

Today, most of our energy still comes from burning fossil fuels, but this contributes to global warming and climate change. To protect our planet, we need to shift toward renewable options such as solar, thermal, and hydropower. However, green energy sources can be unpredictable (think of cloudy days with very little wind) therefore we need better ways to store the extra electricity they generate when conditions are ideal. Currently, the most common batteries are lithium-ion batteries (LIBs). Despite their high energy density (they store a lot of energy), they have drawbacks - they can't deliver power as quickly as we sometimes need, they use flammable liquid electrolytes, and lithium itself is becoming harder and more expensive to obtain. Because of these limitations, researchers are looking for alternatives. One promising option is a type of device called a zinc-ion hybrid supercapacitor. Zinc is cheaper and more abundant than lithium, and it is safer and kinder to the environment. Moreover, zinc-based hybrid supercapacitors are especially attractive due to zinc's favourable electrochemical properties including better chemical stability, high theoretical capacity (823 mAh/g) and low redox potential (-0.76 V vs. standard hydrogen electrode). If we can build a device around zinc that combines high energy storage with fast charging, we could have a powerful, safe, and affordable way to store renewable electricity. To create better zinc-ion devices, scientists are experimenting with new materials called covalent organic frameworks (COFs) - a two-dimensional scaffold made from organic (carbon-based) building blocks. Because these scaffolds are highly ordered and full of small pores, they can pack in a lot of active sites where chemical reactions happen. In theory, COFs could hold lots of zinc ions and let them move in and out quickly - exactly what we need for fast, high-capacity energy storage. In practice, though, COFs sometimes grow in uneven, unpredictable shapes (and dimensions). This irregular growth can reduce the total surface area and block some of those tiny pores, making the material less effective at holding and releasing charge. To solve this problem, we propose a "template" strategy. During the COF's creation, we will add a temporary mould - like a microscopic balloon or bead - around which the COF material will form. Once the COF is built, the template will be removed, leaving a uniform, hollow structure full of open channels. By carefully choosing which organic building blocks (monomers) to use - ones that contain electrochemically active groups such as carbonyls, hydroxyls, or nitrogen and sulfur atoms - and selecting the right template material (e.g., tiny spheres of polystyrene or zinc oxide), we will generate COFs with a much larger surface area and more consistent pore structure. This "templating" approach will help to ensure that every part of the COF is active and accessible.