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Plasmonic metasurface to enhance difference frequency generation for THz radiation

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Plasmonic nanostructures have been extensively investigated in recent years for their ability to concentrate light to sub-wavelength scales. Plasmonics allows us to overcome the diffraction limit and confine an intense field to spatial dimensions that are not achievable with a laser or dielectrics, which are typically used in nonlinear optics. The strong fields created by arrays of nanoantennas and metasurfaces can be used to locally enhance nonlinear optical processes, such as surface enhanced Raman scattering (SERS) or second harmonic and difference frequency generation (SHG and DFG), opening new opportunities in, *e.g.*, nonlinear spectroscopy, nonlinear microscopy, near-field sensing, and bio-sensing. Plasmonic nanostructures also alter the local density of optical states (LDOS), impacting radiative processes of nearby nano-scale emitters (*e.g.*, molecules, quantum dots). Our plasmonic metasurfaces are modelled using the finite-difference time-domain (FDTD) method, exploiting the most powerful supercomputer accessible in Canada (an IBM BlueGene/Q, Southern Ontario Smart Computing Innovation Platform), which allows us to perform simulations of complex problems with high resolution and accuracy in a short time, speeding-up the design process. We show a plasmonic metasurface which can enhance perpendicularly polarized incident beams in the same volume. This can be exploited to generate THz radiation by DFG in $\bar{4}3$m crystal class materials, such as GaAs.

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