

Covalent organic framework for energy applications

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Covalent organic frameworks are an emerging class of porous crystalline organic materials that can be designed and synthesized from the bottom up. Despite progress made in synthesizing COFs of diverse topologies, the synthesis methods are often tedious and unscalable, hampering practical applications. By considering the relationship between layer packing arrangement and the ability to restrict intramolecular rotation, we demonstrate a scalable, robust method of producing highly crystalline acylhydrazone two-dimensional (2D) COFs with diversified structures (six examples) under open and stirred conditions, with growth typically completed in only 30 min [1]. Our strategy involves selecting molecular building blocks that have bond dipole moments with spatial orientations that favor antiparallel stacking and whose structure allows the restriction of intramolecular bond rotation (RIR) via intra- and interlayer hydrogen bonding. We found that antiparallel stacking encourages interlayer hydrogen bonding interactions that lead to dual emission in photoluminescence, a phenomenon that can be exploited for tuning white light emission from COF for the first time [2]. At the same time, the presence of well-ordered one-dimensional (1D) channels and stability against phase transition in covalent organic frameworks (COFs) render them potential candidates for low-temperature SEs. Using hydrazine COF as a solid state electrolyte in lithium ion battery, we achieved an ion conductivity of 10^{-5} S cm^{-1} at -40 °C with a Li^+ transference number of 0.92. Using 1,4-benzoquinone as the cathode, a lithium battery using hydrazine COF as a SE runs for 500 cycles at a steady current density of 500 mA g^{-1} at 20 °C [3]. Finally, we consider the question of how to render 2D COF, which is actually quasi-2D, truly 2D. Our strategy involves the integration of mechanically interlocked molecular architectures (MIMAs) into quasi-2D COF. Depending on the number of layers of COF that can be interlocked per molecular complex, this affords a strategy to partition the interlayer space into pseudo-unit cells [4], from which we can exfoliate high yield monolayer or bilayer COF.

References

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Figures

