Abstract

The epoxy based polymer is one of the very common polymers, which was used as a host to create new better materials - nanocomposites. This thesis focused on the improvement of the thermomechanical properties of the epoxy thermosets without deteriorating their existing benefits and on further potential application of this knowledge in “smart” systems. The largest part of this work is dedicated to the reinforcement of epoxy thermosets by *in situ* generated silica and synthesis of organic-inorganic nanocomposites. Borontrifluoride monoethylamine (BF_3MEA) was chosen as effective catalyst for the formation of nanosilica in epoxy-amine network matrix under nonaqueous (non-hydrolytic) sol-gel process. We proposed the mechanism of the nonaqueous sol-gel procedure, studied the structure evolution during the nanocomposite formation, and also determined the structure, morphology and thermomechanical properties of the obtained epoxy-silica nanocomposites. Significant attention in this work was given to the application of coupling agent and ionic liquids to improve compatibilization of the organic matrix and the inorganic part. As a result of the nonaqueous sol-gel process optimization by combination of the tetramethoxysilane (TMOS) and the coupling agent glycidyloxypropyltrimethoxysilane (GTMS), the high-T_g and heat resistant nanocomposites were synthesized. Application of ionic liquids allows tuning the interface interactions in nanocomposites by producing a sequence of physical or chemical interactions. The epoxy-based nanocomposites were applied in the second part of the thesis for the study and preparation of temperature responsive shape memory polymers (SMP). The investigation was focused on general study of shape memory (SM) behaviour and enhancement of mechanical strength of SMP in order to design and prepare the high performance SMP nanocomposite. The tuning of thermomechanical, tensile and viscoelastic properties enabled to optimize the SM behaviour. The synthesized nanocomposite-based SMP shows improved SM properties such as perfect shape fixity and recovery, including the enhanced high recovery stress and recoverable deformability.

Keywords: organic-inorganic nanocomposite, *in situ* build silica, nonaqueous sol-gel process, interphase interaction, ionic liquids, toughness, shape-memory polymer, recovery stress.