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Title: Flexible Visible-Infrared Metamaterials and Their Applications in Highly Sensitive Chemical and Biological Sensing
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Abstract: Flexible electronic and photonic devices have been demonstrated in the past decade, with significant promise in low-cost, light-weighted, transparent, biocompatible, and portable devices for a wide range of applications. Herein, we demonstrate a flexible metamaterial (Metaflex)-based photonic device operating in the visible-IR regime, which shows potential applications in high sensitivity strain, biological and chemical sensing. The metamaterial structure, consisting of split ring resonators (SRRs) of 30 nm thick Au or Ag, has been fabricated on poly(ethylene naphthalate) substrates with the least line width of similar to 30 nm by electron beam lithography. The absorption resonances can be tuned from middle IR to visible range. The Ag U-shaped SRRs metamaterials exhibit an electric resonance of similar to 542 nm and a magnetic resonance of similar to 756 nm. Both the electric and magnetic resonance modes show highly sensitive responses to out-of-plane bending strain, surrounding dielectric media, and surface chemical environment. Due to the electric and magnetic field coupling, the magnetic response gives a sensitivity as high as 436 nm/RIU. Our Metaflex devices show superior responses with a shift of magnetic resonance of 4.5 nm/nM for nonspecific bovine serum albumin protein binding and 65 nm for a self-assembled monolayer of 2-naphthalenethiol, respectively, suggesting considerable promise in flexible and transparent photonic devices for chemical and biological sensing.