Novel membrane separation technologies and membrane processes

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Membrane-based separation technologies have received increasing attention attributing to lots of advantages such as the low energy consumption, easy operation, and environmental friendliness. In recent years, the emergence of novel two-dimensional (2D) materials, such as graphene, provides a new opportunity for membrane development. Thus, *Frontiers of Chemical Science and Engineering* (FCSE), one of the transactions of Chinese Academy of Engineering, organized this Special Issue aiming to illustrate some of the exciting progresses and achievements in the relevant research fields. In this Special Issue, we included seven review articles and six featured research papers from research groups from China and overseas, including 2D nanosheets membranes separation (MXene membranes, graphene oxide (GO) membranes, MoS₂ membranes) and imprinted membranes, as well as several membrane processes, such as nanofiltration process, membrane distillation, membrane-coupled photodegradation, films for X-ray shielding and membrane contactors for CO₂ capture.

This review titled “Recent progress of two-dimensional nanosheet membranes and composite membranes for separation applications”, presents the development, progress, and recent break-through of different types of 2D membranes, including membranes based on porous and non-porous 2D nanosheets for various separations. And the separation mechanism of 2D membranes, their fabrication methods, challenges and future directions of 2D membranes for wide utilization are discussed in brief [1].

Emerging MXene-based membranes play significant roles in the competitive membrane-separation field. The review paper “Recent progress in the design and fabrication of MXene-based membranes”, gives recent major advances of MXene-based membranes based on gas-molecule sieving, ion sieving, and other small-molecule sieving. New horizons for MXene-based membranes are highlighted from four aspects, including MXene nanosheet cross-linking, constructing additional nanochannels, MXene hybrid membranes, and MXenes as 2D scaffolds in this review [2].

As an alternative option, GO membranes show great potential in water–ethanol separations for producing bio-ethanol. “Theoretical study on Janus graphene oxide membrane for water transport” computationally design the Janus GO membranes for water separation from ethanol. They report that the Janus GO membrane with an OPOP orientation exhibited an exceptionally high water flux ($\sim 40.9 \text{ kg} \cdot \text{m}^{-2} \cdot \text{h}^{-1}$), highlighting the important roles of the oxidized upper surface and interlayer channel in water crossing through the aligned GO pores for selective water transport [3].

Moreover, the emerging 2D material nanopores have provided a new avenue for high performance DNA

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sequencing, which is critical for modern chemical/biological research or applications. In “Molecular dynamics simulation on DNA translocating through MoS₂ nanopores with various structures”, Li et al. simulated DNAs translocating through various MoS₂ nanopores in a stepwise manner, yielding stable signals (e.g., ionic current) for DNA sequencing. Various factors regulating the translocating process and associating ionic current were studied, providing with useful insights or guidelines for the development of nanopore-based DNA sequencing technologies [4].

Besides the separation applications of 2D membranes, some other membrane processes are also reviewed. Obtainment of sugar from biomass is important for food and biomanufacturing industries, and nanofiltration membranes with 0.5–2 nm pore size enable their use in fractionation and purification of sugar from biomass. The review paper “Nanofiltration for separation and purification of saccharides from biomass” summarizes recent advances on the applications of nanofiltration in separation of saccharides, provides an insight into the mechanisms of mass transfer and membrane fouling as well as membrane cleaning strategies, and discusses the challenges and possible solutions of membrane technology in sugar industry [5].

We sincerely thank the Editors-in-Chief and editorial team to assemble this Special Issue and hope the readers enjoy the articles.

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Guest Editors

Prof. Yanying Wei received her Ph.D. degree under the supervision of Prof. Haihui Wang at South China University of Technology in 2013. During 2013–2015, she worked as a Humboldt research fellow in Prof. Juergen Caro's group at Leibniz University of Hannover. She is currently a professor in the School of Chemistry & Chemical Engineering at South China University of Technology. Her research focuses on novel 2D nanosheets membranes, MOF membranes for various separation and catalytic membrane reactors. She has published over 70 peer-reviewed journal papers at *Nat. Sustain.*, *Nat. Commun.*, *Sci. Adv.*, *JACS*, *Angew. Chem. Int. Ed.*, etc., 2 co-authored monographs and held 39 patents.

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