Photonic band gap synthesis by optical phase mask lithography

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We provide a simple and efficient approach for fabricating diamond architecture photonic crystals with large photonic band gaps (PBG's) using single-exposure, single-beam, optical interference lithography based on diffraction of light through an optical phase mask (OPM) [1]. The OPM consists of two, orthogonally-oriented, binary gratings joined by a thin, solid layer of homogeneous material. Illuminating the OPM at normal incidence produces a five-beam diffraction pattern which can be used to expose a suitable photo-resist and produce a photonic crystal template. The diffraction pattern resulting from the illumination of an appropriately designed OPM exhibits isointensity surfaces corresponding to a diamond-like (face centered cubic) structure, with high intensity contrast. When the photo-resist templates are replicated with silicon, with dielectric contrast 11.9 to 1, the resulting photonic crystals have optimized PBG's of up to 24% of the gap center frequency. The existence of OPM's, capable of encoding the entire architecture of 3D PBG materials, raises prospects for simple, low cost, mass production of photonic crystals.

[1] T.Y.M. Chan, O. Toader, and S. John, *Phys. Rev. E*, **73**, 046610 (2006).