

## DESCRIPTION FOR THE GENERAL PUBLIC

One of the challenge of present-day condensed matter physics is to elucidate the relationship between macroscopic properties of soft materials and their microscopic structure. Over the last decades, leading research centres throughout the world have become involved in research on the phenomenon of supercooling liquids and polymers to a glassy state and the accompanying changes in their physicochemical properties. One intriguing feature of the verification process is the occurrence of a drastic concomitant increase of substance viscosity over several orders of magnitude. **The understanding of the glass transition** is important for academic purposes and has great significance for material engendering, as well as for the pharmaceutical and food industries. For practical purposes, many materials should not undergo crystallization. One way to influence the phase diagram in this regard is by **spatially restricting the substance in nanometric length scales**.

In this project, we plan to study the dynamics and thermodynamic properties of various molecular systems, i.e. **liquids, liquid crystals and polymers, in porous systems**. A combination of dielectric and infrared spectroscopies will allow us to better visualize intra- and inter molecular mobility, and to explore the interaction between molecules and pore walls. The impact of two-dimensional confinement on the thermal effects of phase transitions will be analyzed based on differential scanning calorimetry measurements. Additionally, we plan to take advantage of **recent achievements in the synthesis of porous materials such as porous silica: thin films only tens of nanometers thick**, with unidirectional pores perpendicular to the surface. Such systems **provide three dimensional confinement** and a unique opportunity to verify whether by altering the pore size in one direction, it is possible to modify the molecular dynamics. The goal of this research is to determine how the molecular structure and intermolecular interactions affect the tendency of materials to vitrify or crystallize under conditions of geometrical confinement in comparison to the bulk material. An understanding of this relationship will allow better **control of the properties of the substance and for unique nanostructures to be obtained by selecting** the type and size of pores.

The project will also investigate **electrospun polymer/liquid crystal composite fibres**. These systems were first reported as recently as 2008, in a paper which presented the properties of polymer fibres with a nematic liquid crystal in their core. Polarized Raman spectroscopy measurements indicate that molecules in the nematic phase are oriented with their long axis along the fibres. Interestingly, this configuration was found to have a similar effect as what was previously observed for nematic liquid crystals in pores, i.e. stabilization of the nematic phase in the polymer shell and a lack of character of the first order phase transition for the nematic to isotropic transition. There have been few reports published in this field so far, and these are focused only on the behaviour of the nematic phase in fibres. In this project, we plan to **prepare and characterize fibres from various polymers and liquid crystals**. We will analyse how the molecular structure and amorphous and polycrystalline states of polymers affect the formation of smectic and columnar liquid crystalline phases. It is important to note that according to our preliminary findings, one of the smectic phases possesses **interesting dynamic peculiarities** when confined by the presence of macromolecules. We are convinced that our planed experiments will greatly expand knowledge in this area, and enable new functional materials to be obtained in the future.