Geo-inspiration to extend the library of functional inorganic nanoparticles

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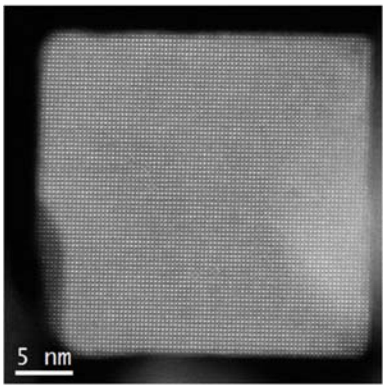
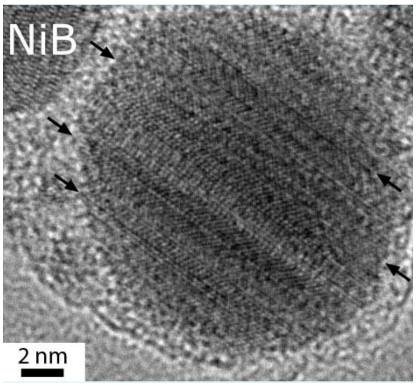
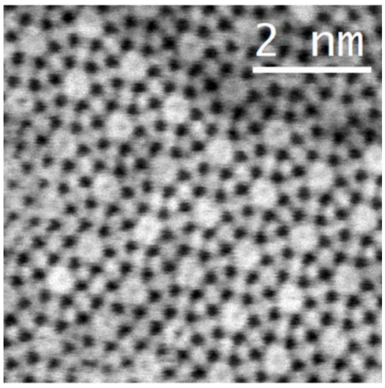
The range of solids reported as nanoparticles is strikingly narrow compared to the library of bulk solids reported from conventional solid-state chemistry[1]. Many of these solids unreported at the nanoscale show properties without equivalent among more common solids studied as nanoparticles, including ultrahardness and (electro)catalysis. Because nanoscaling can deeply modify such properties, efforts to reach still unreported nanoparticles are of high importance. Yet, researchers face a synthetic challenge: how to produce nanoparticles of solids typically obtained by solid-state reactions at high temperature? I will present our recent efforts to reach such challenging nano-objects, by focusing on syntheses inspired from geological processes, namely in water, inorganic molten salts and under very high pressures[1–6]. Aqueous syntheses provide ideal conditions to isolate nanoparticles of new metastable solids, while molten salts are thermally stable, possess large solvating ability, and fasten reactions compared to solid-state reactions, thus leading to original nanostructures under kinetic control, even at high temperatures. On the other side, high pressures provide specific conditions of crystallization. I will discuss cases of nanoparticles showing properties different than those of bulk phases. Perovskite oxide nanocrystals[3] with original spin transport properties will be addressed, then we will move to metal borides[2,5] and oxides[6,7] for electrocatalysis and energy conversion.







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