Nanocomposites and nanomaterials

Cross-linked hydrogels filled by semiconductor nanoparticles

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Introduction of inorganic nanoparticles (NPs) into soft and elastic hydrogels can result in materials with enhanced performance and new properties that are useful for a variety of applications: from biology and biomedicine (biomarkers, biosensors) to photo-, opto- and microelectronics (photodetectors, light-emitting devices, thin-film transistors, solar cells, holography, waveguides etc). The present work is devoted to the study of the formation processes of nanocomposite hydrogels filled by cadmium sulphide NPs and their properties.

The cross-linked hydrogels were synthesized via radical copolymerization of acrylamide (AcAm) with either acrylic acid (AA) or 2-(dimethylamino)ethyl methacrylate in water media in the presence of 0.2-2% N,N'-methylenebisacrylamide (MBA) as curing agent. Additionally, the different amounts of cadmium acetate (10-25% relative to monomer weight) were added to those reaction mixtures as the NPs precursor. The copolymerization kinetics was studied and it was revealed that an addition of cadmium acetate caused a slight decrease in the reaction rate while not affecting the maximal conversion degree, which in all cases remained close to 100%. As a result we obtained thin cured water-swelled hydrogels (with swelling degree reaching 750-900%) with incorporated Cd^{2+} ions bound with the polymer matrix through ionic and coordination bonds. The values of gel-fraction for the obtained hydrogels were 15-20% lower and compression strain 15-20% higher as compared with hydrogels formed in the absent of cadmium salt. This phenomenon can be explained by an inhibiting effect of the salt on the processes of free-radical copolymerization.

At the final stage CdS nanocrystals were formed inside hydrogels via their expose to gaseous H_2S; that gave transparent yellowish nanocomposites. UV-vis spectroscopy proved formation of CdS nanoparticles with an average size of 4-6 nm. NPs size decreased with increasing degree of the hydrogel curing; that witnessed in favour of our assumption about their formation in the cells of the cross-linked hydrogel.