

Inorganic Clathrates: Structure-Property Relations and Potential Applications

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Open-framework materials, also referred to as inclusion compounds, can be thought of as guest-host complexes whereby atoms or molecules of one constituent form “cages” that can encapsulate other constituents within the crystal structure. Clathrate hydrates, in which face-sharing polyhedra formed by oxygen bonds enclose guest species, is one example and have been known for well over a century. The tetrahedral bonding found in clathrate hydrates are typical of group 14 elements. Thus isostructural inorganic compounds in which group 14 elements form the framework host lattice with alkali-metals, alkaline-earth, rare-earth or less-common metals as guest species within these polyhedra also exist. In particular, silicon clathrates have been known since the work of Cros and co-workers almost five decades ago. Nevertheless, processing new compositions and the novel properties associated with their guest-host interactions continue to be of interest, both from a fundamental standpoint and for technical applications. Furthermore, new materials research via growth and processing by traditional techniques is especially challenging and new synthetic techniques are essential in investigating the fundamental properties of new and novel group 14 clathrates. I will provide a brief overview of silicon clathrates and present some of the new and novel work in the field while concentrating on our work and developments.