

Amgen Seminar Series in Chemical Engineering
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Polymer-Grafted Nanoparticle Membranes with Unusual Gas Separation Properties

By



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Polymer membranes are employed in several critical sustainability applications involving the separation of gas mixtures based on size differences. In spite of their widespread use, important performance challenges remain outstanding - the need to dramatically affect the transport of a desired mixture component and improving mechanical resilience relative to the current state-of-the-art. Here, we develop novel membranes based on polymer-grafted nanoparticles (GNPs) which possess controllable, spatially inhomogeneous gas transport behavior. We show that smaller gases are transported more uniformly than larger solutes in the polymer layer of pure GNPs; these larger gases preferentially move through the interstices between the NPs. Free chains added to these GNPs preferentially segregate into these interstices where they selectively hinder large solute motion and thus yield dramatic performance improvements for several industrially relevant gas pairs. The magnitude of these effects are controlled by grafting parameters and the length of the free chains. Our ability to create and tune spatial inhomogeneities in GNPs, apparently through judicious manipulation of chain entropy, is thus a new, apparently general, physics-based paradigm to design membranes with unprecedented performance even using common polymers.

Collaborators: Connor Bilchak, Yucheng Huang, Daniele Parisi, Zaid Abbas, Werner Egger, Ferruccio Doghieri, Matteo Minelli, Marcel Dickmann, Brian Benicewicz, Jacques Jestin, Michael Rubinstein, Dimitris Vlassopoulos, Ludwik Leibler, Christopher Durning

Appointments:

2016-present Bykhovsky Professor of Chemical Engineering, Columbia University
2010-2016 Chair, Chemical Engineering, Columbia University
2006-2010 Professor, Chemical Engineering, Columbia University
2002-2006 Professor, Chemical and Biological Engineering, Rensselaer Polytechnic Institute
2001-2002 Professor of Materials Science & of Chemical Engineering, Penn State University
1997-2002 Professor of Materials Science, Penn State University
1993-1997 Associate Professor of Materials Science, Penn State University
1988-1993 Assistant Professor of Materials Science, Penn State University

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