Proposal for a Master 2 or Engineering internship at INPHYNI (Nice): :

"Optical components laser-inscribed in preforms for optical fibres: Additive fabrication by multiphoton photopolymerisation using active silica-loaded resins".

Context :

Two-photon polymerization (TPP) is a technique of additive manufacturing of three-dimensional (3D) structures with sub-100 nm resolution using a pulsed laser, directly into the volume of a transparent photosensitive resin via a two-photon absorption process confined to the laser focal point (Fig 1) [1,2]. The size and shape of the final 3D-microstructure depends on many parameters : laser operation, montion controls, composition of the resin, etc. Thus this approach offers a great design flexibility. In particular, TPP allows to fabricate pure-glass 3D-microstructures thanks to (1) special resins charged with inorganic nanoparticles (silica NP), and (2) optimized heat post-treatments (debinding and sintering; Fig. 1) [3]. Many research groups in the world are developing new 3D glass-objets by TPP for various applications, including for the field of photonics.

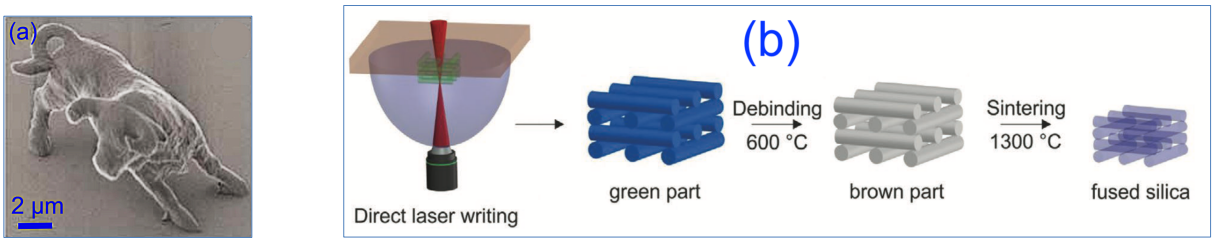


Figure 1: (a) Historical demonstration of a 10-µm bull 3D-printed in a polymer resin [1]. (b) schematic principle of TPP 3D-printing of glass objects, using a silica-NP charged resin [3]. Green part= NP charged solid polymer; Brown part: porous silica. Notice the shinkage during the debinging and sintering thermal treatments.

At INPHYNI, we are seeking the fabrication by TPP of silica-based objects directly within optical fibres. Further, the new embedded objects shall have specific, or 'active', properties, e.g. luminescence, light amplification, or non-linear optical properties. Newly developed NP-loaded resins contain rare-earth elements that luminesce in the visible and the near-infrared wavelength ranges. The characterization of the properties of these resins during the whole TPP fabrication process must be carefully performed in order to develop the fabrication process of future active objects. Also, the development of a specialized "suite of processes " is needed to allow the embedding of the active objects within optical fibres.

Internship:

The internship will firstly aim to (1) experimentally characterize the new resins loaded with rare-earth luminescent elements, (2) adapt the TPP parameters to polymerize the resin, and (3) optimize the heat post-treatments to obtain doped-silica objects (in collaboration with IMREDD). Subsequently, the intern will contribute to (4) developing a process to incorporate the active objects inside optical fibre preforms. The intern will be tutored by specialists in laser-matter interaction and in glass sciences. Fabrication and characterisation facilities include a fully equipped chemistry laboratory and clean-room, a pulsed-laser TPP set-up, heat-treatment furnaces (at IMREDD right next-door), the "Specialty Optical Fibre" fabrication center, optical and electron microscopes for imaging objects, and spectroscopic equipements for characterizing luminescence.

Required profile :

The candidate will be in Master 2 or in the final year of engineering school in physics. We are looking for a rigorous, curious personality, with good written and oral communication skills. Knowledge of French is not required. In this case, a level in English B2 is required. We are looking for candidates who are highly motivated to conduct research and have a keen interest in material sciences and physics, particularly in the field of photonics and/or polymer and glass sciences.

Duration : 5-6 months from February (Master 2 or final of engineering school)

Stipend : ~680 €/month. **PhD follow-up**: possible under application to doctoral school EDSFA.

CV, cover letter and references to :
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