Tunable Metamaterials Based on Liquid Crystals at THz Frequencies

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Abstract: The search for new low loss nematic liquid crystal mixtures with enhanced birefringence and low temperature of nematic-to-isotropic phase transition plays a pivotal role in a development of new applications of electrically and thermally tunable metamaterials. Here, electrically and thermally switchable terahertz metamaterials employing a specially designed nematic liquid crystal mixtures are proposed. It is shown that the resonant response of a metamaterial devices can be effectively tuned both in terms of its magnitude and wavelength. Electromagnetic simulations confirm tests and match the experimental observations well. The suggested approach opens new routes for next-generation soft-matter-based filtering and sensing components and devices.

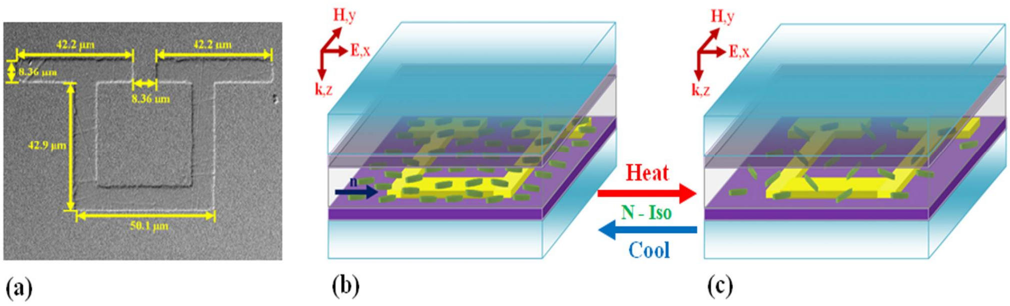

Fig. 1. Thermally reconfigurable photonic metamaterial. Schematic impression of hybrid liquid-crystal cell with microstructured metasurface (yellow) supported by quartz glass (blue) coated with a thin film of uniformly rubbed polyimide (violet). (a) Scanning electron microscope (SEM) image of a single metamolecule. The liquid crystals can exist in two phases. (b) In one phase, the molecules (green) tend to line up; this is called the nematic phase. The vector *n* denotes the local director field. (c) At sufficiently high temperatures, a nematic-to-isotropic phase transition occurs, and the crystalline phase disassociates into an isotropic phase in which the molecules have no preferred orientation. On cooling, the isotropic material returns to the original liquid crystalline state, *i.e.*, the process is completely continuous and is reversible.

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