Covalent Organic Frameworks and Reticular Nano-Synthesis

Prof. Dr. Rahul Banerjee

Department of Chemical Sciences, Indian Institute of Science Education and Research (IISER) Kolkata, Mohanpur Campus, Mohanpur 741 252
E-mail: r.banerjee@iiserkol.ac.in

Covalent Organic Frameworks (COFs) represent a new class of highly porous, crystalline polymers with uniformly arranged ordered pore channels. Even though COFs have been used for the storage of a wide variety of molecular species like gases, nanoparticles, enzymes, and drugs, the benefits of their ordered pore channels for molecular separation are hardly extracted. The key issue behind this problem is fabricating COF particles into a self-standing, stable membrane form. Apart from the processability, the other formidable obstacle preventing the utilization of COFs in real-life applications is i) chemical stability, ii) complicated synthetic procedures and iii) scalability. In this context, we have successfully overcome the chemical stability problem of COFs, by synthesizing *β-ketoenamine* based frameworks. Irreversible enol to keto tautomerism resulted in exceptional stability within the frameworks. While processability, synthetic hurdles, and scalability of COFs still remain unexplored. To address these critical issues, we have developed a straightforward, scalable, and novel methodology by which COFs can be synthesized by simple mixing and heating of the reactants. Using this method, COF can be processed into self-standing covalent organic framework membranes (COMs). The resultant COMs display higher porosity and crystallinity over their reported powder form. These self-standing COMs are flexible, continuous, devoid of any internal defects or cracks, show long-term durability. It retains structural integrity in the water, organic solvents, and mineral acid (3 N HCl). We have utilized these COMs for separation applications such as wastewater treatment and recovery of valuable active pharmaceutical ingredients [APIs] from organic solvents. Our result highlights that COMs could satisfactorily address the world's most challenging separation problems, including wastewater treatment and drug recovery from organic solvents in pharma industries.