# DESIGN, DEVELOPMENT, AND ASSESSMENT OF $OH^-$CONDUCTING MOFs

**Qingqing Shao[1], Truls Norby[1] and Petra Ágota Szilágyi[1]**

**[1]Department of Chemistry, Faculty of Mathematics and Natural Sciences, University of Oslo, Oslo, Norway**

*Corresponding author's e-mail address: p.a.szilagyi@kjemi.uio.no*

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## ABSTRACT

There is a global consensus on the necessity for transitioning from fossil fuels to renewable energy sources due to climate change, biodiversity loss, and energy-carrier price fluctuations. While renewable sources are abundant, their intermittency poses challenges for universal adoption, requiring efficient energy-storage solutions. Hydrogen, known for its high energy density and versatility, holds promise for energy conversion and storage. Currently hydrogen is oxidised to water in Proton-Exchange Membrane Fuel Cells (PEM-FC) while electricity is generated, but the Alkaline Anion Exchange Membrane (AAEM) technology, based on $OH^-$ transport, offers advantages over PEM technology by using more affordable electrocatalysts, thereby reducing reliance on scarce noble metals, and lowering costs. To commercialize AAEM technology, advancements in membrane stability, ion conductivity, and scalable production are crucial. Metal-organic frameworks (MOFs) show potential for enhancing AAEM-FCs due to their porous structures and adaptable ion-conduction pathways.[1] However, challenges such as chemical stability under operational conditions must be addressed to improve their performance and applicability in hydrogen energy projects.

This study focuses on the development of robust, intrinsically conductive MOFs for AAEM technology. In particular, MTBT (M=Co/Zn; TBT=dehydrated 4,4'-thiobisbenzenethiol), a highly stable and alkali-resistant MOF. [2] MTBT exhibits an octahedral single-crystal morphology and maintains thermal stability up to 250 °C. We demonstrated its hydrophilicity and electric insulation, in addition it withstands exposure to concentrated alkaline solutions (20M KOH and NaOH) for >5 days without structural degradation. Analyses including subtle shifts in XRD peak positions, and using FTIR and SEM EDX techniques reveal effective penetration of $OH^-$ ions through the MOFs' pores. These findings collectively indicate its potential for high ionic conductivity, making it suitable for AAEM applications. Recent electrochemical tests on pristine CoTBT at 30 °C and 80% RH reveal a significant conductivity of $\sigma$=1.08x$10^{-3}$ S/m, susbtantally exceeding the typical ionic conductivity of empty MOFs, which typically around $10^{-11}$ S/m. Future steps include conductivity testing at 100% RH and exploring ion-conductivity mechanisms to enhance MOF performance through additional treatments. However, accurately discerning the contribution of $OH^-$ ions to $\sigma$ remains a challenge and thus must be part of future investigations in this project.

References

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