Photocatalytic-triggered nanopores across multilayer graphene for high-permeation membranes

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2D nanoporous graphene nanomaterials have been considered for the development of high permeability membranes, compared to dense laminate architectures. Current perforation technologies, however, have struggled to deliver a membrane for practical use due to a lack of scalability and increased related complexity/costs over commercial membranes. Herein, the perforation of ultrathin graphene membranes, with thicknesses ranging from 50 to 200 nm were performed via a triggered and site-selective photocatalytic etching process. The perforated graphene membranes exhibited a narrow distribution of in-plane nanopores with sizes ranging from 20 and up to100 nm, depending on irradiation durations. The surface pore density across porous graphene can be tuned, achieving a maximum surface density of 1011 cm−2, depending on the amounts of pore-mediators i.e. nano-catalysts loaded to multilayer graphitic assemblies. The perforated membranes exhibited a water permeation of 85 LMH/bar, 3.5 times higher compared to unperforated membrane analogues though a decrease in dye removal (∼20% for the methylene blue organic dye) was noted over the extended permeation duration (2-hour). The synergetic characteristics between inherent nanochannels between graphite planes and incorporated nanopores across such ultrathin perforated graphene membranes promise improvements in water treatment using such architectures of high permeability graphene membranes.

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