Title: Self-Healing Metal-Organic Framework Hybrids for Water Purification

Mixed-matrix membranes (MMMs) offer a straightforward hybridization platform to attain crystalline, microporous metal-organic framework (MOF) solids as free-standing, pliable films, applying an amorphous organic polymer as a binder.[1] MMMs find wide applications across molecular separation, catalysis, and others.

Conventional MMMs are incapable of recycling, which imposes significant limitations, particularly when subjected to catastrophic damage that prematurely turns them waste. Furthermore, the binders of a waste MMM require separate and laborious attention for their decomposition. From a sustainable perspective, it is imperative to enhance the service life of MMMs.

Dynamic covalent chemistry (DCC) has garnered attention in developing polymer materials with improved longevity through integrating self-healing and recycling functionalities.[2] DCC has yet to be deeply investigated in the context of MOF hybrids.

This project seeks to investigate new fabrication methods for self-healing and/or recycling MOF-polymer hybrids, including MMMs, using DCC (**Figure 1**). The primary objective of this research is to comprehensively understand such hybrids synthesis and assess their practical applicability, such as for water purification. Various characterization techniques, including NMR, UV-Vis spectroscopy, tensile testing, scanning electron microscopy (SEM), transmission electron microscopy (TEM), powder X-ray diffraction (PXRD), and thermal instruments, will be used to evaluate the material properties.

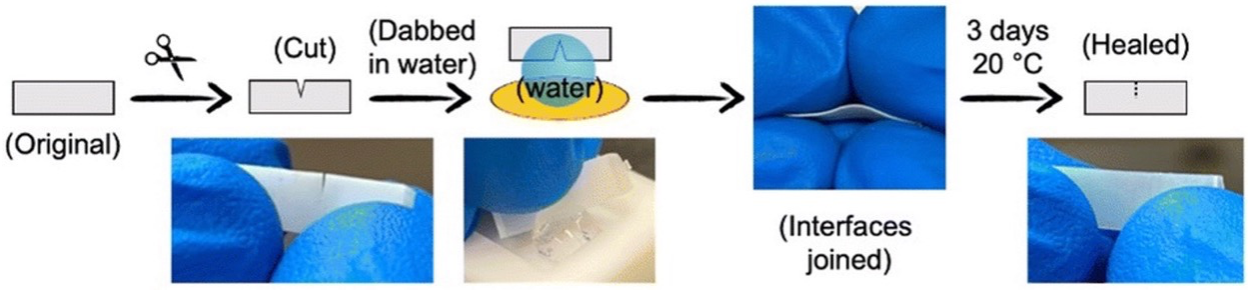

Figure 1: Pictorial demonstration of a self-healing MOF-based MMM.[3]

Required skills:

- Fundamentals of MOF and polymer chemistry
- Practical laboratory experience in wet lab settings
- Self-reliant laboratory work skills
- Effective communication abilities

Skills that you will acquire:

- MOF synthesis, MOF-polymer hybrids fabrication, and their characterization
- Polymerization and polymer recycling approaches

References: 1) Cohen et al. *Angew. Chem. Int. Ed.* **2015**, 54, 9029-9032; 2) Ayres et al. *Polym. Chem.* **2020**, 11, 1410-1423; 3) Cohen et al. *Chem. Sci.* **2022**, 13, 12127-12135.