Chemical Aspects of Three-Dimensional Photonic Crystals

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Three-dimensional (3D) photonic crystals are crystalline materials with periodically modulated refractive index on a length scale comparable to the wavelength of light. A photonic crystal that has complete photonic bandgaps can reflect incident light from any direction. In this review, we will focus on the chemical aspects in fabrication of high index 3D photonic crystals, specifically, recent advancement and breakthrough in large area fabrication with high fidelity. First, we discuss different approaches to create 3D photonic structures via self-assembly and lithography-based techniques, including microphase separation of block copolymers, colloidal assembly, holographic lithography and phase mask interference lithography, and two photon lithography. The directly fabricated 3D structures are then used as templates for backfilling of high index inorganic materials. We overview various backfilling chemistries, including chemical vapor deposition (CVD), atomic layer deposition (ALD), sol-gel reactions, supercritical deposition, electrochemical deposition, and chemical reduction, and discuss their advantages and limitations.