Three-dimensional polymer and silicon inverse photonic quasicrystals for infrared frequencies

Alexandra Ledermann[1], Ludovico Cademartiri[2], Martin Hermatschweiler[1], Costanza Toninelli[3], Geoffrey A. Ozin[2], Diederik S. Wiersma[3], Martin Wegener[1], and Georg von Freymann[1]

[1]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft, D-76021 Karlsruhe, Germany, DFG-Center for Functional Nanostructures (CFN) and Institut für Angewandte Physik, Universität Karlsruhe (TH), Wolfgang-Gaede-Straße 1, D-76131 Karlsruhe Germany

[2]Department of Chemistry, University of Toronto, 80 St. George Street, Toronto, Ontario, M5S 3H6, Canada

[3]European Laboratory for Nonlinear Spectroscopy (LENS) and INFM, I-50019-Sesto Fiorentino, Firenze, Italy

Quasicrystals represent a class of solids which lack translational symmetry, but nevertheless exhibit perfect long-range order and reveal well-defined rotational symmetries, which are not necessarily consistent with periodicity. The existence of long-range order, the possibility of high-fold rotational symmetries and the distinct local environment of each quasicrystal lattice point promise richer optical properties than for photonic crystals.

Using direct laser writing [1] we fabricate three-dimensional icosahedral SU-8 photonic quasicrystals of high quality, characterized by electron microscope images and visible-light Laue diffraction experiments [2]. The latter clearly reveal the expected rotational symmetry. Reflectance measurements indicate a stop band in the infrared.

These SU-8 structures serve as templates for a subsequent novel silicon inversion procedure [3]. Electron microscope images and Laue diffraction patterns prove the successful fabrication of the silicon inverse photonic quasicrystals.

This work paves the road for future work on low- or high-index contrast photonic quasicrystals, e.g., on anomalous diffusion of light or nonlinear optical properties.

[1] M. Deubel, G. von Freymann, M. Wegener, S. Pereira, K. Busch, and C. M. Soukoulis, *Nature Materials*, **3**, 444 (2004).

[2] A. Ledermann, L. Cademartiri, M. Hermatschweiler, C. Toninelli, G. A. Ozin, D. S. Wiersma, M. Wegener, and G. von Freymann, *Nature Materials,* **5**, 942 (2006).

[3] M. Hermatschweiler, A. Ledermann, G. A. Ozin, M. Wegener, and G. von Freymann, submitted (2006)**.**