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Synthesis and study of composite silver-polymer metamaterials

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— We have designed, synthesized and characterized a range of non-magnetic metamaterials with continuously tunable dielectric constant. Powders of 30 nm silver nanoparticles were suspended in Tetrahydrofuran solution of Polymethylmethacrylate and exposed to Q-switched laser radiation in order to separate nanoparticles and/or reduce the degree of aggregation. The films of Ag-PMMA composites with different concentrations of silver nanoparticles N were deposited onto glass substrates and characterized in optical transmission and reflection experiments. Using known formula for reflectivity and transmissivity in three-layered structures, we extracted from the experimental data the spectra of real ε_{eff}'(λ) and imaginary ε_{eff}"(λ) parts of the effective dielectric constants. The experimental maximal value of ε_{eff}' exhibited monotonous growth and reached ε'=12.8 at λ=2.4 μm at the maximal concentration of Ag nanoparticles studied. The demonstrated value of ε_{eff}' exceeds that in Si and appears to be the highest in 1.5-2.5 μm spectral range. The demonstrated easy-to-synthesize nanocomposite adds to the tool box of photonic metamaterials with extreme values of ε.

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