Nickel and Cobalt Separation by Metal-organic Frameworks (MOFs) Mixed Matrix Membranes

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Abstract:

The demand for energy storage is exponential due to population growth and the critical rush to lower global CO2 emissions. The most commonly used lithium ion batteries (LIBs), which are central to addressing these demands, feature cathodes comprised of Li(Ni,Mn,Co)O2 mixed metal oxides. Over the next decade, the demand for critical battery minerals Nickel (Ni) and Cobalt (Co) are set to outstrip the supply, which is diminishing as the most accessible mineral deposits are exhausted or are associated with geo-political strife. These minerals are often co-located, meaning that many assets become stranded due to the cost of purification being prohibitive. Furthermore, the recycling of lithium-ion batteries harbours the same technical challenge - to simply, sustainably and efficiently separate Ni from Co. This project aims to address this timely challenge by developing separation membranes that can deliver Cobalt and Nickel without the need for major input of energy or harsh chemicals.

Membrane-based technology can offer a good alternative to solvent extraction due to low energy requirement, low cost, high efficiency, easy maintenance and operation. Among a wide variety of synthetic membrane technologies, MOFs based mixed-matrix membrane is of interest because of the abundant functional groups provided by both MOFs and polymers as well as the robustness and simplicity provided by polymer matrix.

Selective separation of Ni and Co is challenging because their adjacent position in the periodic table makes them have similar physical and chemical behaviour. Inspired by nature Ni carrier – histidine, histidine-based MOF have been prepared and chitosan polymer have been selected to provide selective membrane for Ni and Co separation.

Keywords: Nickel, Cobalt, separation, mixed-matrix membrane, Metal-organic frameworks

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