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Efficient Focusing with an Ultra-Low Effective-Index Lens Based on Photonic Crystals

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Abstract

This work focuses on photonic crystals (PC) that can be ascribed an effective index of refraction > 1 or even > 0. We investigate the possibility to design optical elements (in this case a lens) based on this type of PC. A new approach for determining the effective refractive index of PCs with unusual index of refraction is used, which is simpler than earlier methods based on analyzing equi-frequency surfaces in k-space. An ultra-low refractive index PC is given a form approximating a concave lens and is proven theoretically and experimentally that it efficiently focuses the electromagnetic radiation in the microwave range. Strong focusing effects are found for both polarizations (TE and TM mode). Intensity gains as large as 35 for TM polarizations and 29 for TE polarizations are found. Measurements are in a good accordance with simulations.