THE UNIVERSITY OF HONG KONG

DEPARTMENT OF CIVIL ENGINEERING

SEMINAR

Green synthesis of cation exchange membranes

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The University of Leuven (KU Leuven) in Belgium

Date: July 8, 2025 (Tuesday)
Time: 3:00 p.m. – 4:30 p.m.
Venue: Room 612B, 6/F Haking Wong Building, The University of Hong Kong

Abstract
Climate change and environmental pollution incentivized a transition towards more sustainable technologies. Cation exchange membrane (CEM) applications, such as CO2 electrolyzers, artificial photosynthesis, fuel cells and electrodialysis play an important role in this transition. Despite the envisioned application of these technologies to support sustainable development, the state-of-the-art fabrication of CEMs cannot be considered green nor sustainable, due to the use of perfluorinated polymers, or toxic solvents during their fabrication. This seminar highlights the fabrication of CEMs using greener and non-hazardous materials, using non-fluor containing compounds and a variety of green organic solvents.

Methanol rejection and ionic conductivity are two key performance parameters for a variety of CEM applications, including CO2 electrolyzers, artificial photosynthesis and direct methanol fuel cells. Conventional membranes suffer from the typical trade-off between rejection and conductivity, where improving retention comes at cost of the conductivity and the other way around. The design of a new CEM should overcome this trade-off, while making use of non perfluorinated membrane building blocks. By using crosslinked sulfonated polyether ether ketone (sPEEK) resulted in proton conductivities superior to the commercial benchmark, Nafion 117, and a better methanol rejection.

As tools for sustainable synthesis, seven alternative green solvents were explored: dimethyl sulfoxide (DMSO), Tamisolve NxG, Rhodiasolv® PolarClean, Cyrene™, acetyl triethyl citrate, acetyl tributyl citrate and γ-valerolactone. However, based on Hansen solubility analysis, and upon preliminary testing, only Tamisolve NxG and DMSO were deemed suitable for CEM fabrication. A blend of these solvents resulted in a crosslinked sPEEK/DCX-10/90% CEM with both lower ionic resistance (0.036 Ω vs. 0.089 Ω) and lower methanol permeation ($2.06 \cdot 10^{-3}$ min^{-1} vs. $2.8 \cdot 10^{-3}$ min^{-1}) compared to Nafion 117. Thus, it was concluded that a smart choice of solvents may allow for a similar or better performance, with a sustainable synthesis procedure.

About the Speaker
Bart Van der Bruggen is professor at the University of Leuven (KU Leuven) in Belgium, where he leads a group of 35 PhD students in the research division “Process Engineering for Sustainable Systems” within the department of Chemical Engineering. His expertise is in separation technologies for sustainable processes, with an emphasis on membrane science and technology.

He authored over 800 publications related to membrane technology in international scientific journals and 30 book chapters (current h-index: 110, Web of Science). He was the President of the European Membrane Society (EMS) from 2013 to 2017, and the Founding President of the World Association of Membrane Societies (2017-2020). Since 2014 he is also Extraordinary Professor in Tshwane University of Technology (South Africa), professor at the Technical University of Ostrava (Czech Republic) and Korea University (Seoul, Korea) since 2024, and professor at the University of Aruba (since 2025). He is editor for several scientific journals, including Separation and Purification Technology (Editor-in-Chief), Journal of Chemical Technology and Biotechnology, Heliyon and Process Safety and Environmental Protection.

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