Popular science project abstract

Although the crystallization is known since ancient ages and at present it is used in multiple industrial processes all around the world, still the stochastic nature of his phenomenon is the issue that needs to be dealt with. During the generation of the driving force of this process i.e. oversaturation, e.g. by salt solution cooling, the system achieves the saturation curve entering into metastable zone. The moment at which nucleation will occur, i.e. the appearance of the first stable crystal nucleus, depends on the process conditions such as cooling rate, solution volume or presence of impurities. These factors directly influence crystallization stochastic nature resulting in blurring of upper limit of the metastable zone width, i.e. oversaturation curve.

The goal of this project is to investigate the impact of phase transition of stimuli-responsive polymers on the crystallization process course realized by cooling of aqueous solutions of inorganic salts. It should be expected that the phase transition of stimuli-responsive polymers, from the hydrophilic into hydrophobic form will instantaneously induce nucleation in the whole solution volume, and in effect will significantly decrease or even eliminate the stochastic nature of crystallization. This in turn would facilitate the control over this phenomenon and would decrease the investment and operating costs of industrial plants in which crystallization is used. Not without significance is the influence of expected result on the natural environment.

Crystallization induced by phase transition of stimuli-responsive polymers is a totally new phenomenon which needs to be profoundly investigated in order to deeply understand its mechanism. It seems to be possible to adjust the nucleation and phase transition of polymer in such a way that sudden drop of salt concentration resulting from crystallization would reverse the phase transition of polymer which was caused by the prior change of temperature. In result, the only solid phase present in the system would be the created crystals.

During the project realization different kinds of stimuli-responsive polymers will be investigated. Their Upper Critical Solution Temperature will be determined using spectrophotometric method with a special emphasize on phenomena occurring at high salt concentration and for different pH. In research commercially available polymers as well as samples synthesized at place will be investigated. The polymers will be synthesized using ATRP (Atom Transfer Radical Polymerization) and RAFT (Reversible Addition−Fragmentation chain-Transfer polymerization) techniques. For the next stage of research macromolecules characterized by polymerization degree (PD), composition and topology suitable for crystallization applications will be selected. During the second stage of research the analysis of crystallization process course in the presence of stimuli-responsive polymers will be performed. The research will focus on the Metastable Zone Width. For this purpose a specially designed laboratory setup will be used. The Metastable Zone Width will be determined on the basis of temperature measurement utilizing energetic effect of crystallization. Additionally, the particle size distribution during the crystallization process will be investigated using laser light diffraction technique and the shape of created crystals will be tested using a microscope coupled with a camera.

The results of performed research will allow one to better understand the crystallization process in the presence of stimuli-responsive polymers. In effect, it will be possible in future to create so called “intelligent crystallizers” for production of food, medicaments or chemical compounds.