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Efficient Manipulations of Circularly Polarized Terahertz Waves with Transmissive Metasurfaces

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The unrestricted control of circularly polarized (CP) terahertz (THz) waves is important in science and applications, but conventional THz devices suffer from issues of bulky size and low efficiency. While Pancharatnam–Berry (PB) metasurfaces have shown strong capabilities to control CP waves, transmission-mode PB devices realized in the THz regime are less efficient, limiting their applications in practice. Here, based on Jones matrix analysis, we design a tri-layer structure (thickness of~ λ /5) and experimentally demonstrate that the structure can serve as a highly efficient transmissive meta-atom (relative efficiency of ~ 90%) to build PB metadevices for manipulating CP THz waves. Two ultrathin THz metadevices are fabricated and experimentally characterized with a z-scan THz imaging system. The first device can realize a photonic spin Hall effect with an experimentally demonstrated relative efficiency of ~90%, while the second device can generate a high-quality background-free CP Bessel beam with measured longitudinal and transverse field patterns that exhibit the nondiffracting characteristics of a Bessel beam. All the experimental results are in excellent agreement with full-wave simulations. Our results pave the way to freely manipulate CP THz beams, laying a solid basis for future applications such as biomolecular control and THz signal transportation.

SHORT BIO:

Qiong He received his PhD degree in Physics from Paris Institute of Optics in Paris-Sud University (Orsay, France) in 2008. From 2009 to 2013, he was postdoctoral fellow in Physics Department of Fudan University. He is currently an associate professor at Physics Department of Fudan University (Shanghai, China). His research interests focus on metamaterials and plasmonics. He has coauthored more than 50 publications in scientific journals.

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