Pyro-layering Heterostructured Nanosheets as Molecular Sieving Membrane for Selective Hydrogen Transport

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Abstract:

Membranes have been engineered from two-dimensional materials to possess molecular sieving channels that facilitate fast and selective gas molecule transport. Particularly, fabricating heterostructures by layering two-dimensional materials have produced unique physiochemical properties that are significantly different from structures made from their pure counterparts. We propose a simple and versatile pyro-layering approach to fabricate heterostructured membranes from boron nitride nanosheets as the main scaffold and graphene nanosheets derived from chitosan precursor as the filler. The rearrangement of the graphene nanosheets adjoining the boron nitride nanosheets during the pyro-layering treatment forms precise in-plane slit-like nanochannels and plane-to-plane spacing of ~3.0 Å, thereby endowing specific gas transport pathways for selective hydrogen transport. The heterostructured membranes are highly permeable to H_2 (1340 GPU), with ideal selectivity of H_2/CO_2, H_2/N_2 and H_2/CH_4 of 399, 383 and 237, respectively. The facile and scalable technique to fabricate heterostructures as next-generation membranes for precise gas molecule transport holds great promises in advancing gas separation and purification processes.

Keywords: gas separation, boron nitride, membrane, hydrogen separation, two-dimensional materials