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research highlights

FUEL CELLS

Making membranes

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Proton exchange membrane fuel cells (PEMFCs) typically rely on Nafion — a sulfonated-polymer — as the membrane to transport protons between the electrodes, but cheaper alternatives are sought. Covalent organic frameworks (COFs), which are made up from molecular building blocks to form porous, crystalline materials, are potential substitutes due to their tunable properties, facile functionalization, low density and high chemical and thermal stability. However, processing and integrating COFs onto substrates has remained challenging. Now, Pilar Ocón, Félix Zamora and colleagues across Spain demonstrate synthesis of an imine-based COF that, under the right conditions, can be processed for integration as the membrane in a PEMFC.

The researchers synthesise the COF by direct reaction of 1,3,5-tris(4-aminophenyl)benzene (TAPB) and 1,3,5-benzenetricarbaldehyde (BTCA). The COF that forms can incorporate guest molecules such as acetic acid into its cavities, yielding a highly hydrophilic material with a proton conductivity of 5.25×10^{-4} S cm^{-1} at 313 K and 100% relative humidity. The proton conductivity can be enhanced by post-synthetic modification with LiCl to rival the best-performing COFs. For the unmodified COF, by using the appropriate amount of acetic acid and applying pressure, the researchers are able to process it into a flexible film that retains structural order and properties, allowing the material to be integrated into a full-cell device with peak power density of 12.95 mW cm^{-2}. Whilst the performance of Nafion-based PEMFCs is superior, the demonstrated processability of COFs and their inherent design flexibility suggest they could be viable options in the future.

James Gallagher