The Optical Helmholtz Resonator: a breakthrough for extreme light confinement from IR to RF

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I will present some recent results from MINAO laboratory. MINAO (MIcro and NAno Optics) is a "Laboratoire Commun de Recherche" between CNRS (Laboratoire de Photonique et Nanostructures, Marcoussis, France) and ONERA (Departement d'Optique Théorique et Appliquée, Palaiseau, France). Mixing various backgrounds and scientific cultures, MINAO works on a wide activity spectrum from concepts (Technology Readiness Level TRL 1) to pre-industrial developments (TRL 7-8). Based on a long term collaboration (started Jan 2005), its activity is focused on nano-patterned structures for infrared applications.

The evanescent wave engineering for energy redirection by magneto-electric interference[1] appears as an efficient tool to conceive perfect optical antennas from very simple subwavelength structures.

The combination of several nanoslit structures permits to do photon-sorting operation at subwavelength level[2] .This is a breakthrough for multispectral IR plane arrays, that can be developed for both bolometers [Collab. CEA-Leti] and quantum devices.

The combination of a nanoslit with a box (the Optical Helmholtz Resonator [3], Fig.1), permits to attain field intensity enhancement as high as 10^7 in far IR, and 10^5 in near IR. This open the way to several applications including SEIRA, chemical and bio sensors, highly sensitive detectors, and non-linear devices.

Figures

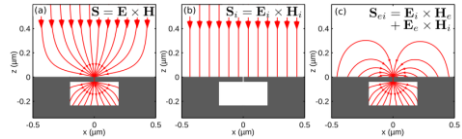

Figure 1: Poynting-vector streamlines on one period of the slit-box structure at λ = 10 μm. (b) Streamlines of the incident wave. (c) Streamlines of the interference between the incident wave and the evanescent field.

References

[1] Light Funneling Mechanism Explained by Magnetoelectric Interference, F. Pardo et al, Phys. Rev. Lett. 107, 093902 (2011)
[2] Analyt. descr. of subw. plasmonic MIM resonators and of their combination, C. Koechlin et al, Opt. Expr. 21, 7025 (2013)
[3] Optical Helmholtz resonators, P. Chevalier et al, Appl. Phys. Lett. 105, 071110 (2014)