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Functionalized latex particles for preparation of colloid-stable nanosized selective sorbents and composite materials for decontamination of radioactive waste

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Here we discuss preparation of a new type of colloid-stable nanosized sorbents based on functionalized latex particles, which can be directly applied for decontamination of liquid and solid radioactive wastes or used for construction of fibrous or mesoporous composite sorption materials. Carboxylic latex (siloxane-acrylate and polystyrene-acrylate) functionalization is performed via immobilization of nanocrystals of the selective to radionuclides sorbents (ferrocyanides of transition metals and sulfates of calcium/barium) into the polymer matrix.

The presence of anionic centers on the latex particle surfaces stipulates for the possibility of binding to them ions of divalent metal-precursors of selective sorbents. With the added metal concentration increase one can observe the decrease of electrokinetic potential (by module) at invariable particle size. The residual negative charge on the surface provides the system high colloid stability. To form stable nanoparticles of a selective sorbent it is crucial to limit the amount of introduced divalent metal ions by the beginning of the plateau on the dependence of electrokinetic potential on the metal concentration in solution. AFM imaging of the functionalized latex particles shows that, as a result of introducing cobalt ferrocyanide nanoparticles, the initially spherical polystyrene-acrylate (PA) particles transform into a cubic shape, which is characteristic for ferrocyanide macrocrystals.

Due to immobilization into stable polymer colloids, the selective sorbents nanoparticles preserve high stability at filtration in porous media. After 50 filtration cycles of emulsion of the siloxane-acrylate (SA) latex with immobilized nanoparticles of cobalt ferrocyanide through a layer of natural zeolite, the cobalt content in the emulsion remained nearly constant. When such colloid-stable sorbents are directly applied for decontamination, after radionuclides sorption the stability of such systems can be controllably reduced by addition of cationic flocculants, thus providing high efficiency of radionuclide removal from solution. The combination of high selectivity of nanosized sorbents immobilized into latex particles with ease of their removal from solution by flocculation/coagulation process enables one to recommend the developed schemes for different materials decontamination, first of all, for solid bulky wastes –soils, grounds, metal constructions. To extend suggested approach for production of different types of sorption materials pre-formed colloidal-stable selective sorbents were deposited on carbon fibers by electrochemical method or used as a template during formation of mesoporous SiO_2, ZrO_2 and TiO_2 sorbents. The selective sorption materials obtained showed good kinetics of radionuclides sorption and distribution coefficients for cesium up to 1e+7.

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