Dr. Iurii Chubak

Novel states of matter for topological polymers

Supervisor: Prof. Christos Likos

Abstract:

Functionalized polymeric structures have recently attracted considerable interest due to their responsiveness to externally imposed stimuli. Such systems can be used to design next-generation materials with controllable properties. This work focuses on two classes of polymeric systems with nontrivial architectural composition, stars and rings, that contain functionalized blocks. In each case, the coupling between a stimulus and functionalized blocks introduces distinctive microscopic dynamics that can yield unique macroscopic self-organization pathways. In the case of stars, where the stimulus leads to the solvent quality dependent attraction strength between the functionalized blocks, we find the formation of interconnected micellar aggregates in very dilute solutions and the development of a network-like system structure as the polymer concentration is increased. In the case of rings, where the stimulus is introduced in a non-equilibrium way through different activity levels between functionalized and non-functionalized blocks, we find the formation of a hitherto unobserved state of matter that is built on topological threading constrains and activity at high polymer concentrations — the so-called active topological glass. The properties of equilibrium ring polymer melts as well as of the active topological glass are further discussed in relation to biophysical phenomena in the cell nucleus.