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PhD research proposal

All-Dielectric Metamaterials for Terahertz metadevices

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General framework

Metamaterials have opened a new field in physics and engineering. Indeed, these artificial structured materials give rise to unnatural fascinating phenomena such as negative index, sub-wavelength focusing and cloaking. Metamaterials also exhibit near-zero refractive index [1]. These open a broad range of applications, from the microwave to the optical frequency domain. Metamaterials have now evolved towards the implementation of optical components [2].

We consider All-Dielectric Metamaterials which are the promising alternative to metallic metamaterials, because they do not suffer from ohmic losses and consequently benefit of low energy dissipation and because they are of simple geometry. They consist of high permittivity dielectric resonators involving Mie resonances. We have experimentally demonstrated negative effective permeability and/or permittivity by the means of all-dielectric metamaterials [3]. Previously, we have also demonstrated a negative index all-dielectric metamaterial [4]. Recently, we have numerically demonstrated a metadevice, namely, a metalens that focuses an incident plane wave, is less than one and a half wavelength thick. Its focal length is only a few wavelength and the spot in the focal plane is diffraction - limited. [5]. We also study role of the coupling of the modes of Mie resonances in an all-dielectric metamaterial so as to achieve negative index at terahertz frequencies (see fig. 1) [6].

Work Plan

During this thesis, all dielectric metamaterials will be designed, fabricated and characterized for the terahertz range. Negative index will be studied in this frequency domain, which is a challenge. Various devices which will be investigated such as flat lens, gradient devices, etc. This work takes place within a group of scientists of different disciplines (chemists, material scientists, physicists).

Bibliography

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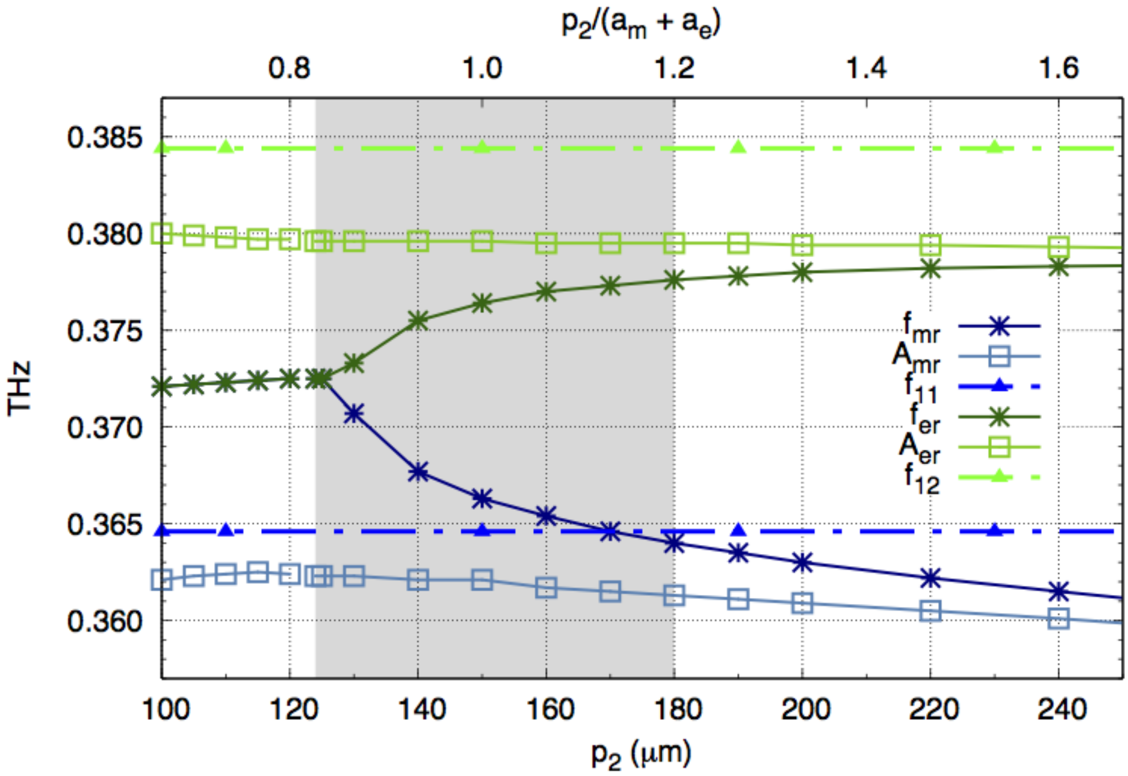

FIGURE 1 – *Spatial* mode coupling : frequency of the first two modes of Mie resonances in function of the distance p_2 between two resonators which is half the lattice period l_p. The shaded area corresponds to negative value of the effective index n_{eff}. It evidences the mode degeneracy [6].

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