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Towards Three-Dimensional Photonic Metamaterials

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Summary

Metamaterials are man-made composite structures composed of metallic subwavelength scale functional building blocks that are densely packed into an effective material [1,2]. This approach especially allows for artificial magnetism at elevated frequencies. At optical frequencies, however, almost all published nanostructures consist of just a single functional layer. The resulting designs hardly qualify as a "material" in the usual sense (with few notable exceptions [3,4]). Thus, one of the main challenges in this field lies in the realization of *three-dimensional* (3D) rather than planar structures.

Direct Laser Writing (DLW) can be viewed as the 3D analogue of 2D electron-beam lithography and has recently emerged as a reliable standard tool for fabricating 3D polymeric templates (see, e.g., www.nanoscribe.de) with lateral resolutions down to 100nm. Subsequent coating of these polymeric structures with metals (e.g., silver) via Chemical Vapor Deposition (CVD) appears to be a promising route towards 3D photonic metamaterials (schematically illustrated in Fig.1).

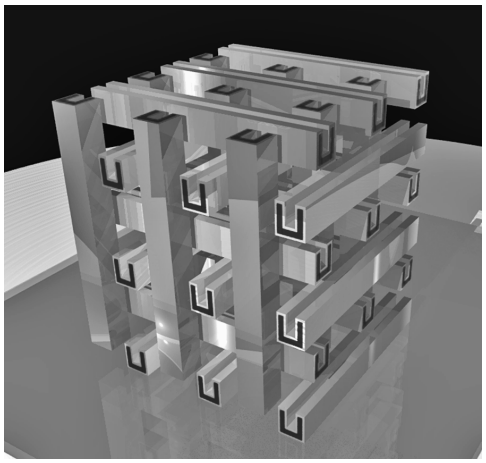

Figure 1: Artist's view of a 3D photonic metamaterial composed of elongated split-ring resonators made by DLW of a polymeric backbone and subsequent coating via metal CVD.

Here, we report on first experimental steps in this direction. Precisely, we show that our CVD silver films are of sufficient quality in that their optical properties follow

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the expected Drude-type behavior. Furthermore, we have implemented first simple blueprints for metamaterials that acknowledge the conceptual boundary conditions of the DLW-CVD approach (i.e., only connected metal films can be made).

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