

Creation of Novel Ionic Conductors with Metal-Organic Frameworks

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Abstract:

Recently, metal–organic frameworks (MOFs) have been emerged as novel class of designable solid-state materials for gas storage, catalysis, magnetism, and electrical conduction.¹ They have both high regularity and high synthetic variety due to their hybrid character of organic and inorganic compounds. In the field of proton conductors, the potentially designable MOFs have started to be investigated as a new candidate for novel proton conductors. So far, the MOFs having the guests as hydrous and anhydrous conducting media (e.g. water, imidazole) have been reported as novel proton conductors.² Designable porous framework can contribute to rational arrangements of acidic species and conducting media, such as water molecules, for proton conduction. Additionally, guest-accessible pores may give an opportunity to control proton conductivity by guest molecules.

I have focused on creating novel ionic conducting materials by using MOFs. I have designed and synthesized a novel MOF, $(\text{NH}_4)(\text{adp})[\text{Zn}_2(\text{ox})_3]\cdot 3\text{H}_2\text{O}$ (adp = adipic acid; ox = oxalate) (Fig. 1.), that includes dissociative protons and water molecules in interlayer space.^{2a} Two-dimensional hydrogen bonding networks among ammonium ions, adp molecules, and water molecules are formed in the pores. This MOF shows very high proton conductivity of $0.8 \times 10^{-2} \text{ S cm}^{-1}$ at ambient temperature. This was the first example of MOF exhibiting superprotonic conductivity. From the result of X-ray crystallography, mechanism of proton conduction is assumed to be Grottuss mechanism,³ because the guests are arranged closely. From quasi-elastic neutron scattering (QENS) measurements, it is clear that there exist the rotational motions of protons inside the MOF.

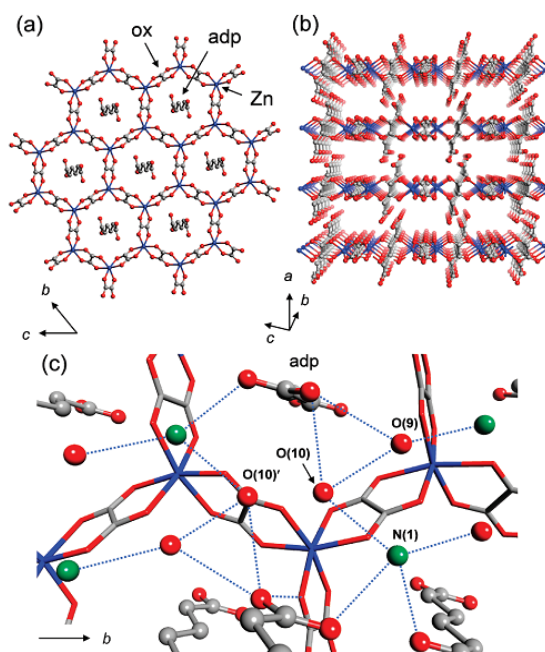


Fig. 1. Crystal structure of $(\text{NH}_4)_2(\text{adp})[\text{Zn}_2(\text{ox})_3]\cdot 3\text{H}_2\text{O}$ ^{2a}

Reference:

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