Green Chemistry Nanomaterials and Catalysis

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EDITORIAL

Solvent-free synthesis of porous nanomaterials

The porous materials are very attractive because of their properties such as high surface area, tenable acidity, ordered micropores, active site access, and stability. For example, SBA-15, MCM-41, zeolites, and metal-organic framework (MOF) structures are highly used in catalytic process because they can be used as support. The synthesis of supported nanoparticles (NPs) allows good dispersion, controls allocation of active sites, and contributes to NP stabilization. The mechanochemical method have emerged as a green method because they allow solvent-free synthesis of the catalyst supported on mesoporous material, especially metal oxide NPs, compared with wet impregnation or coprecipitation. As proof of that, Siberia et al. synthetized Fe_2O_3/SBA15, for which Fe $(NO_3)3H_2O$ and propionic acid were dispersed using a planetary ball mill and then calcined at 30°C for 30 min. The nanomaterial was magnetically separable with a high surface area (SBET = 322 m^2/g). But previously, nonmagnetic FeeSBA-15 modified by sulfonic groups was reported. Moreover, to enhance the catalytic properties, Pineda et al. supported Co_3O_4 on SBA15, achieving a bifunctional nanomaterial with redox and acid sites, with an SBET of 625 m^2/g. Following the same route, Au and Ag were also supported on SBA-15. Similarly, Al species were supported on SBA-15, MCM41, and MOF. The green synthesis route presented les acidity and lower superficial area than the impregnation method.

Green synthesis of two-dimensional materials. The two-dimensional (2D) materials have been continuously revolutionizing the materials science field in the last years. They are formed by a sheet-like structure composed from a single atomic layer to a few numbers of layers, which can be used to tune their physical, chemical, optical, and electronic properties. In addition, they have become essential materials toward the fabrication of a myriad of high-performance devices from ultra-efficient electrocatalysts and flexible/wearable electronics to energy harvesting and sensing technologies owing to their unique physical and chemical properties. Nevertheless, extensive research has not been conducted on the development of sustainable and eco-friendly synthetic approaches to create 2D materials. In this direction, with the aim to obtain highly sustainable 2D nanostructured materials, various research groups have recently delivered significant endeavors. Remarkably, Pei et al. have reported a green, Free-solvent routes for mesoporous nanomaterials. The synthesis was carried out at room temperature following two electrochemical (EC) steps. First, a high potential of 1.6 V for 20 min was applied over commercial flexible graphite samples immersed in H_2SO_4 (98%) solutions to trigger an EC intercalation process. Second, the resulting compound was used as the anode in diluted H_2SO_4 (50%) solutions to start an EC reaction at 5 V, at which the oxygen radicals of the anodic electrocatalytic oxygen evolution reaction play a key role in the formation of GO layers with low oxidation degree. Another attractive strategy to synthesize low-dimensional nanomaterials using environmentally friendly process is based on the sonication of Ni_2þ and Fe_2þ in the presence of MoS_2 as 2D templates. Following this methodology, 2D/2D heterostructures composed of NiFe nanosheets onto MoS_2 layers are fabricated taking advantage of the weak van der Waals interactions at the 2D interfaces. In addition, an impressive approach to obtain high yields of 2D MOFs. They established a surfactant-mediated methodology in which the interaction of the surfactant with MOF crystal defects provides a pseudo assembly process to exfoliate the 3D MOFs and in turn produce 2D sheets.

Substantial advances have been also achieved on the green fabrication of MXenes nanosheets, a relatively new promising 2D material. In this direction, Zhang et al. have developed a simple template-free method by liquid rapid freezing in nitrogen, paving the way toward the fabrication of low-cost 3D microporous structured MXenes.

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