"Hairy" Nanoparticles as Building Blocks for Nanoporous Membranes

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Abstract:

Nanoporous membranes attract increasing attention due to their applications in molecular separations, biosensing, drug-delivery and catalysis. Many of these applications require control over the nanopore size with a narrow size distribution and the ability to further modify the membrane surface. Most currently used membranes are formed by introducing pores into bulk materials in a variety of irreversible processes. Membranes formed from nanoparticles using non-covalent interactions, on the other hand, are capable of reversible assembly which could prove useful for fabrication, processing, cleaning, reusing and would possess facile control over the membrane porosity and nanopore surface properties.

This talk will describe the preparation and characterization of durable, reversible nanoporous ultrafiltration membranes with controlled thickness, area and pore size by self-assembly of silica nanoparticles grafted with polymer brushes ("hairy" nanoparticles, HNPs). The nanoparticles used to form the membranes were prepared by first modifying their surface with 2-bromoisobutyrylbromide (ATRP initiator). The pSPM-r-pEEMA, pDMAEMA-r-pMMA, pSPM, pHEMA, pHEMA-r-pSPM and pSPM-r-pEEMA brushes were grown on the surface of silica spheres using ATRP.

We prepared three types of HNP membranes: membranes made of HNPs grafted with polymer brushes carrying acidic and basic groups, membranes in which the grafted polymer brushes have neutral groups, and membranes grafted with negatively charged polymer brushes. Depending on the HNP building block type the membranes are stable in most organic solvents and easily disassemble in water, or water-stable and capable of disassembly in organic solvents. All types of membranes are nanoporous and capable of size-selective transport and ultrafiltration. We will also describe the formation of nanoporous membranes from HNPs grafted with copolymer brushes carrying functional groups in the side chain, and combining reversibility with ultrafiltration, charge selectivity and affinity properties.

Recent Publications

1. Green, E.; Fullwood, E.; Selden, J.; Zharov, I. Functional Membranes via Nanoparticle Self-Assembly. *Chem. Commun.* **2015**, *51*, 7770-7780.

2. Khabibullin, A.; Zharov, I. Mesoporous Films and Membranes from Assembly of Silica Colloidal Spheres. In *Comprehensive Guide for Mesoporous Materials, Vol. 1: Synthesis and Characterization.* Aliofkhazraei, M., Ed. Nova Science Publishers, Inc., **2015**, pp 55-82.

3. Khabibullin, A.; Fullwood, E.; Kolbay, P.; Zharov, I. Reversible Assembly of Tunable Nanoporous Membranes from "Hairy" Silica Nanoparticles. *ACS Appl. Mater. Interfaces* **2014**, *6*, 17306-17312.

4. Khabibullin, A.; Zharov, I. Nanoporous Membranes with Tunable Pore Size by Pressing/Sintering Silica Colloidal Spheres. *ACS Appl. Mater. Interfaces* **2014**, *6*, 7712-7718

5. Ignacio-de Leon, P. A.; Zharov. I. SiO_2@Au Core-Shell Nanospheres Self-Assemble to Form Colloidal Crystals That Can Be Sintered and Surface Modified to Produce pH-Controlled Membranes. *Langmuir* **2013**, *29*, 3749-3756.

Biography



Ilya Zharov is an Associate Professor at the Chemistry Department, University of Utah. He obtained his BS in 1990 from Chelyabinsk State University, his MS in 1994 from the Technion, and his PhD in 2000 from the University of Colorado, Boulder. In 2000-2003 he was a Beckman Postdoctoral Fellow at the Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign. His research focuses on novel nanoporous materials, ion conductive membranes, and on theranostic agents. Among his awards are Camille and Henry Dreyfus Foundation New Faculty Award and the National Science Foundation CAREER Award. He was named an Emerging Investigator by the Chemical Communications in 2011 and serves on the Editorial Board of Current Smart Materials.

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