Ph.D application

Investigation of the kinetics of the femto-second laser-induced phase separation in nanoparticle-doped optical fibers

Project description

Since the 1960s, optical fibers have enjoyed considerable growth, first in the field of telecommunications, then as high-power fiber lasers, sensors and more. Optical fiber of 125 μm in diameter is obtained by drawing a preform of 1 cm in diameter at a temperature around 2000 °C. From the beginning, the control of the drawing proved essential to improve the transparency of optical fibers. More recently, this step proved crucial in shaping nanoparticles (NPs) within the fiber core for a new family of optical fibers developed by the Institut de Physique de Nice.

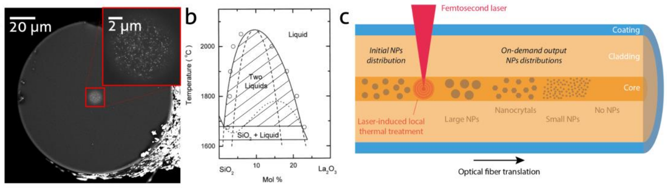

Figure 1: a) SEM image of the cross section of a fiber containing nanoparticles in the core. b) Phase-diagram of the SiO_2-La_2O_3 system. c) Illustration of the expected effect of the femto-second laser developed in the project.

The purpose of the project is to develop an original fabrication process dedicated to the new family of optical fibers containing NPs inside their cores as illustraded in Figure 1-a. By doping the core with La_2O_3, the phase diagram depicted in Figure 1-b presents a miscibility gap explaining the NPs formation. The development of these fibers depends strongly on the ability to control the size and the structure of NPs. A high repetition rate fs laser source will be used to selectively heat at the appropriate temperature the NPs-doped fiber core with high spatial resolution (μm^3). By changing the laser writing parameters (the repetition rate, the writing velocity, etc.), it will be possible to precisely tune the temperature, targeted in the range 1000-2300 °C to modify on-demand the size and the structure of the NPs sketched in Figure 1-c.

The aim of the Ph.D thesis is to predict numerically the phase separation described by the phase field theory. The kinetics of NPs will be studied numerically with a time-dependent temperature in agreement with the experimental device taking into account the heating and cooling stages. A mesoscopic modeling using the Cahn-Hilliard model will be used to predict the nucleation rate. The second step will consist to develop a macroscopic modeling at the optical fiber scale. The numerical procedure will be applied on fiber geometry to know more clearly the effect of writing parameters.

Desired profile

With a Master 2 in materials science or applied mathematics, the candidate must have a solid knowledge in theory of materials sciences. Good knowledge of partial differential equations and the numerical methods to solve it is required. Autonomy, initiative and the ability to work in a team are also required.

Working environment and contacts

This work will be carried out at the Centre of Material Forming of Mines Paris | PSL university on the Pierre Laffitte campus in Sophia Antipolis. The Ph.D thesis is funded by the FESTNOS ANR project. The annual gross salary is set to 27000 €.

To apply, send your CV and a covering letter to the following contacts:

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