Department of Civil Engineering
The University of Hong Kong
香港大學土木工程系

Distinguished Public Lecture (Online)

Wrinkles and Aging

Membranes for Molecular Separations

Date: 26 May 2021 (Wed)

Time: 5:00 p.m. (HKT)

via Zoom (Meeting ID: 990 9349 7051)

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Queen Mary University of London

About the Speakers

Andrew Livingston (AGL) is from Taranaki NZ, and studied Chemical Engineering at University of Canterbury. He then worked at an NZ food processing company followed by a PhD at Cambridge UK, and in 1990 joined the Department of Chemical Engineering at Imperial College, serving as Head of Department during 2008-2016. He leads a research group of 15 PhD students and Post-Docs, with interests in membranes for molecular separations in liquids and the development of chemical processes using these membranes. Awards include the Junior Moulton Medal, Cremer and Warner Medal, and Underwood Medal of IChemE, Research Excellence Medal from Imperial College and Silver Medal of Royal Academy of Engineering. AGL was elected a Fellow of the Royal Academy of Engineering in 2006.

From October 2016 he was the inaugural Director of the Barrer Centre at Imperial College, and from 1 July 2017 he served as the interim academic lead, from 1 Jan 2019- May 2019 the interim director, of the new Rosalind Franklin Institute, set up with a £100M investment from the UK Government to carry out ground-breaking research at the interface of engineering, physical sciences and life sciences. In 1 November 2019 he joined Queen Mary University of London as the Vice Principal, Research and Innovation.

In 1996, AGL founded Membrane Extraction Technology (MET), a spin-out company which evolved to manufacture solvent stable Organic Solvent Nanofiltration (OSN) membranes for molecular separations in organic liquids. On 1 March 2010 MET was acquired by Evonik Industries of Essen, Germany, and continues in business as Evonik MET Ltd., a part of the Evonik Fibres and Membranes Business. In 2018 AGL founded Exactmer, a company dedicated to the production of exact polymer molecules including oligonucleotides, peptides and synthetic polymers such as PEG, using Nanostar Sieving technology which is actively engaged in developing new manufacturing routes to polymeric therapies including peptides and oligonucleotides.

Abstract

Membranes have had a huge impact in molecular separations in aqueous systems, especially desalination. It is generally accepted that 40-70% of capital and operating costs in chemical and pharmaceutical industries are dedicated to separations; and a substantial fraction of this cost is related to processing of organic liquids. Membrane technology has the potential to provide game changing alternatives to conventional concentration and purification technologies such as adsorption, chromatography, liquid extraction, evaporation and distillation, through Organic Solvent Nanofiltration (OSN) [Chemical Reviews, 114, 10735-10806 (2014)]. The membranes must offer resilience in organic environments, display attractive selectivities, and have good permeance. Ideally they should also be resistant to physical aging and fouling under use.

This presentation will focus on research into advanced membranes for OSN and their applications. Ultra-thin polyamide films (sub-10nm) have been formed by interfacial polymerisation and then used to fabricate composite membranes. These can be activated by a strong solvent, and have excellent permeance and high rejection [Science, 348, 1347-1351 (2015)]. The fascinating surface morphology of these membranes can be manipulated from smooth to wrinkled; and the wrinkled form offers higher permeance through a higher area. It has been found that the aging of these composite membranes derives from properties of the support membrane rather than the thin film itself. Intrinsic microporosity can be introduced into the ultra-thin polymer films through selection of contorted monomers for interfacial polymerisation. These intrinsically microporous polymer nanofilms provide higher interconnectivity of pores and greater permeance than films obtained from planar monomer systems [Nature Materials, 15, 760-767 (2016)]. Further, new integrally skinned asymmetric membranes capable of filtration of solutions of DMF and other solvents at over 140°C have been developed by taking advantage of the properties of poly-ether-ether-ketone (PEEK) [J. Mem. Sci., 525, 48-56 (2017)], while new ultra-selective membranes using designer polymers are able to offer class-based separations in crude oil [Science, 369, 310-315 (2020)]. Finally, some applications and expected future developments of OSN will be introduced.

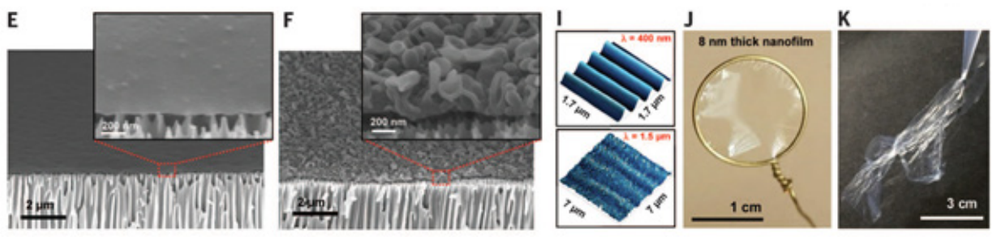

Figure – Thin polyamide films 8nm thick showing smooth and crumpled structures [Science, 348, 1347-1351 (2015)]

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