Roadmap for Graphene and Other 2D Materials Applications in Water Desalination

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Abstract

Amid the global effort to combat water scarcity, the tide has shifted towards developing solutions that aim at seawater and brackish water desalination. Over the past three decades, the proliferation of desalination has soared, emerging as a potent answer to the world's water shortage bottleneck.
A myriad of innovations has driven down the price of desalinated water significantly. From the widespread adoption of membrane-based reverse osmosis (RO) technology to breakthroughs like pressure exchangers, low-energy RO membranes, and membrane-based pretreatment systems, each stride has propelled towards more cost-effective solutions. Furthermore, the sharp decline in solar energy costs, notably in the Middle East, has boosted desalination operations. Yet, despite these achievements, thirst for more cost reductions persists among global utility firms. For instance, the introduction of new ultrafiltration (UF) membranes promises to improve the pretreatment process within RO plants. The revolution of two-dimensional (2D) materials, such as graphene and MXenes, allow the reshaping of the desalination technology. These unique materials could enhance water permeability, selectivity, and antifouling properties in membrane applications [1].
The versatility of 2D materials goes beyond membranes. It extends to a range of potential applications, such as combatting biofouling in intake pipes, offering coatings that deter the attachment of marine organisms. Their innate properties, abundant surface area, mechanical resilience, and chemical stability make 2D materials' surfaces resilient to the rigors of marine environments [2]. The utility of 2D materials doesn't end there. Their anti-corrosion qualities are utilized in sealants and coatings, which protect equipment in desalination plants and reduce maintenance cost [3]. In media filters, they improve pollutant removal, reduce fouling, and strengthen structural integrity [4]. 2D materials also find their place in emerging capacitive deionization (CDI) process, acting as novel electrode materials to improve ion adsorption and desorption. This integration increases salt removal capacity and energy efficiency, pushing the limits of desalination efficiency [5]. Finally, in sensory applications, 2D materials emerge as sentinels, detecting in real time contaminants critical to maintaining water quality in desalination operations [6]. These applications and more will be covered in this talk.

References

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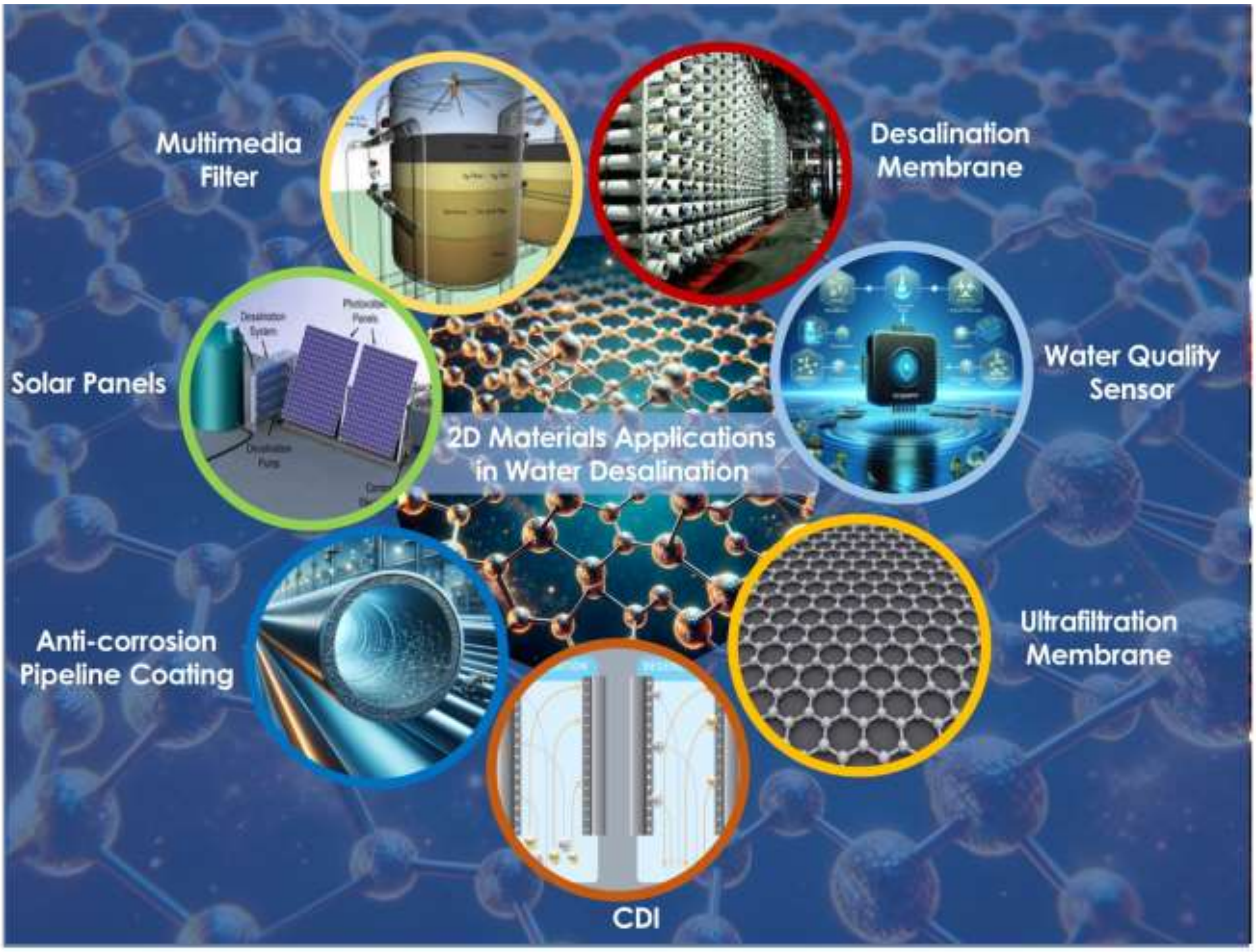

Figure 1: Potential applications of 2D materials in desalination plants.