Nonporous Adaptive Crystals (NACs) for Separation and Adsorption

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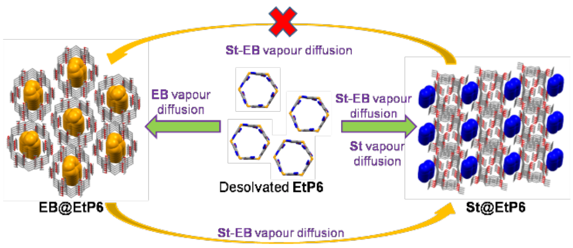
In the chemical industry, distillation is a very important method to purify chemicals. In fact, distillation takes about 10-15% of global energy consumption. This is equal to 100 million tons of carbon dioxide emissions and 4 billion dollars in energy costs annually. Therefore, it is necessary to develop energy-saving approaches to purifying chemicals. For this purpose, adsorption and separation based on porous materials have been widely investigated. There are two main types of porous materials. At macromolecular level, we have zeolites, MOFs, and COFs. They are crosslinked organic and inorganic polymer networks. At molecular level, we have porous organic cages or POCs. In this talk, I will introduce a novel kind of solid materials for adsorption and separation, nonporous adaptive crystals (NACs), which function at the supramolecular level. They are nonporous in the initial crystalline state, but the intrinsic or extrinsic porosity of the crystals along with a crystal structure transformation is induced by preferable guest molecules. Unlike solvent-induced crystal polymorphism phenomena of common organic crystals that occur at the solid-liquid phase, NACs capture vaporized guests at the solid-gas phase. Upon removal of guest molecules, the crystal structure transforms back to the original nonporous structure. I will focus on the discussion of pillararene-based NACs for adsorption and separation and the crystal structure transformations from the initial nonporous crystalline state to new guest-loaded structures during the adsorption and separation processes. Compared with traditional porous materials, NACs of pillararenes have several advantages. First, their preparation is simple and cheap and they can be synthesized in large-scale to meet practical demands. Second, pillararenes have better chemical, humid and thermal stability than crystalline MOFs, COFs and POCs, which are usually constructed based on reversible chemical bonds. Third, pillararenes are soluble in many common organic solvents, which means that they can be easily processed in solution. Fourth, their regeneration is simple and they can be reused many times with no decrease in performance. It is expected that this kind of materials will not only exert significant influence on scientific research, but also show practical applications in the chemical industry.



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