Three-dimensional photonic crystals (3D PhCs) enable light manipulations in all three spatial dimensions, however, real-world applications are still faced with challenges in fabrication. Here, a facile fabrication strategy for 3D silicon PhCs with a simple cubic (SC) lattice structure is presented, which exhibits a complete photonic bandgap at near-infrared wavelengths of around 1100 nm. The fabrication process is composed of standard deep ultra-violet stepper lithography, followed by a single-run modified plasma etch process.

By applying a direct dry etch release step at the end of the 3D structural etch process, the fabricated 3D PhCs can be released and transferred in the form of a membrane onto other substrates such as glass, polymers, or even substrates with engineered surface. The thickness of the demonstrated membranes is around 2 μm and the size can be up to a few millimeters. A high reflectivity is observed at the stop band frequency, and a planar defect is introduced during the etching process resulting in an optical resonance mode with a small linewidth of around 30 nm. The structure constitutes an optical bandpass filter and can be used as a sensor for organic solvents.