Light steering with a metal-free chiral-sensitive metasurface at telecommunication wavelengths

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Controlling the direction of light propagation, or light steering, enables the addressing of individual optical elements in high-density and complex photonic integrated devices. Light steering is therefore crucial to the development of photonic/plasmonic integrated circuits. Chiral-sensitive metasurfaces using metallic nanostructures have been used to realize light steering by coupling incident light of different spins to surface plasmon polaritons propagating in different directions. However, surface plasmon polaritons-based devices suffer from short propagation lengths and narrow resonance wavelength ranges resulting from ohmic losses in their metal layers. Bloch surface waves can be seen as a metal-free analogy to surface plasmon polaritons with superior properties such as low propagation losses and wide operating wavelength ranges. Here, we demonstrate a metal-free chiral-sensitive Bloch-surface-wave steering circuit consisting of a carefully arranged array of U-shaped apertures, guiding slabs, and grating couplers. By engineering the amplitude and phase of the Bloch surface wave to achieve spin-controlled unidirectional coupling, control of the propagation direction of Bloch surface waves is realized. Very high directional selectivity is reported at the telecommunications wavelength of 1550 nm, both theoretically at 23 dB and experimentally at 13.5 dB. The ability to realize spin-controlled light steering on a chip at telecommunications wavelengths using metal-free chiral-sensitive metasurfaces should benefit the development of low-loss on-chip photonic integrated devices.