Postdoctoral position (12 months)

Laser polarization-controlled crystallization and orientation of nonlinear optical nanocrystals in multicomponent glasses using a femtosecond laser for photonic applications

Key words: Glass Science, Photochemistry, Femtosecond Laser, Rare-Earth Spectroscopy, Nano-crystallization, self-organized nanogratings; crystallization

Funding Support: LabEx Charm3at; http://www.charmmmat.fr/en/

Location: Université Paris-Saclay, Institut de Chimie Moléculaire et des Matériaux d'Orsay (ICMMO), team SP2M, group MAP ; https://www.icmmo.u-psud.fr/en/teams/sp2m/thematics/advanced-materials-photonics/

Availability and salary: Open for application (deadline August 31st 2021); expected start: Nov. 1st 2021; gross income: 2500€/month

Femtosecond (fs) laser direct writing (FLDW) is a powerful and versatile tool to enable a large variety of optical components and functions to be fabricated in transparent materials such as glasses (e.g., Bragg gratings, waveguides, graded index lenses, birefringent optics). By tuning the fs-laser parameters it becomes possible to induce controlled and permanent modifications, hence local physical properties, inside the glass. One example to this is the photo-precipitation of $LiNbO_3$ nanocrystals in Li_2O – Nb_2O_5 – SiO_2 glass matrices (LNS), having properties such as piezo- and ferro-electricity. Under certain writing laser conditions and by controlling the laser polarization, the orientation of the precipitated $LiNbO_3$ nanocrystals' polar axis can be dictated, yielding to an angular modulation of $\chi^{(2)}$ properties, such as second harmonic generation (SHG) (1).

In this context, the candidate joining the group will investigate the possibility to induced $LiNbO_3$ oriented nanocrystals in various glass families in order to comprehend what are the mechanisms that drive crystallization (nucleation and growth) and formation of self-induced phase separation (nanogratings). This work is in the continuity from recently conducted work in borosilicate glasses (2,3), and will specifically focus on the effect of glass composition. The group has a long history in this topic and has pioneered several aspects related to the proposed work, including the demonstration that light polarization could control the photo-precipitated crystal orientation.

The expected work includes, but is not limited to, glass synthesis, femtosecond laser irradiation, and characterization of the fs-laser modified regions using various techniques (second harmonic generation, optical and electron microscopies, fluorescence measurements, etc.). Moreover, the candidate will be responsible of the Laser Platform within the group. The research results will be disseminated through journal articles and conferences.

Candidate profile: Background in glass science (thermodynamics, physical properties, solid state physics, characterization techniques) and glass synthesis, as well as light-matter interaction (laser beam properties).

Application procedure: Curriculum Vitae and Cover letter.

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1. Cao, J., Poumellec, B., Brisset, F., Helbert, A.-L. & Lancry, M. Tunable angular-dependent second-harmonic generation in glass by controlling femtosecond laser polarization. *J. Opt. Soc. Am. B* **33**, 741–747 (2016).
2. Muzi, E. *et al.* Towards a Rationalization of Ultrafast Laser-Induced Crystallization in Lithium Niobium Borosilicate Glasses : The Key Role of The Scanning Speed. *Cryst. MDPI* **11**, 1–26 (2021).
3. Muzi, E. *et al.* Controlled Orientation of Second Harmonic Generation Induced by femtosecond laser Crystallization in Li_2O-Nb_2O_5-SiO_2-B_2O_3 glasses. *Opt. Mater. Express* **11**, 1313–1320 (2021).