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A New Approach to Developing MOFs with Novel Characteristics

In order to develope metal-organic frameworks (MOFs) having novel properties, over the past two decades, many scientists in various fields have made intensive efforts. Recently, MOF-on-MOF architecturing has been actively studied by combining two or more MOFs into a composite. Composite metal-organic frameworks (MOFs) are comprised of one MOF and another material with noticeably different properties. In general, MOFs are viewed as attractive candidates to construct new composite materials given their facile synthesis and a large library of synthesized MOFs (over 100,000) that can be used as building blocks. As such, many researchers have integrated MOFs with other classes of materials (e.g., other MOFs, carbon-based materials, oxides, metal nanoparticles, polymers) to produce new structures with synergetic properties. Unfortunately, in many of these composite MOFs, the precise nature of the interaction and the bonding at the interface between the two materials is unknown and cannot be characterized well with any of the known methods. In this talk, we present a joint computational/experimental workflow that screens thousands of metal-organic frameworks (MOFs) and identifies the optimal MOF pairs that can seamlessly "connect" to one another by taking advantage of the fact that the metal nodes of one MOF can form coordination bonds with the linkers of the second MOF. Based on this synthetic strategy, we report the composites of dimensionally (2D and 3D) and functionally (conductive and porous) different two MOFs in the form of a well-integrated core-shell structure. The hierarchically assembled 2D-MOF@3D-MOF exhibits new interfacial properties that are responsible for synergetically enhanced sensing performances toward toxic H_2S gas with the lowest recorded limit of detection (1.4 ppb), superior sensitivity ($\Delta R/R_0$ = 3.36), and outstanding selectivity at room temperature in air. Finally, we will introduce carboxylate-based MOF glasses for the first time, as a new class of materials, which show superior mechanical properties in hardness (*H*) and elastic modulus (*E*). Our research is the first step of carboxylate-based MOFs sheds light on the viability of various meltable carboxylate-based MOFs.

References

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