Terahertz Vector Beam Generation Enabled by Photonic Topological Metasurfaces

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We propose and numerically investigate the mechanism of vector beams formation in terahertz spectral range via engineering the band structure of spatially inhomogeneous photonic metasurfaces supporting topologically trivial and non-trivial states.

Structured light [1-2] opens up the new ways for efficient light coupling to resonant modes of single particles and structures [3-4], microscopic techniques and quantum optical applications [5]. Recently, different strategies of creating vector beams for terahertz applications [4] started being studied [6].

Here, we design a metasurface based on a golden film with holes arranged in a triangular lattice, whose band structure hosts a topologically [7] inspired band gap at terahertz frequencies. By judiciously varying parameters of the metasurface in the lateral direction, we are able to engineer a light trapping potential, which supports a hierarchy of eigenmodes with singular radiation profiles.

[1] N. M. Litchinitser, *Science* **337,** 1054 (2012).

[2] A. Forbes, M. de Oliveira, M.R. Dennis, *Nat. Photonics* **15,** 253 (2021).

[3] E. Melik-Gaykazyan, K. Koshelev, J.-H. Choi, S. S. Kruk, A. Bogdanov, H.-G. Park, and Y. Kivshar, *Nano Lett.* **21***,* 4, 1765 (2021).

[4] X. Zhang, Q. Xu, L. Xia, Y. Li, J. Gu, Z. Tian, C. Ouyang, J. Han, W. Zhang, *Adv. Photon.* **2**, 1, 014001 (2020).

[5] H. Rubinsztein-Dunlop, A. Forbes, M. V. Berry, M. R. Dennis, D. L. Andrews, M. Mansuripur, C. Denz, C. Alpmann, P. Banzer, T. Bauer, E. Karimi, L. Marrucci, M. Padgett, M. Ritsch-Marte, N. M. Litchinitser, N. P. Bigelow, C. Rosales-Guzmán, A. Belmonte, J. P. Torres, T. W. Neely, M. Baker, R. Gordon, A. B. Stilgoe, J. Romero, A. G. White, R. Fickler, A. E. Willner, G. Xie, B. McMorran, A. M. Weiner, *Journal of Optics* **19**, 1, 013001 (2016).

[6] Y. Xu, H. Zhang, Q. Li, X. Zhang, Q. Xu, W. Zhang, C. Hu, X. Zhang, J. Han, W. Zhang, *Nanophotonics* **9**, 10, 3393 (2020).

[7] M. Segev, M.A. Bandres, *Nanophotonics*, **10**, 1, 425 (2021).