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Reducing radiation loss of near zero-index metamaterials

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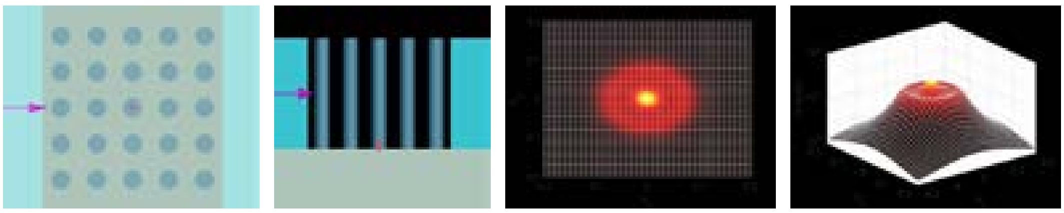
Optical metamaterials can achieve an unconventional effective index of refraction by engineering the geometry of the building blocks. In extreme cases, the effective index can approach zero, resulting in infinite phase velocity and spatial wavelength. However, because of the zero index corresponds to an electric monopole mode and two magnetic dipole modes degenerating at the center of the Brillouin zone, which is innately above the light line, opening a loss channel to the direction perpendicular to the substrate, i.e. the guided wave propagating within the zero-index metamaterial can couple to a plane-wave radiating in the out-of-plane direction (the direction perpendicular to the substrate). Here we eliminate this out-of-plane radiation loss via the destructive interference between the plane waves radiating upward and downward, forming a bound state in the continuum. A zero-index metamaterial design with a reflector that reduces radiation loss through the destructive interference of multiple lossy channels, resulting inbound states in the continuum. The design includes a silicon pillar array and a planar reflector. By adjusting the distance between the reflector and the pillars, out-of-plane radiation can be eliminated completely. However, for near zero-index metamaterials (ZIMs), there is no similar design and method to reduce the out-of-plane radiation losses. We design a low-loss near zero-index metamaterial composing of an array of silicon pillars without a reflector. Under an in-plane TM excitation, the pillars support two Bloch modes at the center of the Brillouin zone: an axial electric monopole mode, and a transverse magnetic dipole mode. By adjusting the radius and pitch of the pillar array, we can achieve the degeneracy of these modes at the center of the Brillouin zone and a given operating wavelength, in our case 1525nm.



Biography

Yuzhen Liang hails from Xiamen, China. She is currently an undergraduate student of photoelectric information science and technology at the Xiamen University of Technology. Her industry experience includes working as an optical assistant at Xiu Yu Incorporated in Taiwan. In this capacity, she helped develop ultra short-focus projection and laser projection technology. At the same time, she worked on the development of automated vehicle systems with regards to visual recognition and produced a smart mattress care system. Her most recent work focuses on the optical engineering of a new keyboard projector..

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