MECHANICAL PROPERTIES OF CARBON NANOMEMBRANES AND CARBON NANOMEMBRANES/PET COMPOSITES DESIGNED FOR WATER SEPERATION TECHNOLOGIES

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ABSTRACT

Water separation technologies are widely applied throughout different sectors of the modern industry and even in many households, aiming to block certain substances and clean water. Ultrathin Carbon Nanomembranes (CNMs) [1] enable a highly selective, fast flow, energy efficient water separation technology as a technological equivalent to the highly efficient biological filtration membranes found in nature. CNMs are two-dimensional (2D) materials of ~1 nm thickness and with sub-nm functional pores for use in demanding water treatment applications. They can be produced on a large scale on porous substrates and their properties can be widely tuned. The research objective of this work is to explore and study the mechanical properties of CNMs and their substrates to ensure the structural rigidity of the membrane during operation.

Membrane mechanical characteristics are critical in pressure-driven membrane processes because these materials carry the mechanical loads generated by liquid flow. At high operating pressures, the membranes may be subjected to significant physical compression, which might reduce or even destroy their performance. When the functional section of a membrane has weak inherent mechanical properties or its dimensions preclude it from operating at high pressures, one solution is to support it with a porous substrate with adequate mechanical stability. As a result, the mechanical behavior of both the active membrane and the substrate of a composite membrane is significant and demands extensive investigation.

Measuring the mechanical properties of nanometer-thick membranes, in contrast to macro-materials, is a difficult undertaking. For this purpose, the membranes were suspended over patterned substrates and their intrinsic mechanical properties were quantified using Atomic Force Microscopy (AFM). Tensile experiments using a Deben™ micro-test tensile stage were used to investigate the mechanical properties of substrates and composite membranes. The influence of substrate thickness and porosity was also investigated. Finally, Thermogravimetric Analysis was used to investigate the behavior of composite membranes at high temperatures (TGA).

KEYWORDS: Carbon nanomembranes, mechanical properties

REFERENCES

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