Artificial multiresonant sheet materials for broadband wave manipulations

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Metasurfaces, ultrathin artificial materials composed of subwavelength resonant meta-atoms, promise to replace bulky conventional optical components, offering significant technological advantages (size & weight reduction, planar fabrication) and the ability to tailor their response at will by engineering the underlying meta-atoms. However, they typically suffer from narrowband response. By judiciously combining multiple meta-atom resonances in the unit cell, we demonstrate that metasurfaces can be made to exhibit arbitrarily broadband (achromatic) response. This is exemplified by delaying broadband pulses without distortion [1], Fig. 1(a). If the supplied group delay is spatially modulated [strips of different delay τ_1, τ_2, … in Fig. 1(b)], achromatic wavefront manipulation can be achieved [2]. The proposed concept has been experimentally verified in GHz frequencies by a multiresonant unit cell comprising five resonant meta-atoms (three electric and two magnetic dipole resonances) on a three-metallization layer printed circuit board [3], Fig. 1(c).

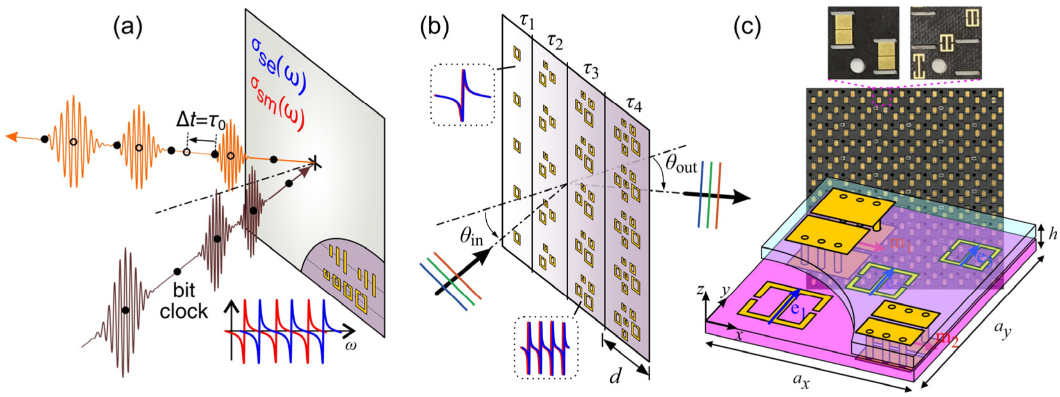

Figure 1: (a) Multiresonant metasurface for broadband pulse delay [1]. Operation in reflection requires spectrally interleaved resonances in the electric and magnetic surface conductivities. (b) By spatially modulating the supplied group delay, the metasurface can implement achromatic wavefront manipulation (e.g. beam steering) [2]. Operation in transmission requires spectrally overlapping electric and magnetic resonances. (c) Physical implementation of multiresonant unit cell for microwave frequencies. ELC and SRR resonators implement electric and magnetic dipole resonances, respectively [3]. Views of the fabricated printed circuit boards.

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References

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