



NEXT GENERATION OF MEMBRANE ABSORBERS FOR METAL EXTRACTION FROM SOLUTIONS

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4 P.M. THURSDAY, MARCH 17, 2016
HILL HALL 202

ABSTRACT

Materials are the building blocks and pillars of a sustainable society and global economy. There is a growing awareness that the development and large-scale implementation of the clean and renewable energy technologies of the 21st century will require sizeable amounts of technology metals. In addition to rare earth elements (REEs) and platinum group metals (PGMs), significant amounts of copper, silver, cobalt, nickel and gold will be needed to build (i) solar cells, (ii) wind turbines, (iii) electric vehicles, and (iv) energy-efficient lighting. Advances in industrial ecology, desalination and resource recovery have established that industrial wastewater, seawater and brines are important and largely untapped sources of critical metals and elements. A Grand Challenge in metal recovery from seawater and industrial wastewater is to design and synthesize high capacity, recyclable and robust chelating ligands with tunable metal ion selectivity that can be efficiently processed into low-energy separation materials and modules. In our efforts to develop high capacity chelating membranes for metal recovery from solutions, I will describe a one-pot method for the preparation of a new family of poly(vinylidene fluoride) (PVDF) ultrafiltration (UF) membranes with embedded dendrimer-like particles that can serve as high capacity sorbents for metal ions. The key feature of our new membrane preparation method is the in situ synthesis of dendrimer-like particles in the dope solutions prior to membrane casting using low-generation poly(amidoamine) (PAMAM) dendrimers as particle precursors and epichlorohydrin (ECH) as crosslinker. By using a combined thermally-induced phase separation (TIPS) and non-solvent phase separation (NIPS) casting process, we successfully prepared a new family of asymmetric PVDF ultrafiltration membranes with (i) neutral and hydrophilic surface layers of average pore diameters of 22-45 nm, (ii) high loadings (~48 wt%) of dendrimer-like PAMAM particles with average diameters of ~1.3-2.4 μm and (iii) matrices with sponge-like microstructures characteristics of membranes with strong mechanical integrity. Preliminary experiments show that these new mixed matrix PVDF membranes can serve as high capacity and selective sorbents for Cu(II) recovery from aqueous solutions by ultrafiltration.

ABOUT THE SPEAKER

Prof. Mamadou Diallo was trained both as an environmental/chemical engineer and physical chemist. He holds an Engineer Diploma in Mineral Engineering from Ecole Nationale de L' Industrie Minerale (Rabat, Morocco), a Master of Science degree in Chemical Engineering from Colorado School of Mines, a Master of Science degree in Chemistry and a Ph.D. degree in Environmental Engineering from the University of Michigan. He also completed post-doctoral training in Computational Chemistry at the California Institute of Technology. Prof. Diallo's current research interests and activities focus on the use of advanced polymers as building blocks for novel separation membrane materials and systems for sustainable chemistry, engineering and materials (SusChEM) including (i) water purification, (ii) resource recovery and (iii) CO₂ capture and conversion. In December 2009, Prof. Diallo began a joint faculty appointment between the Korea Advanced Institute of Science and Technology (KAIST) and the California Institute of Technology (Caltech). At KAIST, he serves as Associate Professor and Director of the Laboratory of Advanced Materials and Systems for Water Sustainability of the KAIST Graduate School of Energy, Environment, Water and Sustainability (EEWS). At Caltech, he is a Visiting Faculty in the Environmental Science and Engineering Department. In addition to his professorial duties, Prof. Diallo also serves as Associate Editor of the Journal of Nanoparticle Research and member of the Editorial Advisory Board of Environmental Science and Technology (ES&T). He is also a member of the Scientific Advisory Boards of the US DOE Critical Materials Institute and the Nanosystems Engineering Research Center for Nanotechnology-Enabled Water Treatment at Rice University.