Resonant Lattice Kerker Effect in Metasurfaces of Titanium Dioxide Nanodisks

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With the rapid development of the concept of light-induced artificial electromagnetics in the field of metamaterials, the Kerker effect (resonant suppression of the backward scattering or reflection) has been promoted as never before and quickly penetrated into nanophotonics. Many optical phenomena such as perfect reflection and perfect transmission are linked directly to the multipolar interference mechanism of the generalized Kerker effects. Nanostructures enabling Kerker effect have been demonstrated, for example the periodic array of spherical and core-shell silicon nanoparticles. [1, 2]

Here we investigate the arrays of titanium dioxide (TiO_2) nanodisks, which support electric dipole resonance, magnetic dipole resonance and lattice resonances. Transparent TiO_2 is widely considered as a good candidate for fabricating all-dielectric metasurfaces in the visible range since it is has lower loss than silicon and has larger refractive index than silica and polymer. By choosing the lattice periods along the x and y directions, we achieve a full overlap between the electric dipole resonance and magnetic dipole resonance and realize the resonant lattice Kerker effect. It is shown that the Kerker effect can be assisted by the lattice resonance and be inhibited by the substrate.

In practice, the quartz substrate is etched 500 nm depth in order to eliminate the influence of the substrate on the electric dipole resonance and magnetic dipole resonance. The fabrication process is as follows. First, 210 nm thick TiO_2 film is deposited on the quartz substrate by magnetron sputtering. Second, 170 nm thick PMMA resist is spin-coated and then exposed by e-beam lithography. Third, 40 nm thick Cr film is deposited by electron beam evaporation. Finally, Cr etching mask is formed by lift-off and the pattern is transferred to TiO_2 and the quartz substrate by dry etch. The metasurfaces with perfect transmission can be fabricated and provide a guidance to novel designs of optical metadevices for advanced applications.

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[1] Viktoriia E. Babicheva and Andrey B. Evlyukhin, in *Laser & Photonics Reviews* (2017), Vol. 11;
[2] W. Liu and Y. S. Kivshar, Opt Express **26** (10), 13085 (2018).

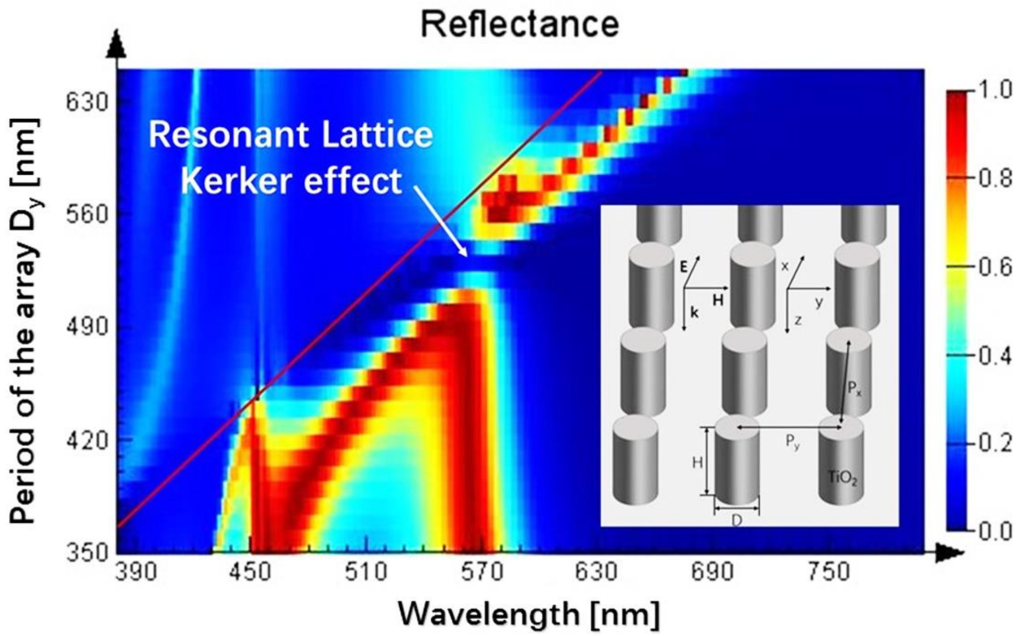

Figure 1: The reflectance of metasurface versus the array period P_y and wavelength for P_x = 450 nm. It presents that the peak resonance wavelength changes with the array period P_y. Red line shows wavelength of Rayleigh anomalies (RA). White arrow points out the resonant lattice Kerker effect where the reflection is suppressed. Inset: An array of nanodisks with diameter D, periods P_x and P_y , and normal incidence of light with electric field **E** along the x-direction.