

Understanding CO₂ Electrosorption on Conductive Metal-Organic-Frameworks

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The escalating demand for affordable carbon dioxide capture solutions is becoming increasingly urgent. To cap the global temperature rise at 1.5 °C within the next century, substantial advancements in CO₂ mitigation are imperative. Current capture methods, such as amine scrubbing, face significant challenges, including high energy requirements for regeneration, high operational expenses, and durability issues.

An emerging and energy-efficient alternative to traditional methods involves electrochemically driven carbon dioxide capture.¹ For instance, redox-active quinone molecules possess the capability to adsorb CO₂ through electrochemical reduction and can subsequently release it during oxidation.^{2,3} Despite notable progress in quinone chemistry for electrochemical CO₂ capture, integrating these molecules into practical carbon capture devices remains a persistent challenge.⁴

In this work, we introduce a new candidate for direct electrosorbent of CO₂ - a conductive metal-organic framework (MOF). This MOF is characterized by its open metal sites and ultramicroporosity. The feasibility of the material to adsorb/desorb CO₂ through an electrochemically driven process has been demonstrated using cyclic voltammetry. Notably, in the specific applied potential window, desorption of CO₂ occurred without the reduction of carbon dioxide. CO₂ electrosorption was investigated in various aqueous electrolytes, with sodium perchlorate being the optimal choice for material evaluation. One of the primary advancements of utilizing MOFs for CO₂ electrosorption on MOFs is the possibility of operating under mild conditions — ambient pressure, temperature, and neutral pH. This study opens new avenues for designing and discovering improved materials for electrochemical CO₂ capture.

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References

- 1 M. Ozkan, A. Shiner, N. Kongi, T. A. Hatton, S. Oldham and E. Sanders, *Chem*, 2024, **10**, 3–6.
- 2 H. Seo and T. A. Hatton, *Nat. Commun.*, 2023, **14**, 313.
- 3 S. Voskian and T. A. Hatton, *Energy Environ. Sci.*, 2019, **12**, 3530–3547.
- 4 F. Simeon, M. C. Stern, K. M. Diederichsen, Y. Liu, H. J. Herzog and T. A. Hatton, *J. Phys. Chem. C*, 2022, **126**, 1389–1399.