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Arbitrary Order Bessel Beam Generation Using Gallium Phosphide in Visible Domain

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Highly non-diffracting bessel beams are of great intrest these days due their several applications in optical communication, display trapping and manipulation. By exploiting the full phase control of the metasurfaces composed of subwavelength nano-resonators, bessel beams of distinct orders can be generated [1]. In prior works, bessel beams are obtained with titanium dioxide and gallium nitride based metasurface but they have bottlenecks due to complex and expensive fabrication. Here, we have demonstrated bessel beam generation by exploiting the gallium phosphide (GaP) based single layer metasurface. The governing equation for bessel beam functionailty is:

$$\phi_r(x,y) = 2\pi - \frac{2\pi}{\lambda_o}(\sqrt{x^2+y^2}).NA + l.\tan^{-1}(\frac{y}{x}) \tag{1}$$

To engineer the desire phase, geometric phase [2] is utilized which is associated with the rotation of nano-pillars. The proposed metasurface has high transmission efficiency in visible regime and generates four bessel beams of distinct orders without the addition of extra complexities in conventional nano-pillar geometry. Simulated electric field intensity and phase profile of the propposed metasurface are shown in Figure 1.

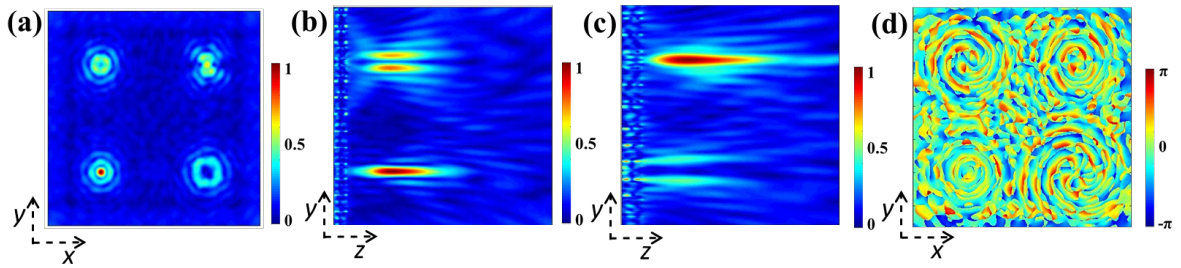

Figure 1. Optical characterization of bessel beams of different orders with NA = 0.7. (a) Simulated electric field intensity at wavelength $\lambda_o = 532$ nm in *xy*-plane (b, c) in propagation direction and (d) Phase Profile of metasurface.

The property of orbital angular momentum, these versatile order bessel beams have capacity for data storing. Arbitrary order, low loss and high transmission in visible domain makes the metasurface pertinent for numerous phenomena such as data encryption, data transferring, optical communication and displays.

References

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