

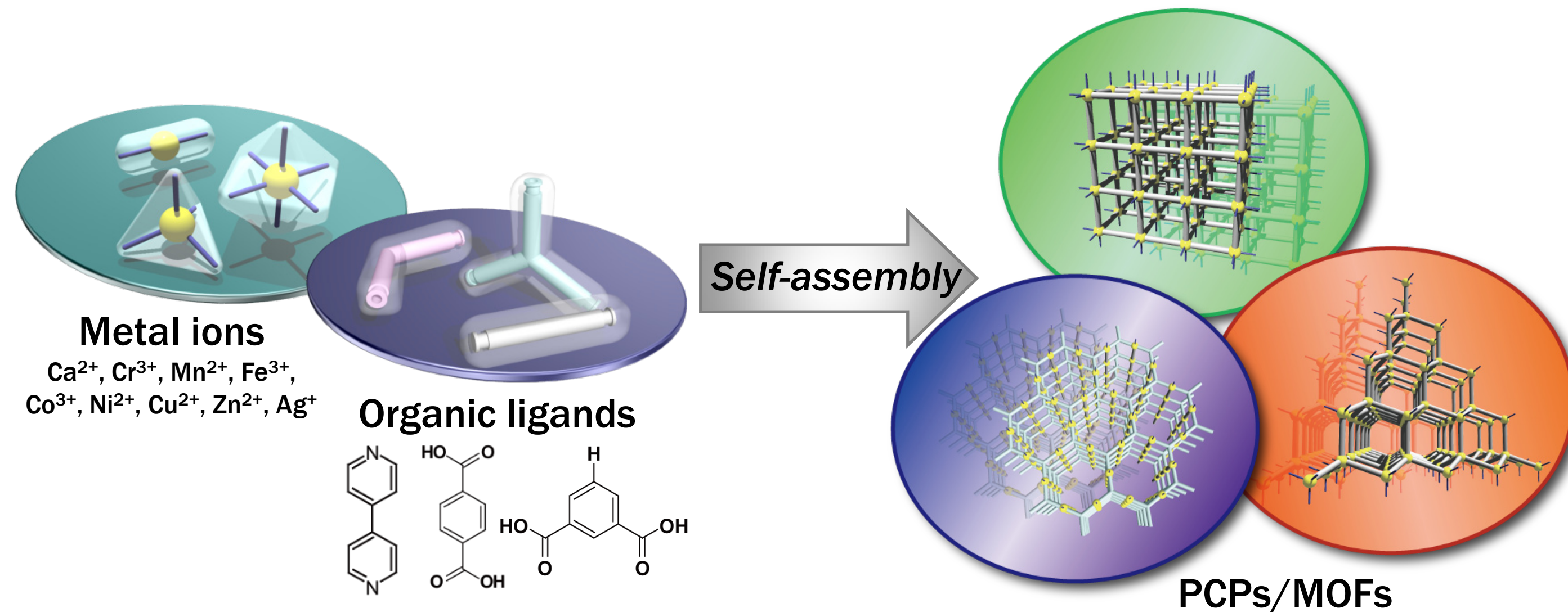
# Smart porous materials

## Metal-organic frameworks (MOFs) / Porous coordination polymers (PCPs)

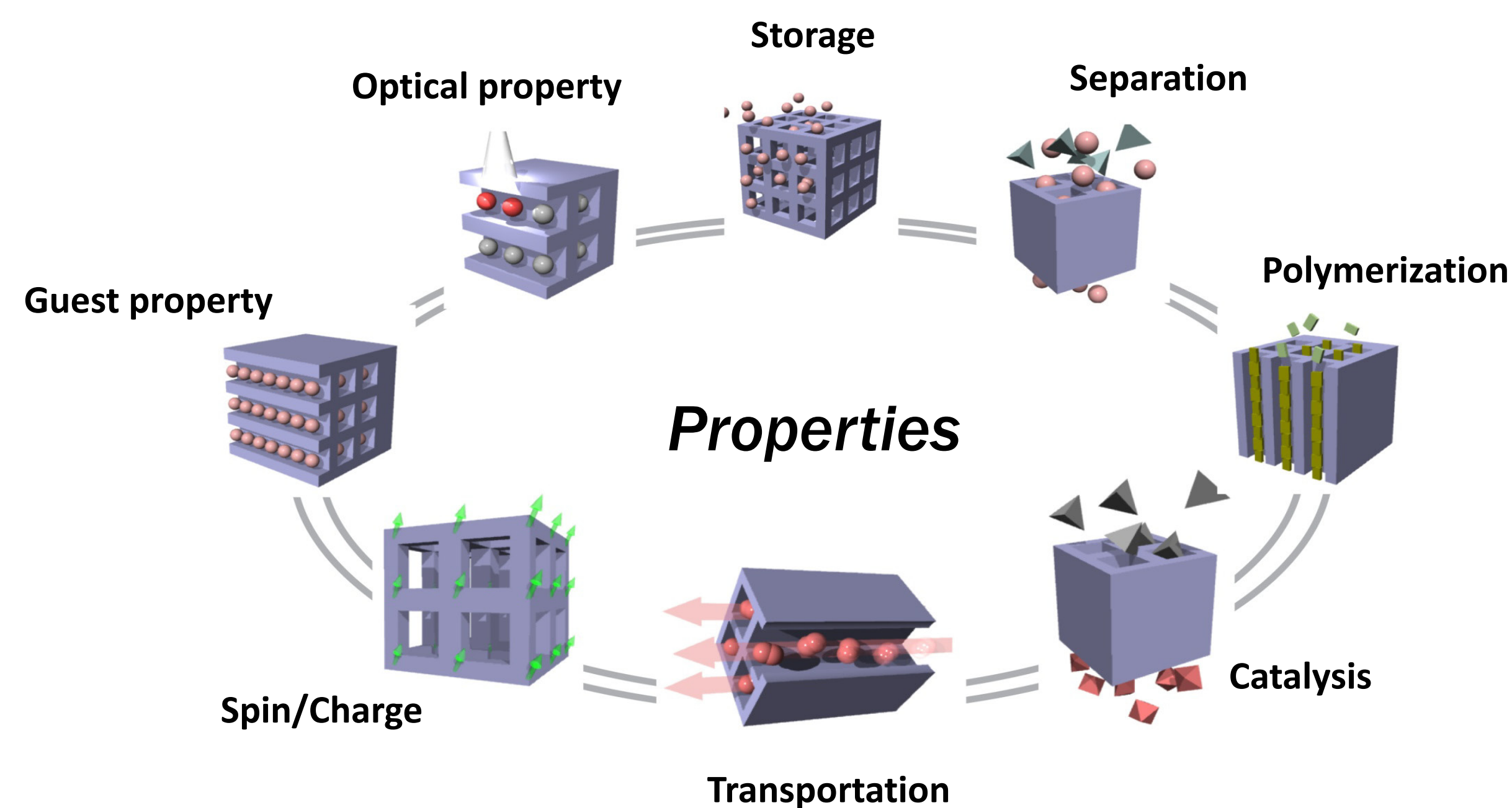
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## 1 What are PCPs ?

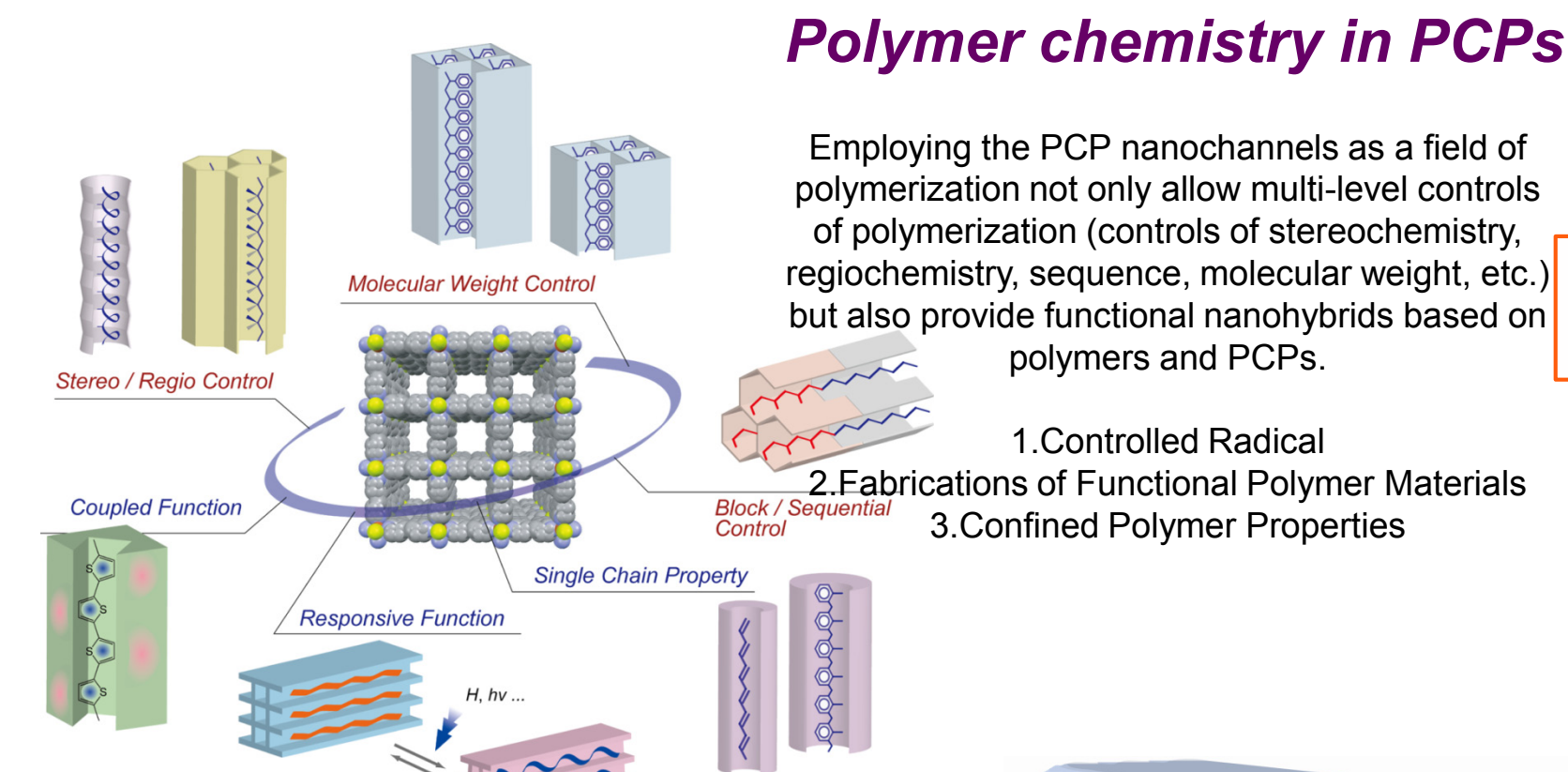


Well-designed metal-organic hybrid porous materials—so-called porous coordination polymers (PCPs) or metal-organic frameworks (MOFs)—can be made from an assembly of organic linkers with metal ions. This class of materials was recently recognized as an intriguing class of crystalline nanoporous materials for gas sorption, separation, and catalysis because their framework topologies and pore sizes can be designed for selective guest accommodation, and the functionality of the pore surfaces directly influences the interaction with guest molecules.



The properties of PCPs are basically derived from the framework itself, the inherent pores in the materials and their interplays. In addition to the basic porous properties such as storage and separation, chemistry in pores/channels allows us to carry out the reactions such as catalysis and polymerization and physics in pores/channels enables us to use them as carriers of ions and molecules. Thanks to the chemical diversity for the construction of PCPs, we can investigate the framework properties such as magnetic, electronic, and optical properties.

## 2 Functions of PCPs

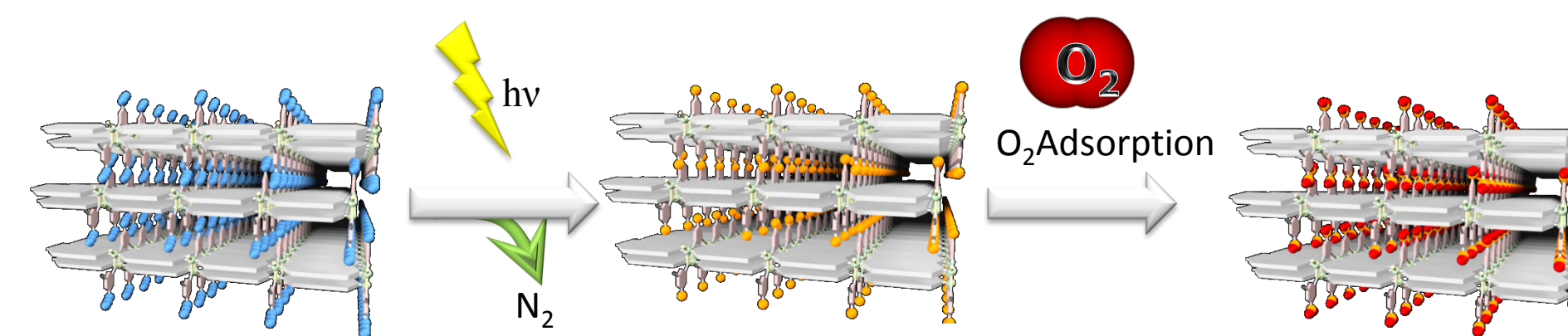


# Polymerization

# Transportation

The proton conducting solids, which act as electrolyte of fuel cell has received much attention. Especially the proton conductivity working under anhydrous conditions and at middle temperature region ( $>100^\circ\text{C}$ ) is regarded as significant target. To construct the proton conductors, we have focused on hybridization of proton carrier and PCP/MOF frameworks in molecular scale. Regular nanochannels and molecular dynamics of PCP frameworks are attractive platform to create a proton conduction pathway and systematic hybridization of PCPs and proton carrier molecules provides a new class of ion conductive solid materials.

### Highly selective gas adsorption



We have developed a porous material, decorated with a highly reactive 'species' of molecules that can be activated remotely using a technique called photoactivation. Since porous materials have large surface areas for a given volume, they can be used for gas storage, and for the acceleration of chemical reactions. The ability to turn these molecular species 'on' or 'off' increases their utility. The novel porous material is also unique for its high degree of reactivity, which traditionally has been difficult to achieve while maintaining material stability.

# Separation

### Multifunctional PCPs

PCPs with individual functions such as storage, separation, exchange and catalysis can be developed for use on an industrial scale, where, for example, billions of single crystals used for each individual function are produced at the factory. On the other hand, there are many other potential applications of PCPs in the nanometer-micrometer range, especially in biological systems, where the target environments are biological cells with sizes around 1–2  $\mu\text{m}$ , and in electronics, where the devices should be fixed on substrates with ordered structures at nanometer scale. For the application of PCPs in the nanometer-micrometer regime, the hybridization of each function into a single particle is essential, creating so-called 'single particle devices', which can harmonize with their targeted environments.

# Hybridization

