Metal-Organic Frameworks as multifunctional materials

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The main objective of the Advanced Porous Materials Unit at IMDEA Energy Institute is to develop innovative multifunctional materials, with a full understanding of their structural features for improving the materials properties targeting specific relevant applications (i.e. energy, environment and health), and including the scale-up and fabrication of adapted devices. In this context, a selection of some significant and recent results will be shown. For instance, some examples in the field of energy include the synthesis of new metal organic frameworks (MOFs) and their composites based on phosphonate ligands and different cations, exhibiting porous and robust structures with excellent proton conductivity (10-2-10-1 S/cm) and being promising materials as efficient proton exchange membrane in fuel cells [1]. Also, several novel MOF structures have been prepared and fully characterized using electro/photoactive ligands and cations (e.g. Ti, Zr, Hf) with outstanding stability and optical properties. Without further modification and in absence of any co-catalyst or sacrificial agent, they are able to produce H2 and O2 from water at rates among the highest ever reported under visible light [2].

Concerning environmental applications, novel adsorbent and/or (photo)catalytically active materials (MOFs, carbons, composites) have been synthesized for both water remediation and fresh water treatment [3]. In particular, a composite based on ultrasmall Ag-clusters (1 nm; 28 Ag atoms) and a photoactive Ti-MOF has demonstrated a great potential for the in-continuous visible light assisted degradation of challenging emerging organic contaminants in tap water (e.g., methylene blue, sulfamethazine) [4]. In a further step, agrochemicals based MOFs have been originally prepared to progressively release a cocktail of biologically active ingredients (e.g. antibiotics, antifungals, pesticides, micronutrients) to crops, improving their efficiency and avoiding toxic side effect [5].

Finally, regarding the health-related applications, innovative formulations based on MOFs and challenging pharmaceutical active ingredients (e.g. drugs, proteins, nucleic acids, cosmetics) have been prepared, proving their safety and efficiency upon their administration by different routes (i.e. intravenous, oral, pulmonary, cutaneous) [6].

References

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