Disordered photonic materials derived from three dimensional hyper uniform point patterns

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We discuss the mesoscale fabrication and characterization of (polymeric) templates for isotropic photonic materials derived from hyperuniform point patterns using direct laser writing in a polymer photoresist. We study experimentally the microscopic structure by electron microscopy and small angle light scattering. Reducing the refractive index mismatch by liquid infiltration we find good agreement between the scattering data and numerical calculations in the single scattering limit. We are able to fabricate templates with the typical structural length scale of the seed pattern from a = 3.3 micron to a = 2micron, fairly close to the technologically relevant fiber-optic communications wavelength range around 1.5 micrometer. We have employed scanning electron microscopy coupled with focused ion beam cutting to look inside the bulk of the samples of different height. Moreover we demonstrate the use of laser scanning confocal microscopy to assess the real space structure of the samples fabricated by direct laser writing. We address in detail question about scalability, finite size effects and geometrical distortions. We also study the effect of the lithographic voxel shape, that is the ellipsoidal shape of the laser pen used in the fabrication process. To this end we employ detailed numerical modelling of the scattering function using a discrete dipole approximation scheme.

1. J. Haberko, N. Muller and **F. Scheffold**, Direct laser writing of three dimensional network structures as
templates for disordered photonic materials, submitted to Phys. Rev. A

2. J. Haberko and **F. Scheffold**, *Fabrication of three-dimensional disordered photonic materials from hyperuniform point patterns*, Optics Express, Vol. 21, Issue 1, pp. 1057-1065 (2013)