Contribution ID: **884** Type: **Oral**

Composite ”track-etched membrane modified with chitosan and metal–organic framework”for heavy metal sorption

Tuesday, 12 October 2021 11:15 (15 minutes)

In the last time, the problem of water purification from dangerous substances is becoming more and more acute. A large number of studies are devoted to the extraction of heavy metals from aqueous solutions [1,2,3]. In addition, the extraction and concentration of valuable heavy metals from solutions is also of interest. The creation of solid adsorbents with high capacity and stability in the aquatic medium is a very important task. One of the promising types of adsorbents is metal-organic frameworks (MOF). MOFs are crystalline materials consisting of an infinite network of metal-ions, or metal-ion clusters, bridged by organic ligands through coordination bonds into porous two- or three-dimensional extended structures. Very few MOFs are used as adsorbents from aqueous solutions because most MOFs are unstable in aqueous medium [1]. In our work, Ni-MOF {[Ni(L-trp)(bpe)(H2O)]•H2O•NO3}n was synthesized (L-trp = L-tryptophan, bpe = 1,2-bis(4-pyridyl)ethylene). It is stable in an aquatic environment. With UV-Vis spectrometry, we investigated the properties of Ni-MOF in the process of ruthenium sorption from aqueous solutions of ruthenium chloride as model. Effects of pH, adsorbent dosage and contact time in Ru(III) sorption on Ni-MOF were studied in detail. The sorption capacity of the material was measured at different concentrations of ruthenium in solution (10, 25, 50, 100, 200, 300 mg L-1).
The possibility of efficient and convenient extraction of the adsorbent from the solution is significant. Most often, the sorbent is recovered by centrifugation or filtration, or using a magnet in the case of magnetic materials. Therefore, the number of works on the creation of magnetic composites based on MOFs is increasing [2]. Another interesting direction of the creation composite materials for adsorption is the infliction of MOFs on polymer substrates (membranes and fibers). Some researchers have proposed the use of MOFs as fillers in electrospun nanofibers [3]. But in this case a lesser region of the MOF particle is exposed to the bulk for adsorption. Another variant is self-assembly of the adsorbent on a substrate [4]. In this case, the formation of centers for the nucleation of adsorbent crystallites is desirable. This method was chosen in our work. A track-etched membrane, modified with chitosan, was studied as a substrate for the MOF. The membrane was received from Flerov Laboratory of Joint Institute for Nuclear Research (Dubna, Russia). The synthesis of Ni-MOF takes place under mild conditions that do not destroy either the membrane or the chitosan fibers. Only in the presence of chitosan MOF particles firmly adhere to the substrate. This is due to the structure of chitosan molecules, which can act as nucleation centers and increase hydrophilicity of the membrane. The synthesized materials were characterized by X-ray diffraction, scanning electron microscopy and thermal analysis. It was shown that the crystal structure and microstructure of pure MOF and MOF supported on the membrane are identical. In the future, we plan to study the adsorption properties of the obtained membranes coated with MOF particles. In case of successful work, these composites can become a basis of filters for water purification from heavy metals.

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Session Classification: Condensed Matter Physics

Track Classification: Condensed Matter Physics