Layered Coordination Polymer with Remarkable Proton Conductivity

Ricardo F. Mendes,[1] Paula Barbosa,[2] Eddy M. Domingues,[2] Patrícia Silva,[1] Filipe Figueiredo,[2] Filipe A. Almeida Paz[1]

1 – Department of Chemistry, CICECO – University of Aveiro
2 – Department of Materials & Ceramic Engineering, CICECO – University of Aveiro

As energy consumption and demand increases new alternative energy technologies are required. In recent years, new materials with improved proton conduction have been investigated for the incorporation into Fuel Cells. The structural and chemical nature of Metal-Organic Frameworks (MOFs) and Coordination Polymers (CPs) are expected to boost their proton conductivity, ultimately supported by the ability to tailor pores or channels with specific conductive species such as water or ions. To this end, we investigated the effect of a whole structural modification of a CP on its proton conductivity. $[Gd(H_4nmp)(H_2O)_2]Cl{\cdot}2H_2O$, a charged layered material counter-balanced by chloride anions, suffers a structural transformation at high humidity and temperatures into $[Gd_2(H_3nmp)_2]{\cdot}xH_2O$ (**2**) (x = 1 to 4) (see Fig. 1). This modification is accompanied by the exchange of chloride ions with water leading to a significant increase in conductivity, from 1.23 x 10^{-5} $S{\cdot}cm^{-1}$ to 0.51 $S{\cdot}cm^{-1}$, being to date one of the highest values ever reported for proton conducting CPs. While this conductivity is only observed after the structural transformation, this constitutes a remarkable "proof of concept" to explore in the future other types of transformation to further improve the conductivity of these hybrid materials.

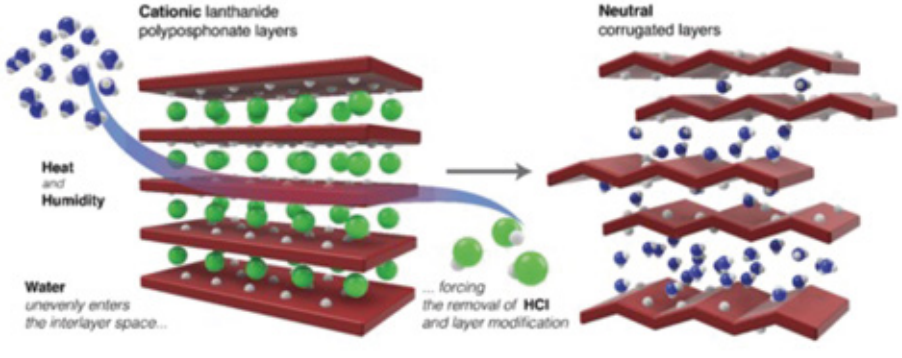

FIGURE 1
Schematic representation of the structural transformation of $[Gd(H_4nmp)(H_2O)_2]Cl{\cdot}2H_2O$ (*left*) into $[Gd_2(H_3nmp)_2]{\cdot}xH_2O$ (*right*) (x = <1 to 4) at high temperatures and humidity. The figure emphasizes the exchange of the Cl^- anion (released as hydrochloric acid) with water molecules.

Reference
Enhanced Proton Conductivity in Layered Coordination Polymers
Ricardo F. Mendes, Paula Barbosa, Eddy M. Domingues, Patrícia Silva, Filipe Figueiredo, Filipe A. Almeida Paz
Chemical Sciences, 2020, Volume 11, Pages 6305-6311
http://dx.doi.org/10.1039/D0SC01762K