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*Chemeca 2026 and Hazards Australasia  
28 – 30 September, Melbourne, Australia*

# **Electrospun thermally rearranged polybenzoxazole nanofiber membranes with enhanced water flux for direct contact membrane distillation**

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## **ABSTRACT**

*Despite extensive research on membrane distillation (MD) for potable water production, achieving high water flux while maintaining stable performance over long-term operation remains a significant challenge. Conventional fluoropolymer membranes, such as PVDF and PTFE, suffer from pore wetting, flux decline, and limited lifespan despite their inherent hydrophobicity. To overcome these limitations, membranes with low thermal conductivity, low surface energy, and high thermal and chemical stability are essential for sustained MD performance. Recently, aromatic, microporous thermally rearranged (TR) polybenzoxazole membranes have emerged as promising candidates for direct contact MD owing to their superhydrophobicity, which enables high water permeability and excellent salt rejection. In this work, we develop electrospun nanofiber TR membranes which combine high porosity, superhydrophobicity, interconnected pore structures, and enhanced surface area, making them highly suitable for improving flux and long-term stability.*

*The thermally rearranged polybenzoxazole-co-imide (TR PBOI) membranes were fabricated through three sequential steps: synthesis of polymer precursors, electrospinning of the precursors, and thermal rearrangement. A two-step synthesis was performed to produce ortho-acetyl copolyimide (AcPI) polymers, which served as precursors for TR PBOI membranes. A hydroxyl-containing poly(amic acid) precursor was synthesized through polycondensation of 4,4'-(hexafluoroisopropylidene) diphthalic anhydride (6FDA), 4,4'-Diamino-[1,1'-biphenyl]-3,3'-diol (HAB), and 4,4'-Oxydianiline (ODA) followed by chemical imidization to produce AcPI. The AcPI solutions were electrospun to form nanofiber membrane mats. TR PBOI nanofiber membranes were obtained by solid-state thermal rearrangement of the AcPI nanofiber mats at temperatures above 400°C under an argon atmosphere.*

*Incorporating composite layers during electrospinning of TR PBOI nanofiber membranes enhanced surface roughness and hydrophobicity, enabling higher liquid entry pressure and improved water flux through additional microparticles and beads-on-string layers. Highly porous TR PBOI nanofiber membranes with tuneable morphologies were successfully fabricated, as confirmed by SEM. The formation of benzoxazole rings within the*

*membrane structure was verified using ATR FTIR. The resulting membranes exhibited high surface hydrophobicity, with water contact angles exceeding 140°, as well as excellent thermal stability above 500°C, as demonstrated by TGA. Membrane performance was evaluated using 35 g/L NaCl solutions in a lab-scale MD system, demonstrating >99.8% salt rejection. The scalable fabrication process underscores the potential of superhydrophobic, highly porous TR membranes to bridge the gap between laboratory development and industrial commercialization, offering a sustainable solution for high-salinity desalination.*

#### **KEY WORDS**

*Desalination, Electrospinning; Membrane distillation; Polybenzoxazole membrane; Thermal rearrangement*

#### **BIOGRAPHY**

Anniza Cornelia Augusty is currently pursuing her Ph.D. in Chemical Engineering at RMIT University, Australia under the guidance of Dr. Seungju Kim and A/Prof. Linhua Fan. She received her M.Eng degree in Chemical Engineering at Chulalongkorn University in Bangkok, Thailand. Her research interests are mainly focused on developing new membrane materials for membrane distillation. She is currently also interested in membrane fabrication for water purification and desalination, including surface modification and fouling mitigation.

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