Fano resonance in metal/dielectric/metal fishnet metamaterials with a broken symmetry

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Fano resonance (FR) within the transmission spectrum is demonstrated in the near infrared (NIR) region using elliptical nanoholes array (ENA) embedding through metal-dielectric-metal (MDM) layers. For the symmetric MDM-ENA, it has been shown that a FR can be excited by the normally incident light. This FR response is attributed to the interplay between the bright modes and dark modes, where the bright modes originate from the electric resonance (localized surface plasmon resonance) caused by the ENA and the dark modes are due to the magnetic resonance (inductive-capacitive resonance) induced by the MDM multilayers. Displacement of the elliptical nanoholes from their centers breaks the structural symmetry to excite a double FR as a result of the coherent interaction of the electric resonance with two splitting sub-magnetic resonances at different wavelengths. Moreover, the degree of the asymmetry allows for the tuning of the amplitude and bandwidth of the double FR window. The sensitivity to the slight variations of the dielectric environment has been calculated and yields a figure-of-merit of $0.8RIU^{-1}$ for the symmetric MDM-ENA and $3.0RIU^{-1}$ for the asymmetric MDMENA.