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OPTIMIZATION OF BIMETALLIC MOF-MODIFIED MEMBRANES FOR BALANCED LITHIUM SELECTIVITY AND PERMEABILITY

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Introduction. Lithium is a vital resource in the development of energy storage technologies, and membrane-based extraction is emerging as a promising alternative to traditional lithium extraction methods [1].

Body part of the report summary. This study is focused on the development and evaluation of polymer membranes modified with bimetallic metal-organic framework (MOF). Membrane modifications after three to ten MOF growth cycles were synthesised and compared [2, 3]. The aim was to analyse the impact of MOF content, metal composition, and precursor solution on lithium selectivity and permeability of the polymer substrate. The membranes were characterized by SEM, XRD, and FTIR, and their ion-transport performance was assessed through electrochemical tests.

Characterization analyses confirmed the proper formation and growth of MOF onto the membrane surface. FTIR showed the typical bands of the ligand and metal centers, confirming the formation of the expected MOF onto the substrate. SEM images revealed a progressive increase in surface coverage as the number of cycles increased, whereas EDX mapping confirmed the presence and homogeneous distribution of Zn and Co, with proportions consistent with the ones from precursor solutions. XRD diffractograms showed that the peaks observed in the modified membranes matched those of pure MOFs, therefore indicating the formation of expected crystalline phases.

The results showed that both lithium selectivity and permeability strongly depend on the type of precursor solution used, the Zn:Co ratio, and the number of modification cycles. Membranes with the ratio Zn:Co = 1:2 after 6–7 modification cycles exhibited the most balanced parameters of lithium selectivity and permeability. These results indicate that it is not possible to maximise both properties independently; instead, an intermediate modification provides an optimal balance between the ion separation factor and the ion permeation flux.

Conclusions. Overall, this study demonstrates that optimization of the type of precursor solution, the metal ratio, and the number of growth cycles is essential to maximise the performance of bimetallic MOF-based membranes, thus highlighting the existence of an optimal regime for the most efficient lithium extraction.

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References:

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