Synthesis and Functions of Novel Reticular Polymeric Nanomembranes Formed within Unconventional Electric Double Layer

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An ultrathin free-standing sheets (<100 nm) known as nanomembranes (NMs) have a large potential to carry extraordinary properties in optical, electronic, and separation applications, which are inaccessible using bulk materials.[1,2] However, despite the development of fabrication approaches such as mechanical or chemical exfoliation of 2D crystals, layer-by-layer assembly, and interfacial methods, challenges remain in the development of improved synthetic methods allowing efficient and low-cost access to NMs of precise dimensions and high quality.

Here we report a new environmentally friendly polymerization method of exceptional efficiency to prepare large, smooth, and defect-free NMs of tailorable thickness, which is inspired by our previous study on a self-assembled monolayer which responds to a local pH gradient generated by an applied potential on the electrode surface.[2] It simply requires applying an external potential to an electrochemical cell containing monomers and water alone for as little as 1 minute. The NM formed on the electrode surface was immediately released upon its submersion in pure water, which is difficult to achieve for a NM formed by conventional electropolymerization methods. The resulting polymers possess interconnected voids fostering a reticular framework with the highest Young's Modulus reported thus far for polymeric NMs. This porosity and unrivaled mechanical robustness were brought to bear in the preparation of thin-film composite (TFC) membranes which permitted the characterization of the porous structures by means of nanofiltration, revealing pH-responsive effective pores of ~1 nm capable of separating small organic molecules based on charge and size.[3]

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3) *Submitted*.