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MOF-Derived Nanomaterials for Fuel Cell and Battery Applications

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Abbreviations: MOFs: Metal-Organic Frameworks; MDNMs: MOF-Derived Nanomaterials.

Editorial

Since the inception of nanomaterials, sizes below 100 nm, they have been continuously shown to have interesting physical, chemical, electrical, optical and mechanical properties. These nanomaterials possess small size, high surface area, variations in morphologies and active sites making them suitable for catalytic, magnetic, sorbents, energy, biological and environmental applications. They are prepared or synthesized either by physical and / or chemical methods. The usual methods employed in making the nanomaterials include sol-gel / solvothermal / deposition (Electro, physical vapor and chemical vapor) / mechanochemical / ceramic methods, etc. But the formation of nanomaterials after thermal decomposition of Metal-Organic Frameworks (MOFs) is quite interesting, thought-provoking; and is also an economical and environmentally benign approach [1].

Few decades ago, it was thought that these nanomaterials may also be obtained from thermal decomposition of MOFs, named as MOF-Derived nanomaterials (MDNMs). MOFs are a class of porous coordination polymers, possessing 3-dimensional structures, formed through the connection of metal ions or clusters as nodes by the organic bridging linkers. MOFs possess large surface areas, high pore volumes and low densities far surpassing those of the activated carbon and zeolites. Most of the MOFs that were synthesized have been used in various applications (gas storage, separation, catalysis, sorption, Energy and environmental applications, etc.). Among the applications of MOFs, the application in Energy, especially Fuel Cell and battery applications, has been highly motivated by the researchers and several research articles are also published [2]. There is still much scope to carry the research to make the MOFs as membranes in Fuel Cells and electrode materials in batteries. So far, the MOFs were synthesized and characterized for specific applications. Also, the stability of MOFs were tested to find out what kind of phases are obtained after their thermal decomposition or calcination. After that, the decomposed products were disposed of as a waste. If these waste (disposed) products are made into better products such as nanomaterials for desired applications, this will minimize the economy, reduce wastage, environmental issues, etc. This also makes the researchers interesting, motivating and challenging to obtain the MDNMs.

Apart from the inherent properties of MOFs themselves, the thermal decomposition products of MOFs (MOF-Derived nanomaterials i.e. MDNMs) also possess unique features such as high surface areas, pore volumes (sometimes as observed in parent MOFs) and very narrow pore size distributions. The MOF derived nanomaterials (high surface area metal oxides, metal chalcogenides (where chalcogenides = S, Se, Te), etc.) have also been used as electrode materials in electrochemical energy storage and conversion applications i.e. fuel cell and battery applications [3,4].

Though the MDNMs have shown excellent performance so far in fuel cell applications, it is still however required to obtain these thermally decomposed nanomaterials with an excellent performance. The properties of these MDNMs may also be modified/ enhanced and could be combined with other materials to make nanocomposites for other desired and futuristic applications of these materials.

In conclusion, the thermally decomposed MOFs (MDNMs) are a welcome development as they also show interesting physical, chemical, mechanical, biological, electrical properties for their usage in the diversified applications especially Energy and Environmental applications. This can be achieved with continual research by researchers, technologies, industrialists, etc.

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