Sustainable synthesis of industrial organic products through catalysis.

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Metal catalysis is at the central core of organic synthesis, and modern chemistry requires minimization of metal losses during reaction. Here, we present two different strategies for that. On one hand, nanostructured solids have been traditionally used in fields somewhat away of organic synthesis, such as petrochemistry and water treatment, since spatial restrictions have been viewed as an unsurmountable issue when dealing with relatively big molecules; however, we will show here that this view can be incorrect, and that zeolites and MOFs (containing or not single metal atoms and clusters) can be used as suitable supports for a variety of complex organic reactions.[1] Indeed, the microporous frameworks act as macroligands for the well-defined ultrasmall metal species, to catalyze relatively complex organic reactions with extremely high turnovers, >1 million in some cases. On the other hand, single metal atoms and clusters are formed, in-situ, in solution, to catalyze industrial reactions with just parts-per-million (ppm) amounts. These catalytic approaches are very convenient for industrial purposes, where the amount of expensive metal catalysts must be minimized and allows easy recovery, reuse and implementation in continuous processes, and relevant examples will be shown, including the Mizoroki–Heck carbon–carbon cross–coupling reaction,[2] the hydrosilylation of alkenes and alkynes,[3] the oxidation of alcohols,[4] the epoxidation and isomerization of alkenes [5,6], the carbene insertion reaction [7], the semi–hydrogenation of acetylene in ethylene streams,[8] and the carbonyl-olefin metathesis reaction.[9] These examples will also include metal–free procedures.

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