Tunning of MoS_2/PET Heterostructures: Synthesis, Characterizations, and Applications

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Two-dimensional graphene-like materials such as molybdenum disulfide (MoS_2) exhibit exceptional potential for applications in photocatalysis and environmental sensing. This study explores the development of heterostructures combining nanostructured polymer membranes with MoS_2, engineered to serve as high-performance photocatalytic filters and humidity sensors. MoS_2 layers were deposited onto polyethylene terephthalate (PET) nuclear membranes (NM) using pulsed laser deposition (PLD) with pore sizes tailored through different ion track etching duration. For the preparation of NM, PET foils were irradiated with 170 MeV Xe^+ ions at a fluence of 1×10^6 cm^{-2}, and the etching process yielded pore sizes of 0.45 ± 0.05 µm and 0.75 ± 0.11 µm. Surface morphology and deposited layer composition were characterized using scanning electron microscopy (SEM) and Rutherford backscattering spectrometry (RBS), respectively. Photocatalytic activity, measured via bisphenol A (BPA) degradation, revealed that PLD-coated membranes with larger pore sizes achieved the lower degradation rate constants of 0.034 min^{-1}, resulting in 52% BPA removal within 240 minutes. Humidity-sensing performance, assessed through resistivity measurements, demonstrated a linear response with a sensitivity improvement of 40% compared to the control samples, achieving a dynamic range of 20% to 50% relative humidity. The results demonstrate that the pore size critically influence the functional properties of NM. These findings provide valuable insights into the optimization of membrane systems for applications in environmental remediation and advanced sensing technologies.