Nanoparticle Design: from the Solution to the Nanoscaled Reactive Metal-Containing Solid

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ABSTRACT:

Nanochemistry is at the cross-road of solid-state and molecular chemistry. Moreover, nanotechnology relies both on the core and surface properties of metal-containing nanoparticles. There is a need to design and study these objects with both aspects in mind, especially considering the high capability of matter to reorganize at this scale and the dynamics observed both for the inorganic part of the nanoparticles (the core, such as Cu(0),[1] FeP, or Gd_2O_2S[2]) and for their shell of organic ligands (oleates,[3] alkylphosphines,[4] N-heterocyclic carbenes,[5] etc.).

It is with this mindset that I will discuss the recent developments on four families of nanoparticles: metal and alloys,[6] metal carbides (using KC_8 as a carbon source),[7] metal phosphides (using P_4 or a cyclophosphane)[8] and metal oxysulfides. I will propose principles for a rationale design of new synthetic routes, in which the role of all reactants and their stoichiometry is controlled. I will emphasize how surface reactivity (eg. in the context of catalysis and electrocatalysis) influences the overall behavior of the nanoparticles. Finally, I will discuss how to identify adequate descriptors for tentatively anticipating the synthesis outcome and the material properties.

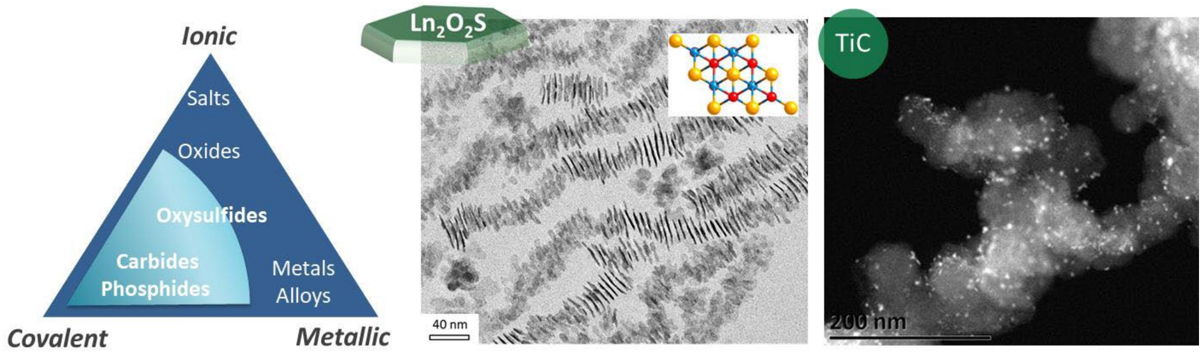

Figure 1: Van Arkel-Ketelaar triangle with the bonding situation of metal phosphides, carbides and oxysulfides. Lanthanide oxysulfide nanoplates and their crystalline structure.[2] Titanium carbide nanoparticles supported on acetylene black, prepared in one step.[7]

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