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Stabilizing single atoms on 2D zeolites to develop sustainable catalysts

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Single-atom catalysts (SACs) can achieve high catalytic activity and selectivity in hydrogenation reactions due to the large surface area of the single metal atoms. However, these single metal atoms are unstable and often sinter at high temperatures, leading to the catalyst deactivation. While this instability is well-known, selecting an optimal support to stabilize them remains a big problem. Nevertheless, two-dimensional zeolites can serve as a support for stabilizing these catalytic species. These zeolites are synthesized in a layered two-dimensional form with limited growth in one direction. These layers can be further swelled to obtain a more disordered structure. The resulting disordered structure effectively stabilizes individual atoms, preventing their aggregation and thus creating a reusable catalyst.

We used several advanced electron microscopy techniques, including SEM, STEM, STEM-EDS and CPEM, to comprehensively characterize the prepared materials. These techniques were crucial for verifying the presence of single atoms, distinguishing them from nanoclusters or nanoparticles, and understanding their distribution within the zeolite framework. The development of such stable SACs represents a significant advancement. These catalysts have great potential for use in industrial hydrogenation processes, offering higher catalytic selectivity and improved reusability.