Revolutionizing Energy Storage with Supercapacitors and Metal Organic Frameworks

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Although the great porosity of metal organic frameworks (MOF) has been used to achieve excellent gas adsorptive properties, MOFs still largely remain unexplored for electrochemical energy storage purposes and devices. This project shows that MOFs in their nanocrystalline forms (nMOFs) can be doped with graphene and successfully incorporated into supercapacitors. Twenty-three nMOFs with various organic functionalities, metal ions, pore sizes and shapes, metal oxide backbones, nanocrystal sizes, and general structure types were prepared and examined. Many members of the series yield high capacitance: especially, a zirconium MOF (nMOF-867) gives exceptionally high capacitance. With extraordinary stack and areal capacitance values, approximately six times that of the supercapacitors made from benchmark commercial activated carbon materials, the zirconium MOF retains identical performance over 10,000 charge/discharge cycles. The successful results indicate that nMOF supercapacitors may indeed be the future of electrical energy storage. Replacing the current lithium-ion batteries that fail to provide high power density and chemically degrade over time, the nMOF supercapacitors may offer solution with their environmental friendliness, quick charge/discharge rates, and near infinite lifecycles. Future work will focus on deciphering the specific impacts of various MOF properties on the observed high capacitance of nMOFs.