Three-dimensional optical metamaterials and nanoantennas: Chirality, Coupling, and Sensing

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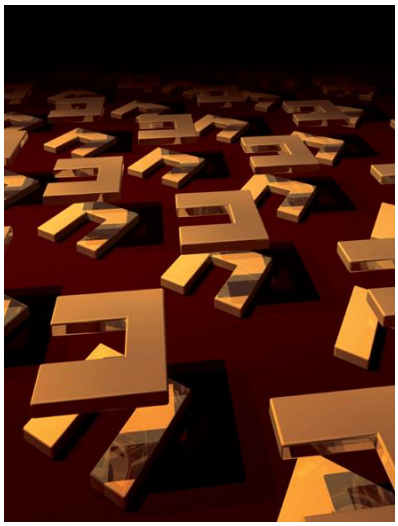
Metallic metamaterials have shown a number of fascinating properties over the last few years. A negative refractive index, negative refraction, superlenses, and optical cloaking are some of the ambitious applications where metamaterials hold great promise.

We are going to present fabrication methods for the manufacturing of 3D metamaterials [1]. We are investigating their coupling properties and the resulting optical spectra. Hybridization of the electric [2] as well as the magnetic [3] resonances allows us to easily understand the complex optical properties. Lateral as well as vertical coupling can result in Fano-resonances [4] and EIT-like phenomena [5, 6]. These phenomena allow to construct novel LSPR sensors with a figure of merit as high as five [7].



The connection between structural symmetry and their electric as well as magnetic dipole and higher-order multipole coupling will be elucidated. It turns out that stereometamaterials [8], where the spatial arrangement of the constituents is varied (see figure), reveal a highly complex rotational dispersion. The chiral properties are quite intriguing and can be explained by a coupled oscillator model.

Our three-dimensional stacking approach allows also for the fabrication of 3D nanoantennas, which are favorable for emitting and receiving radiation from quantum systems [9].

References

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