Three-dimensional complex plasmonic structures: Chirality, Coupling, and Sensing Applications

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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 as well as the magnetic resonances allows us to easily understand the complex optical properties [2]. Lateral as well as vertical coupling can result in Fano-resonances [3] and EIT-like phenomena [4]. These phenomena allow construction of novel LSPR sensors with a figure of merit as high as five [5]. Nanooptics can also aid antenna-enhanced hydrogen sensing [6] and sensitive nonlinear optical nanoantenna-enhanced pump-probe experiments that detect mechanoplasmonic oscillations [7]. Additionally, more complex structures can act as 3D plasmon rulers [8]. By tuning from near-field to far-field coupling [9], additional phase shifts are introduced, and the classical analog of plasmonic electromagnetically induced absorption (EIA) is observed [10].

Our three-dimensional stacking approach allows also for the fabrication of 3D nanoantennas, which are favorable for emitting and receiving radiation from quantum systems [11, 12], as well as 3D plasmonic Bragg structures with an octave wide bandgap [13].

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