Abstract Title

Three-dimensional lithography for photonic microstructures

Symposium Track

Authors' names

D. N. Sharp[1], O. M. Roche[1], J. Scrimgeour[1], R. G. Denning[2] and A. J. Turberfield[1]

Authors' affiliations

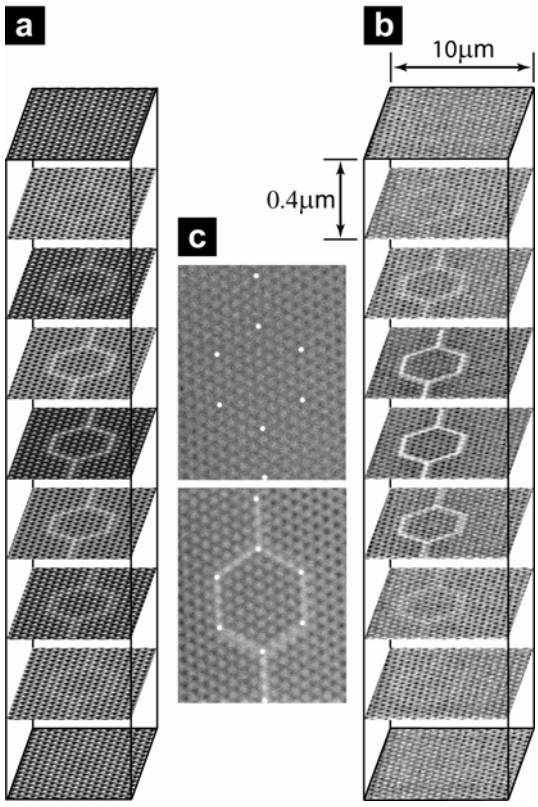
1. *University of Oxford, Department of Physics, Clarendon Laboratory, Oxford, OX1 3PU, United Kingdom*
2. *University of Oxford, Department of Chemistry, Inorganic Chemistry Laboratory, Oxford, OX1 3QR, United Kingdom*

Abstract body

Holographic lithography (HL) is a flexible technique for the fabrication of three-dimensional (3D) photonic crystals with the submicron periodicity required for optical and near-IR applications[1]. We demonstrate two key steps towards the creation of integrated optical devices based on waveguides and microcavities operating within a complete photonic band gap:

1) infiltration of a holographically-defined polymeric 3D photonic crystal template with high-index dielectric by Atomic Layer Deposition (ALD)[2];
2) creation of localised structural defects embedded in, and in registration with, a 3D photonic crystal by direct two-photon laser writing[3].

Structural and optical characterisation of TiO_2 photonic crystals produced by infiltration and removal of the polymer template demonstrates the high quality of the negative replica. Structural characterisation of photonic crystals with embedded defects shows a faithful rendering of the designed structure in the developed polymer photonic crystal. The combination of these three techniques (HL, two-photon writing and ALD) maps out a clear route to device fabrication in high-index 3D photonic crystals.



Latent image of a test device created by sequential holographic and scanning two-photon optical exposure. a) the target structure: the sum of the calculated photoacid densities created in the two-step exposure process. **b)** experimentally measured photoacid density: confocal sections are recorded at 0.4 μm intervals. **c)** (top) confocal section recorded after holographic exposure and used to align the waveguide-writing step and (bottom) the corresponding section after waveguide writing. The overlay of white dots indicates reference points used to align the test device.

Keywords

References

[1] M. Campbell, D. N. Sharp, M. T. Harrison, R. G. Denning and A. J. Turberfield. "Fabrication of photonic crystals for the visible spectrum by holographic lithography." *Nature* 404, 53, (2004).

[2] J. S. King, E. Graugnard, O. M. Roche, D. N. Sharp, J. Scrimgeour, R. G. Denning, A. J. Turberfield and C. J. Summers. "Infiltration and inversion of holographically-defined polymer photonic crystal templates by atomic layer deposition." *Advanced Materials* (manuscript accepted).

[3] J. Scrimgeour, D. N. Sharp, C. F. Blanford, O. M. Roche, R. G. Denning and A. J. Turberfield. "Three-dimensional optical lithography for photonic microstructures." *Advanced Materials* (manuscript accepted).

Corresponding author contact information

Email: d.sharp1@physics.ox.ac.uk