Self-standing Macroscopic Objects Based on Functionalized Covalent Organic Frameworks for Ion Transport

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Covalent Organic Frameworks (COFs) are crystalline porous organic polymers known for their high surface area, chemical stability, and tunable morphology. These properties make COFs promising candidates for diverse applications, including gas storage, filtration, catalysis, and energy storage. However, their usage is often limited by traditional synthesis methods, which predominantly yield insoluble powders.[1]
To overcome this limitation in processability, we explored new synthetic strategies to fabricate macroscopic COF objects. Electrospinning in particular has proven to be a versatile technique to produce fibrous 2D and 3D COF architectures. In this approach, thermoplastic polymers are processed from a solution into fibrous templates, which serve as scaffolds. COFs can replicate these fibers in the next step and form flexible, macroscopic objects.[1-3]
In the context of energy applications, functionalities such as sulfonic acid groups play an important role in providing a high proton and lithium-ion conductivity. These functionalities can be incorporated either by a *de novo* synthesis or by post-synthetic modifications techniques. We are working with sulfonation in the gas-phase, which provides the functionalization of COFs across a wide range of aromatic building blocks.
By utilizing electrospinning and post-synthetic modifications, we present promising ways to develop COF-based materials for fuel cells and lithium-ion batteries.

Keywords: Covalent organic frameworks (COFs), electrospinning, energy storage

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References

[1] Ding, C.; Breunig, M; Timm, J.; Marschall, R.; Senker, J.; Agarwal, S. Flexible, Mechanically Stable, Porous Self-Standing Microfiber Network Membranes of Covalent Organic Frameworks: Preparation Method and Characterization. *Adv. Funct. Mater.* **2021**, 31, 2106507.
[2] Ding, C.; Du, Y; Agarwal, S. Open-Cell Robust COF-Nanowire Network Sponges as Sustainable Adsorbent and Filter. *Adv. Funct. Mater*. **2024**, 34, 2309938.
[3] Ding, C.; Du, Y; Fischer, T; Senker, J.; Agarwal, S. *Angew. Chem. Int. Ed.* **2025**, e202502513.