Mechanochemical synthesis of metal and metal sulfide nanoparticles and sustainable nanoparticle-based catalysis

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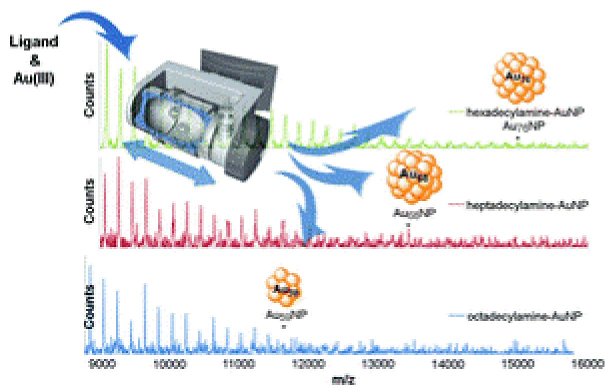
Metal nanoparticles (NPs) are a class of materials intensely researched for their powerful properties applicable in the broad fields of medicine, electronics, optics and catalysis.

Because metal NPs are kinetically stabilized materials, their synthesis often relies on the use of excess solvents, additives and strong reducing agents, which limits their easy scale-up. To address this shortcoming, our research group developed a novel synthetic method for the scalable production of metal and metal sulfide NPs under solvent-free, mechanochemical conditions. The synthesis of Au NPs provided access to gram amounts of monodisperse and ultra-small NPs in the size range of 1–4 nm, without external reducing agents or bulk solvents.[1] We used as a stabilizer long chain amines and observed a dependency of the NP size on the amine carbon-chain length. Using lignin as a biomass-based reducer, we could access other metal NPs, including Ag, Ru, Pd and Re.[2] With Ag, it gave access to antibacterial filters in a simplified fashion.[3]



Beside, we explored the use of cellulose nanocrystals as a non-innocent support to generate metal/cellulose nanohybrids.[4] We showed that, with Pd, we could afford active and enantioselective hydrogenation catalysts,[5,6] while with Ru, extremely active and recyclable catalysts were accessed for the difficult reduction of arenes under mild conditions.[7] These nanocrystals in suspension could allow the direct synthesis of silver nanoparticles without the use of any additional oxidizing or reducing chemical.[8]

At last, recent results on the development of copper-based Huisgens condensation catalysts usable under flow conditions will be presented, as well as early studies on plasmonic hydrogenation nanocatalysts.

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