Interfacial engineering of metal-organic framework nanocomposite membranes

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Abstract:

Metal-organic framework (MOF) materials have been extensively investigated in the field of membrane separation. Their highly tunable structure and chemical properties render them proper candidates for molecular separation membranes. However, their processibility as highly porous framework materials are still hampered due to their chemical instability and potential structural collapse during the treatment. In recent years, we have explored a series of different technique to regulate the interfacial properties between MOF and the surrounding polymers, which include chemical functionalisation, in-situ nucleation and mechanical treatment. With the discovery of unique melting behaviour of some MOF materials in the recent years, the thermal treatment for nanocomposite membrane performance enhance has also been identified as a viable approach. In one of our recent works, Non-stoichoimetric crystalline ZIF-62 was used as the filler for a 6FDA-DAM polyimide-based composite membrane. In situ melting and vitrification of ZIF-62 was then performed, to yield the ZIF-62 glass phase (a_gZIF-62), within the polymer matrix. Focus ion beam scanning electron microscopy (FIB-SEM), thermal characterisation and membrane separation tests demonstrate the filling of voids at the MOF/polymer interface from the liquid phase of ZIF-62. The array of experimental characterisations shows the in situ melting within matrics effectively heals the defects even at meso- and macroscale. The dynamically under-coordinated metal nodes and organic ligands in the liquid phase conformation form bonds with polymeric matrices, rigidifying the polymer chains. These findings are encapsulated by membrane molecular separation performances, revealing that the in situ melting effectively promotes the membrane selectivity.

Keywords: Metal Organic Frameworks Glass, MOF Composites, Gas Separation Membrane