Sorption Ceramic Membranes with a Functionalized Surface Layer

Zub, Yu.L.
2014

Sorption ceramic membranes with a functionalized surface layer

Yu. L. Zub, V. V. Tomina, I. V. Melnyk, N. V. Stolyarchuk, H. I. Nazarchuk, V. V. Sliesarenko, V. M. Kochkodan, [1]P. Topka, O. Solcova
Chuiko Institute of Surface Chemistry, NAS of Ukraine, 17 General Naumov Str., Kyiv 03164 Ukraine; tel. +38 044 4229609, e-mail: zub_yuriy@isc.gov.ua; [1]Institute of Chemical Process Fundamentals of the ASCR, v. v. i., Rozvojová 135, 165 02 Praha 6, Czech Republic

The application of inorganic membranes in ultra- and microfiltration processes goes back to the 1970s [1]. The benefits of ceramic membranes are their high porosity, flux and resistance to harsh environment [1,2]. The transport properties of such membranes depend on the structure of the surface layer, which determines the rejection and the flux through the membranes. Among the key methods to direct the separation mechanism of the active layer is tuning its pore size and affinity by the introduction of functional groups [3]. The sol-gel method, which is based on hydrolytic co-polycondensation reaction of appropriate trifunctional alkoxysilanes, allows obtaining a thin active layer on the membrane surface with targeted functional groups [4,5,6].

Over last years the surface functionalization of ceramic membranes for selective removal of heavy metals from aqueous environment is of high interest. In this aspect, alkoxysilanes with complexing groups (such as amino and mercapto) are especially attractive as functionalizing components. This is due, primarily, to preferential interaction of sulfur-containing groups as well as electrostatic interactions of amino-groups with heavy and noble metals [7]. We have previously developed the techniques of creating of a monofunctional active layer with mercapto groups on the surface of porous ceramic supports. The developed membranes are capable to maintain high flux inherent to microfiltration membranes and also to reject Ag(I) ions [8,9].

In the current work, we have considered and compared the deposition on the surface of ceramic membrane of the polysiloxane layers with different functional groups, such as $\equiv Si(CH_2)_3SH$, $\equiv Si(CH_2)_3NH_2$, and $\equiv Si(CH_2)_2P(O)(OH)_2$, and $\equiv Si(CH_2)_3NHC(S)NHC_2H_5$. We have also reported the fabrication of ceramic membranes with bifunctional polysiloxane surface layers, containing two types of complexing groups of different nature, or (fluoro)alkyl groups along with complexing groups. Tetraethoxysilane and bis(triethoxy)silane structuring agents were used in the study. The identification of the deposited layers on the membrane surface was carried out by IR spectroscopy. It was shown by SEM, that the functionalized layers themselves are usually formed by 50-70 nm nanoparticles and their porous structure depends on several fabrication factors.

Authors are grateful to NATO Science for Peace Program SPS.NUKR.SFP #984398 for the financial support of the work.

1. M.T. Bryk, Membrane Encyclopedia (Kyiv: "KM Academy": 2005); 2. Inorganic membranes. Synthesis, Characteristics and Application (Ed. R.R. Bhave) (New York: 1991); 3. G.G. Paradis et al., J. Mater. Chem. **22**, 7258 (2012); 4 B.C. Bonekamp et al., in Sol-Gel methods for Materials Processing (Eds. Innocenzi P, Zub Yu.L., Kessler V.G.), Springer, 2008; 5. S. Araki et al., J. Membrane Science **41**, 380 (2011); 6. S. Araki et al., Desalin. Water Treat. 7, 12 (2009); 7. S.M.C. Ritchie et al., Environ. Sci. Technol. **35** 3252 (2001); 8. V.V. Tomina et al. Prot. Met. Phys. Chem. Surf. **49**, 386 (2013); 9. V.V. Tomina et al., Proceedings of the International Conference "Nanomaterials: Applications and Properties" **2**, No 2, 02FNC17 (2013).