High Resolution Terajets Using 3D Dielectric Cuboids

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The limit imposed intrinsically by the diffraction of electromagnetic waves has been extensively studied with the aim to improve the performance of microscopy techniques and to obtain subwavelength resolution. Several techniques have been proposed to solve this disadvantage such as metamaterials and microspherical particles, to name a few.

With the aim to obtain subwavelength focusing, we report here an alternative mechanism to produce jets at Terahertz frequencies (terajets) by using 3D dielectric cuboids illuminated with a planewave with the electric field along y E_y (V. Pacheco-Peña et al., Applied Physics Letters, 105, 084102, 2014). Similarly to the recently proposed micro scaled cylindrical (2D) and spherical (3D) dielectrics at optical frequencies, the dielectric cuboids demonstrate that a focus with subwavelength resolution can be obtained just at the output surface of the cuboid. The dielectric cuboid has lateral dimensions $L = \lambda_0$ along x and y axes while the dimension along z is $H = 1.2\lambda_0$. The performance of the terajet produced by this structure is evaluated numerically by changing its refractive index from 1.2 up to 2 when it is immersed in vacuum ($n_0 = 1$) demonstrating a quasi-spherical terajet just at the output surface of the cuboid when its refractive index is 1.41. Moreover, a full comparison between the 3D dielectric cuboid and its 2D counterpart is performed using a metal particle inserted within the terajet region and evaluating the backscattering enhancement. Demonstrating that both structures are able to produce 3D (spherical) and 2D (teraknife) jets and to enhance the backscattering of particles placed within this region.

The performance of the terajets produced by the dielectric cuboids are evaluated numerically and experimentally at sub-THz frequencies, using a cuboid made of Teflon ($n = 1.46$) with air as background. Experimental and simulation results of the power distribution along the transversal x axis are carried out at the distance $z = 0.1\lambda_0$ demonstrating a good agreement between them with a focusing enhancement (ratio of the power distribution received at the focal position evaluated with and without the 3D dielectric cuboid) of ~10 times the incident plane wave.