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### **Barochemistry: Predictive Solid State Chemistry<sup>1</sup>**

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The application of compression energy comparable to that of chemical bonds, but substantially greater than those of defects and grain boundaries in solids allows us to pursue novel concepts of high-pressure chemistry (or barochemistry) in materials development by design. At such extreme pressures, simple molecular solids convert into densely packed extended network structures that can be predicted from first principles. In recent years, a significant number of new materials and novel extended structures have been designed and discovered in highly compressed states of the first- and second- row elemental solids, including Li, C, H<sub>2</sub>, N<sub>2</sub>, O<sub>2</sub>, CO, CO<sub>2</sub>, and H<sub>2</sub>O. These extended solids are extremely hard, have high energy density, and exhibit novel electronic and nonlinear optical properties that are superior to other known materials at ambient conditions. However, these materials are often formed at formidable pressures and are highly metastable at ambient conditions; only a few systems have been recovered, limiting the materials within a realm of fundamental scientific discoveries. Therefore, an exciting new research area has emerged on the barochemistry to understand and, ultimately, control the stability, bonding, structure, and properties of low Z extended solids. In this paper, we will present our recent research to develop hybrid low Z extended solids amenable to scale up synthesis and ambient stabilization, utilizing kinetically controlled processes in dense solid mixtures and discuss the governing fundamental principles of barochemistry.

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