Negative Refraction Phenomena in Two-Dimensional Photonic Crystals

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Abstract

We have systematically established a model of equal frequency surface configuration to examine the refractive behaviors of the electromagnetic wave propagating through a two-dimensional photonic crystal by using the plane-wave expansion method. Positive refraction, negative refraction, total internal reflection, and uncoupling effect in photonic crystal prisms have been numerically demonstrated by utilizing the finite-difference time-domain method. Applying the Snell's law, we got a well consistence of measuring refractive angles between the infinite case and the finite case. Besides, we have also performed that the flat surface can focus light by virtue of the negatively effective refraction index in a photonic crystal slab and deduced the imaging mechanism of photonic crystal slabs with negative refraction, which is different from the conventional lenses.

In addition, we commented on the recent published paper "all-angle negative refraction in photonic crystals without negatively effective refraction index", published in Phys. Rev. B 65, 201104(2002), and gave a new definition by using the "direct-tunneling effect" what the light is strongly confined in a channel-like around the center of slab and directly tunnels across the slab.