A novel in-situ synthesis of supported metal nanocatalysts for high-temperature catalysis

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Supported metal nanoparticles hold great promise for many fields, including catalysis and renewable energy. Here we report a novel methodology for the in-situ growth of architecturally tailored, regenerative metal nanocatalysts that is applicable to a wide range of materials. The main idea underlying this strategy is to selectively diffuse catalytically active metals along the grain boundaries of host oxides and then to reduce the diffused metallic species to form nanoclusters. As a case study, we choose ceria and zirconia, the most recognized oxide supports, and spontaneously form various metal particles (Ni, Co, Cu, Au, and Pt) on their surface with controlled size and distribution. Metal atoms move back and forth between the interior (as cations) and the exterior (as clusters) of the host oxide lattice as the reductive and oxidative atmospheres repeat, even at temperatures below 700°C. Furthermore, they exhibit excellent sintering/coking resistance and reactivity toward CO chemical oxidation and H2 electrochemical oxidation, demonstrating potential to be used in various applications.