Nanomaterials are currently one of the most explored class of materials. This enormous interest results from their unusual properties often different than the one observed in case of bulk materials. In fact, the spatial nanometric restriction becomes a novel tool that provides outstanding opportunity of producing materials of unique physical properties and morphologies satisfying the industrial requirements (i.e., solar batteries, fuel cell, or drug carriers). Nevertheless, it should be added that apart from the significant industrial potential of the nanometerials a better understanding and eventual correlations between macroscopic properties and behavior of spatially restricted confined matter seems to be a key scientific problem. In this context, it is worthwhile to stress that nanoscale conditions can be a powerful novel tool to investigate the glass transition phenomenon, one of the most fundamental unsolved problem of condensed matter physics.

The main aim of this project is to provide novel experimental data crucial for filling a missing gap in our understanding of the behavior (especially the variation in the molecular dynamics and the glass transition temperature) of the materials confined within porous materials (under so-called two-dimensional, 2D, confinement). By the combination of various experimental techniques, i.e., dielectric spectroscopy, calorimetry, as well as contact angle and surface tension measurements, we are planning to investigate the correlation between the variation in the molecular dynamics of various materials infiltrated within porous template and their interfacial energy, γ_{SL}, where a special attention will be paid to various polymers in particular, characterized by different topologies, molecular weight and terminal groups. Especially, we would like to investigate impact of the changes in the strength of intramolecular interactions between the constrain medium made of different materials, i.e., silica and zirconium oxide, and the confined materials on the molecular dynamics of selected systems. It seems interesting to explore if the similar confinement effects can be observed in these templates do these effects scale with γ_{SL}. Additionally, we would like to explore the correlation between the finite size and the surface effects since our preliminary studies showed that both of them seem to be directly entangled. Last but not least, we are planning to explore the mechanism and the kinetics of the density perturbation of infiltrated materials observed at some specific temperature conditions. Especially, we would like to examine if they are either the same or different for both the low molecular weight glass forming liquids and polymers.

It should be pointed out that all aspects we are going to study obey fundamental problems of the physics of condensed matter intensively investigated in the literature and can be separately considered as a subject of the prepared proposal. Additionally, they open new ways and possibilities of the perception and understanding of the behavior of the spatially restricted systems.

We are strongly convinced that the planned systematic and comprehensive studies on various low and high molecular weight glass formers (including linear and star-shaped polymers) infiltrated within porous membranes made of different materials (i.e., silica, alumina, zirconium oxide) and characterized by various pore size, *d*, and the strength of host-guest molecular interactions. We believe that detailed studies on various systems by means of standard experimental techniques, as Broadband Dielectric Spectroscopy and Differential Scanning Calorimetry (DSC, including thermal-modulated DSC, TMDSC) and supplemented by other methods, i.e., FTIR and Raman spectroscopies, including the pioneering measurements by Atomic Force Microscopy (AFM) and XRD method, give us a unique opportunity to get insight in the microscopic structure and density fluctuations of the confined system allowing to make some more universal conclusions and deliver a model to predict the variation in molecular dynamics and glass transition temperature of the low and high molecular weight glass formers incorporated into pores.

The planned actions are of a great importance in the development of the basic knowledge on the behavior of soft matter under confinement, especially in a better understanding of the relationship between finite size, surface effects (including the surface tension and the interfacial energy) and density fluctuations on the variation in the molecular dynamics and the glass transition temperature, T_g. These aspects seem to be of fundamental significance to verify current approaches used to explain the origin and nature of the properties and behavior of confined materials.