Metadevice of three dimensional split ring resonators

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Split-ring resonator (SRR), a kind of building block for metamaterial unit cell, has attracted wide attentions due to the resonance excitation of electric and magnetic dipolar response. Here, different from prior published lectures, fundamental plasmon properties and potential applications in novel three dimensional vertical split-ring resonators (VSRRs) are designed and investigated. The resonant properties arose from the electric and magnetic interactions between the VSRRs and light are firstly theoretically and experimentally studied (Fig. 1(a)). Tuning the configuration of VSRR unit cells is able to generate various novel coupling phenomena in VSRRs, such as plasmon hybridization and Fano resonance, as shown in Figs. 1(b) and 1(c). Subsequently, the VSRR-based refractive-index sensor will be demonstrated. Due to the unique structural configuration, the enhanced plasmon fields localized in VSRR gaps can be lifted off from the dielectric substrate, allowing for the increase of sensing volume and enhancing the sensitivity (Fig. 1(d)). We further perform a VSRR based metasurface for light manipulation in optical communication frequency, as shown in Fig. 1e. Moreover, isotropic VSRRs are approached by optimizing the structural arrangement within a unit cell (Fig. 1(f)). Figure 1(g) shows the schematic for isotropic VSRR-based perfect absorber. By incorporating a metallic mirror with isotropic VSRRs, a stronger field confinement happens to enhance the absorption ability, benefitting the development of refractive index sensor. Finally, a transverse toroidal moment generated by normal incident optical wave at gold dumbbell-shaped aperture and a VSRR is designed and experimentally demonstrated, as shown in Fig. 1(h).

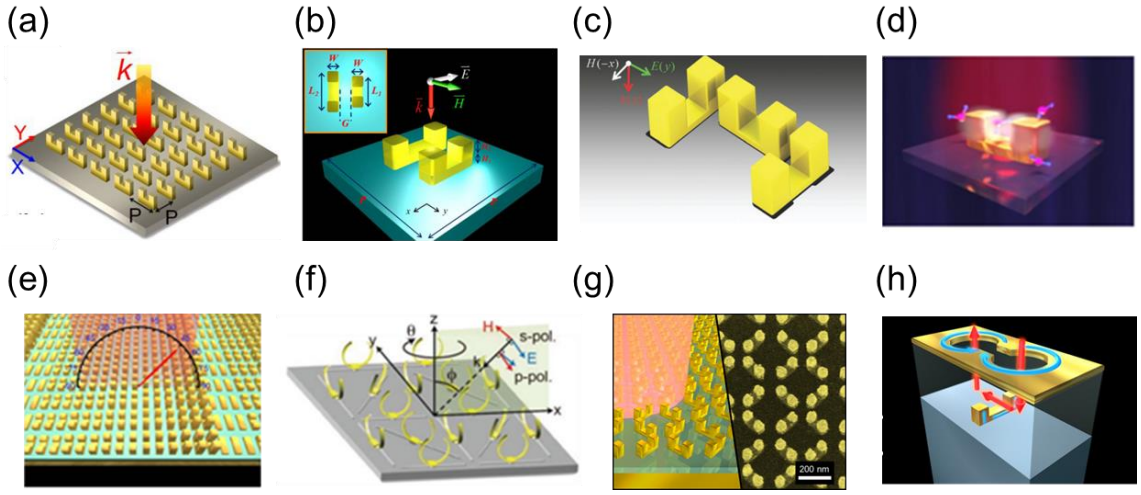

Fig. 1 Schematic diagrams for (a) Single and (b,c) coupled VSRRs, (d) nanoplasmonic sensor, (e) beam deflection metasurface, (f,g) isotropic VSRRs and (h) toroidal metamaterials. [1-7]

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