What are the non-equilibrium glass transition dynamics at the nanoscale? Glass-forming substances are materials characterized by a disordered structure resembling more a liquid state rather than crystals. The properties of such materials often differ significantly at the macro- and nanoscale. This is primarily due to the size reduction but also to the greater role of surface interactions. Interestingly, the macroscopic properties can be recovered over time for nanometer-size samples. This phenomenon is called non-equilibrium glass transition dynamics and applies to many types of nanosystems. Understanding the nature of this process and attempts to control it are the subject of many studies, not only from the point of basic research but also for many potential applications, e.g. in industry and medicine.

Motivation and research objectives **-** In times of ubiquitous miniaturization, one of the fundamental problems today is optimizing and predicting the long-term properties of glass-forming polymers in confined geometry. An important aspect is also determining the influence of various factors on the equilibration kinetics and the possibility of control of this process.

This project is devoted to the study of the impact of the geometrical constraints in one (1D) and two (2D) dimensions on the non-equilibrium dynamics of the glass-forming materials, as well as an attempt to determine what factors affect the equilibration kinetics.

Proposed research - In order to address the above problems, I would like to characterize the non-equilibrium dynamics under geometric constraints. I plan to link this description with the strength of interactions between the hard restrictive surface and the confined polymer. It can be assumed that the equilibrium kinetics in the geometric constraint is somewhat correlated with the interfacial energy, which can be crucial in understanding and predicting the long-term behaviour of nanosystems

This project will cover the following research activities:

(T1) Comparison of the equilibration kinetics in one- and two-dimensional confinement

While keeping the same film thickness and the size of the nanoporous matrices, I would like to carry out the first experimental studies aimed at understanding the effect of the dimensionality of the spatial constraints on the equilibration kinetics of the glass-forming materials at the nanoscale.

(T2) The influence of the type of host material on the non-equilibrium dynamics in confined geometry.

As part of this task, I plan to experimentally determine the effect of the type of supporting substrates and nanoporous matrices on the non-equilibrium glass transition dynamics of polymer in the presence of geometrical confinement. I would also like to link the equilibration processes with the strength of interactions between the substrate/nanoporous matrix and the investigated polymer.

(T3) Influence of pre-annealing on the non-equilibrium glass transition dynamics in 1D and 2D confinement

This task will help to determine how the non-equilibrium glass transition dynamics of polymer in one- and two-dimensional geometrical confinement are influenced by the pre-annealing of the system at a lower or higher temperature, called the intermediate temperature.