sol–gel materials as optical components and devices.

This special issue highlights several of the most scientifically and technologically active areas in the sol–gel field. The papers are organized roughly into five categories: studies of silica-based sol–gel materials, non-silica-based materials, sol–gel biological materials, porous sol–gel materials, and optical sol–gel materials. One of the underlying themes in several papers is the growing sophistication in synthesizing materials with designed chemistry and morphology. This is particularly evident when authors discuss hybrid materials. These materials are largely based on the use of sol–gel approaches to combine organic and inorganic functionalities. The versatility demonstrated in these materials is exceptional, as the range of materials extends from those with local organic groups attached to an inorganic framework to those materials composed of interpenetrating organic and inorganic networks. For a number of years, sol–gel methods have been used to synthesize an exciting generation of materials at the interface between physical science and biology. The contributions to this special issue show the breadth of this active research area and its emerging applications.

Another unique feature of sol–gel materials is control of pore–solid architecture. There is extraordinary control not only of the size (mesopores of 2–50 nm) but also the arrangement of pores within the inorganic (or organic/inorganic) framework. The design of materials with specific architectures is enabling researchers to obtain unique properties in such diverse areas as drug delivery and electrochemistry.

We hope that this issue inspires readers to continue the study of sol–gel materials chemistry. The sol–gel approach is truly a "bottom-up" method, and as new directions develop in the fields of nanoscience and nanotechnology, new opportunities in the sol–gel field will abound.

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