# Defect-Free Submicroporous Interfacially Polymerized Thin-Film Composite Membranes: New Opportunities for Gas- and Liquid Separations

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**Abstract:**

Thin-film composite (TFC) polyamide membranes made by interfacial polymerization (IP), based on the reaction of trimesoyl chloride (TMC) with *m*-phenylene diamine (MPD) or piperazine (PIP), were pioneered by Cadotte and co-workers more than 40 years ago. This technology presented a major paradigm shift in the commercial use of membranes for reverse osmosis (RO) and nanofiltration (NF) applications due to their superior water permeance and extraordinary salt rejection properties compared to any other membrane type. Equally important, the polymer synthesis and membrane fabrications steps were combined in a single roll-to-roll process that was reproducible and easily scalable. Although some progress has been achieved in the development of TFC membranes with enhanced water permeance, most commercial NF and RO membranes exhibit only moderate performance in several important large-scale applications, such boron and arsenic removal from various water sources, due to low-to-moderate rejection.

Interestingly, high-performance commercial polyamide TFC membranes developed for NF and RO contain defects in their dry state, as indicated by Knudsen diffusion type transport properties, which render them unsuitable for gas separation applications. Our group recently developed a modified IP fabrication protocol, named KRO, for the preparation of defect-free submicroporous (pore size < 4 Å) polyamide TFC membranes. The key parameters to eliminate defects during the formation of IP membranes are: (i) long reaction time and (ii) elevated temperature of the TMC solution. In this presentation, we will discuss the superior molecular sieving properties of KRO-based TFC membranes for various polyamide formulations and a variety of important industrial applications, including $H_2/CO_2$ separation from syngas, helium recovery from natural gas, boron and arsenic (III) removal from seawater and ground water etc.

**Keywords**: Interfacial polymerization, KRO process, submicropores, defect-free polyamide, gas- and liquid separations