

ENHANCING LITHIUM-ION-BATTERY PERFORMANCE: METAL-ORGANIC-FRAMEWORKS INTEGRATED SEPARATORS TO IMPROVE THE CYCLE LIFE

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Lithium-Ion Batteries (LIBs) are the most widely used energy storage systems in modern technology, from portable electronics to electric vehicles [1]. Despite their advantages, LIBs face challenges such as capacity loss, safety concerns, and gas evolution during operation, which can degrade battery performance and longevity [2]. The growing demand for efficient and sustainable batteries has led to extensive research to improve battery components, especially separators and electrode materials. One major issue in LIBs is the formation of gases like CO₂, H₂, and O₂ due to electrolyte decomposition and instability of Ni-rich cathodes at high states of charge [3]. These gases can lead to volume expansion, electrode degradation, and safety risks. Metal-organic frameworks (MOFs) have emerged as promising materials to mitigate these challenges due to their highly porous structure and excellent gas adsorption capabilities [4]. By incorporating MOFs into battery separators, the produced gases can be captured, thereby improving cycle life and stability. This work focuses on the development of several MOF-integrated separators to enhance LIB performance. MOFs, particularly zirconium-based MOFs (Zr-MOF-808) and nickel-based MOFs (Ni-MOF-74), have been synthesized using a scalable solvothermal method and characterized using XRD, SEM, and EDX techniques. Afterwards, these MOFs have been incorporated into polyvinylidene fluoride-co-hexafluoropropylene (PVDF-HFP) thin film solid polymer separators (Figure 1a), glass fiber and Celgard 3501 separators to enhance electrolyte uptake, ion transport, and enable gas absorption. To investigate the electrochemical performance, half-cell Li-ion batteries have been fabricated and tested using commercial Lithium Nickel Manganese Cobalt Oxide (LiNi_{0.6}Mn_{0.2}Co_{0.2}O₂, NMC₆₂₂) as cathode, Li-anode, 1 M LiPF₆ in EC/DMC (50/50) (v/v) electrolyte and fabricated MOF-integrated separators. The integration of MOFs into separators provides improved electrochemical stability (Figure 1b) by capturing gases generated during operation and thereby increasing the cycle life and efficiency of LIBs. This research, supported by the EU-funded PHOENIX project (grant agreement No. 101103702), represents an important step towards more sustainable and safer lithium-ion batteries for future applications.

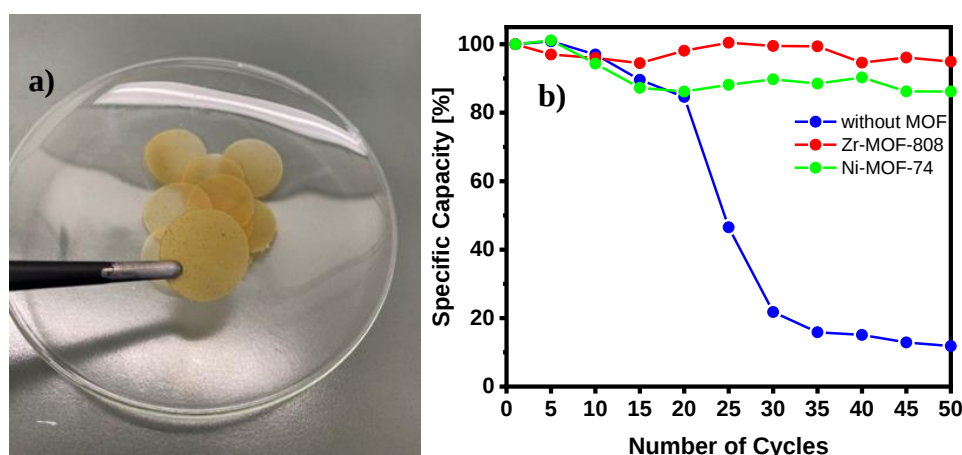


Figure 1 (a) Ni-MOF-74 integrated PVDF-HFP solid polymer separator and (b) long cycle testing of LIBs with and without MOF-integrated PVDF-HFP solid polymer-separators.

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