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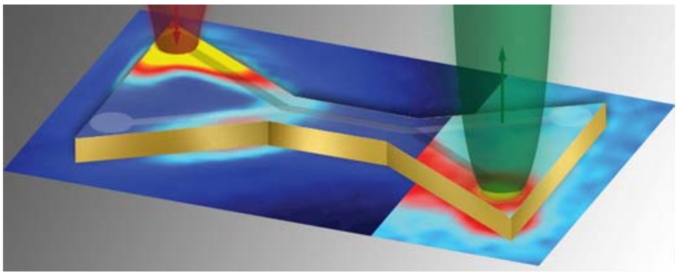
NANOFABRICATION AND OPTICAL CHARACTERIZATION OF MODAL PLASMONIC LOGIC DEVICES

Period	6 months beginning not later than: ☐ January ☒ February ☐ March ☐ April ☐ May ☐ June ☐ July ☐ September 2021
Internship supervisor(s)	name: Erik DUJARDIN, Research Director e-mail: dujardin@cemes.fr group: NanoSciences Group
Location	*CEMES, CNRS UPR 8011* *BP 94347, 29 rue Jeanne Marvig – 31055 TOULOUSE Cedex 4 – France*
This research master's degree research project could be followed by a PhD	☒ YES ☐ NO



A MSc internship in experimental physics is available in the NanoSciences group (CEMES, CNRS) within a ANR-funded project. The proposed work consists in tailoring the shape of crystalline gold platelets to foster plasmon modal patterns able to realize integrated arithmetic and logic devices which will be studied by optical field mapping and spectroscopies.

When free electrons in noble metals are confined, their collective oscillations - *plasmons* – exhibit resonant modes which can be excited optically but also reconvert their energy into emitted photons. The photon-plasmon conversion allows to go below the diffraction limit of light and thus to imagine downsizing optical information processing. Yet the main limitation of plasmons is their intrinsic losses, which damp their propagation with a few hundreds of microns. Nevertheless, when plasmon modes are borne by mesoscale crystalline metallic structures,[1] they possess both a delocalized character that enables optical information transfer within sub-wavelength volumes and a strong enhancement and confinement of the electromagnetic near-field where transduction is effective, for example to excite plasmons,[2] detect their linear [3] or non-linear[1] conversion into photons or to amplify a signal (fluorescence, Raman) emitted in their immediate proximity.[4] In this context, we have been engineering these confined plasmon modes for several years in order to create a new approach to elementary function of information processing: encoding, routing, Boolean logic functions, transduction, détection.[5]

This experimental work will be dedicated either to the design and nanofabrication of reconfigurable logic devices and to their optical characterization. The candidate will prepare the structures from 2D gold nanocrystals to be characterized by scanning electron and atomic force microscopies. Functional devices will then be constructed by nanofabrication combining laser and/or electron lithography with focused ion beam etching. Finally, the student will carry out experimental campaign to characterize individual nanoconstructs by optical microscopies and spectroscopies. If time allows, these devices will be coupled to single photon sources to explore their quantum plasmonic behavior.

References

1 *Nature Materials*, **2013**, 12, 426.
2 *Opt. Exp.*, **2017**, 25, 9138. Opt. Comm., **2017**, 387, 48-54.
3 *ACS Photonics*, **2015**, 2, 744. *Adv. Opt. Mater*, **2019**, 7, 1801787
4 *Opt. Lett.*, **2015**, 40, 2116. Phys. Rev. B., **2017**, 95, 121402(R). *J. Phys. Chem. C*, **2017**, 121, 15908.
5 *ACS Photonics*, **2018**, 5, 2328. Phys. Rev. B, **2020**, 101, 075406. NanoScale, **2020**, 12, 13414.

Keywords, areas of expertise	Nanoplasmonics, nanofabrication, nanooptics
Required skills for the internship	Experimental skills in nanofabrication and/or optics, data processing