DESCRIPTION FOR THE GENERAL PUBLIC

Due to increasing awareness about the global environment a range of new polymeric materials is being developed, especially biodegradable materials and those produced from renewable resources. Contrary to conventional polymers, biodegradable polymers can be converted into biomass or into carbon dioxide and water. Biopolymer blends market shares its continuous growth. It is widely known that the use of several polymers combined in a blend allows obtaining several advantages, in particular, a combination of the best of their properties. Nevertheless, the main drawback of polymer blends is a poor possibility of morphology control and low interphase adhesion that obstruct realization of high-performance blends. Overcoming this problem can be achieved by conversion of polymer blends into in situ composites.

The project assumes application of our recent novel concept of in-situ generation of all-polymer nanocomposites, where the nanofibers of one polymer are formed inside the second polymer during shear processing in a melt. The solidification of nanofibrous sheared inclusions is performed by shear induced crystallization, all during processing. This concept allows formation of “green all-polymer” nanocomposites in a single step. Such approach has been developed recently by us [Composites A, 90 (2016) 218–224]. Our idea has been already verified positively for one system of polylactide (PLA) and poly(1,4-butylene succinate) (PBS). The nanocomposite PLA/PBS is just a ‘‘green all-polymer nanocomposite”. Unprecedented results consisting in simultaneous increase in ductility and retaining rigidity were associated with the formation of shear bands in PLA as well as the generation of PBS nanofibers. Aside from strengthening, the PBS nanofibers acted as effective spanning of PLA craze surfaces, reinforcing the crazes.

Therefore, the goal of the project is the application of the above-mentioned concept to the range of other biopolymers. The concept relays on developing nanofibrillar inclusions in situ during compounding and solidifying the already formed nanofibers by the shear induced crystallization. In this way, we expect to obtain a series of “all-polymer” composites with increased toughness and rigidity that will be biodegradable and made from renewable resources. Pilot experiments with other possible reinforcing polymers indicate that shear induced crystallization can be very effective (PHA showed the increase in nonisothermal crystallization peak temperature by 50^{o}C).

The primary scientific goal of the presented project is acquiring a new knowledge on plastic deformation of biopolymer systems and possibilities of formation of nanofibers of one biopolymer inside the molten matrix of second biopolymer due to shearing forces acting upon melt-mixing that transform inclusions into nanofibers and converts a blend into in-situ nanocomposite.

The other goal of the project is to produce “all-polymer” hybrid composites that will be additionally reinforced by various types of fibers. It is known that composite manufacturing industries produce reinforced composites and hybrid composite materials based on natural and synthetic fibers as an attractive materials alternative to synthetic composites. Unfortunately, polymer composites with hybrid reinforcement solely constituted of natural fibers are less common, but these are also potentially useful materials with respect to environmental concerns. The advantage of hybrid composites is that one type of fibers could complement with what is lacking in the other. As a consequence, a balance in cost and performance could be achieved through a proper material design. The performance of the hybrid composites is dependent on the properties of fibers, their aspect ratio, length of individual fiber, orientation of fiber, extent of intermingling of fibers, bonding of fibers to a matrix and also on moduli and failure strains of fibers. Optimum results are obtained for hybrid composites when fibers are highly strain compatible. For this reason, we propose also a new approach to fabrication of hybrid composites – through combination of rigid and tough fibers generated in situ and the ready-made fibers added to the blend.