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Ultrathin optical switch based on a liquid crystal/silver nanoparticles mixture as a tunable indefinite medium

Elisa Spinozzi, Alessandro Ciattoni

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We predict that a liquid crystal/silver nanoparticles mixture can be designed so that, in a frequency range, its effective ordinary and extraordinary permittivities have real parts of different signs. We exploit this result to design a nano-photonic device obtained by sandwiching a few hundred nanometer thick slab of the proposed mixture between two silica layers. By resorting to full-wave simulations, we show that, by varying the direction of an externally applied electric field, the device can be used as an optical modulator since its transmissivity can be switched between 0.02 and 0.4 at a wavelength close to the frequency range where the medium is indefinite. The device functionality physically stems from the fact the orientation of the hyperbola characterizing extraordinary waves within the indefinite medium follows the applied electric field direction and therefore, if the hyperbola asymptote is nearly normal to the slab, full switch between evanescent and homogeneous propagating waves can be achieved within the medium.

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