Dielectric metamaterial-based gradient index lens in the terahertz frequency range

Fabian Gaufillet, Simon Marcellin and Éric Akmansoy

Institut d'Électronique Fondamentale, Univ Paris-Sud, CNRS, Université Paris-Saclay, UMR8622, Orsay F-91405, France

We have tailored the effective refractive index of dielectric metamaterials to design a flat lens operating at terahertz frequencies. The studied dielectric metamaterials consist of high permittivity resonators, whose first Mie resonance gives rise to resonant effective permeability. The resonance frequency is fixed by the size of the resonators. By varying this size, we could adjust the value of the resonance of the effective permittivity and, thereby, of the effective refractive index. Then, we fitted this one to the profile of refractive index of a graded index flat lens, of which we show that it focuses an incident plane wave at terahertz frequencies and that the spot in the focal plane is diffraction- limited. It is less than one and a half wavelength thick, its focal length is only a few wavelengths. Thus, we show that dielectric metamaterials are suitable for the design of metadevices, that is, photonic components for applications at terahertz frequencies.

Index Terms—Gradient-index lenses, Metamaterials, Res- onators, Terahertz imaging, Dielectric materials.

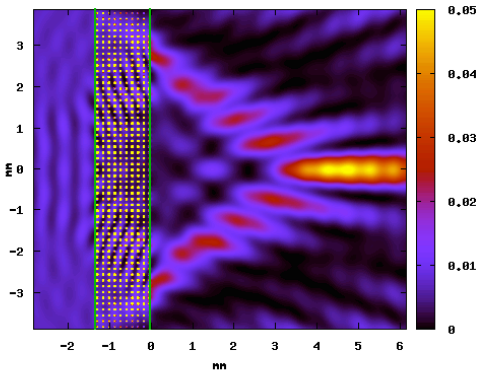

Fig.1. Map of the EM field intensity (time-average of the square of the EM field (H_z^2)) of an incident TE plane wave at 0.3THz on the flat lens ((x,y) plane as in fig. 3). The flat lens consists of a ten layers DMM constituted of square cross section high permittivity cylinders which sustain Mie resonances. Their length size is varying perpendicularly to the direction of propagation from 70µm at the center to 57µm at the edges. The two vertical green lines delimit the lens. The simulated focal length is ≃ 5λ.

References

[1] F. Gaufillet, S. Marcellin and E. Akmansoy, *IEEE Journal on Selected Topics in Quantum Electronics* 23(4),7765126