

Advances on e-beam fabrication of photonic crystal membranes

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In a recent publication¹, we show how free-standing 2D photonic crystals (PC), made by etching a quadratic 490 nm lattice of 290 nm diameter holes in a dielectric membrane, can be used to make a novel nano-particle sensor. The sensor works by enhancing the scattered light from particles trapped in the photonic crystal membrane. It is designed to be applied in bio-sensing, and can potentially provide single molecule sensitivity with wide dynamic range.

Previously the fabrication of the PC membranes was done by depositing dielectric thin films on Si-substrates, followed by e-beam lithography and reactive-ion etching for patterning. TMAH-etching was finally used to free the membranes from the substrate. The latter step can lead to optical degradation, since it involves exposure of the photonic crystal structure to the TMAH-etch, or requires a spin-coated etching mask to protect the crystal. This mask tends to leave residue in the pattern of holes.

Here we present a new fabrication technique, which avoids problems related to the TMAH-etch. We have developed a fabrication technique where e-beam lithography is done directly on free-standing dielectric membranes. The detailed summary of the procedure is given in Figure A. SEM images of the fabricated structures are given in Figure B. SEM images of the PC membranes made with the previous fabrication technique are given in Figure C.

A comparison of images in Figure B and C, show how the structural quality is contained with the new fabrication technique.

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¹ J. O. Grepstad et al., Opt. Express, 20, p.7954 (2012)

Figure A) Fabrication steps

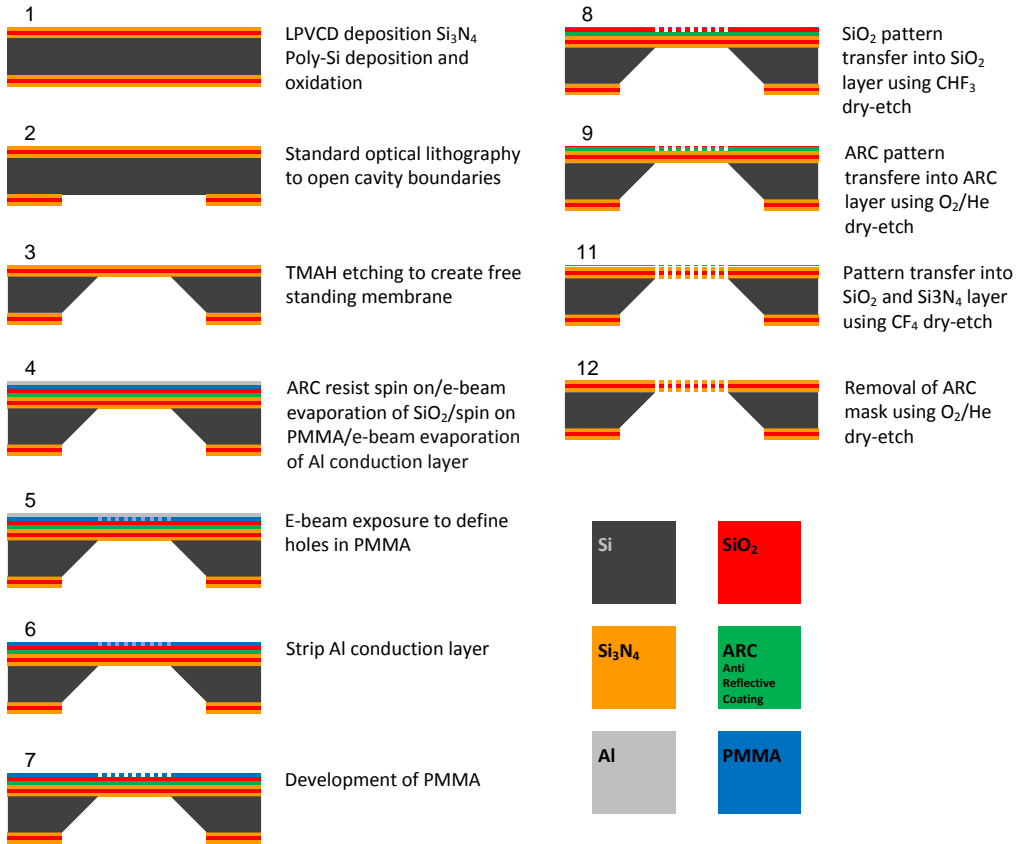


Figure B) SEM image of photonic crystal membrane made using the fabrication technique described in Figure A.

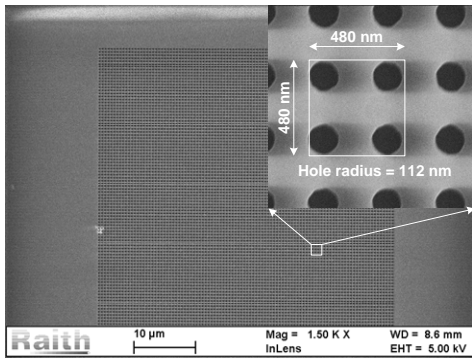


Figure C) SEM image of photonic crystal membrane made using old fabrication technique, where free etching of the membranes using TMAH was the final fabrication step¹

