Highlights

Other Materials - 2016

A hybrid tunable THz metadevice using a high birefringence liquid crystal

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We investigate a hybrid re-configurable three dimensional metamaterial based on liquid crystal as tuning element in order to build novel devices operating in the terahertz range. The proposed metadevice is an array of meta-atoms consisting of split ring resonators having suspended conducting cantilevers in the gap region. Adding a "third dimension" to a standard planar device plays a dual role: (i) enhance the tunability of the overall structure, exploiting the birefringence of the liquid crystal at its best, and (ii) improve the field confinement and therefore the ability of the metadevice to efficiently steer the THz signal. We describe the design, electromagnetic simulation, fabrication and experimental characterization of this new class of tunable metamaterials under an externally applied small voltage. By infiltrating tiny quantities of a nematic liquid crystal in the structure, we induce a frequency shift in the resonant response of the order of 7–8% in terms of bandwidth and about two orders of magnitude change in the signal absorption. We discuss how such a hybrid structure can be exploited for the development of a THz spatial light modulator.

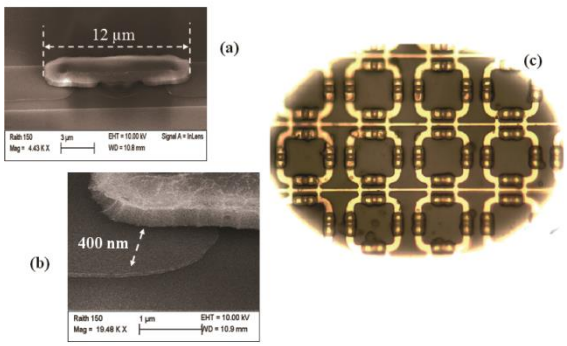

Figure 1. Details of the fabricated meta device. SEM magnification of (**a**) the mushroom-shaped structure formed by two adjacent cantilevers on each side of the gap and (**b**) a single cantilever. (**c**) Optical image (× 100) of the final hybrid meta-device after LC infiltration (and without the cover PET/ITO electrode).

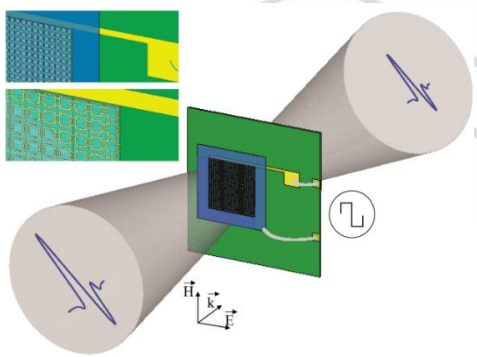

Figure 2. Sketch of the experimental set-up used to test the tunability of the metamaterial response.

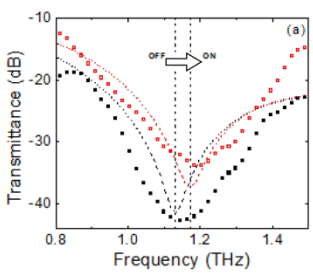

Figure 3. Transmission spectra of the hybrid metamaterial measured at zero bias (state OFF, full black square points) and at 10 V (state ON, open red square points). Dashed curves refer to the results of simulations (OFF, black line; ON, red line), assuming a LC not perfectly aligned with the THz field in the unpolarized state and with a complex anisotropic dielectric permittivity (see text for details). Dashed vertical lines highlight the frequency blue shift switching the metadevice from OFF to ON.