Energy Materials by Gas Phase Condensation

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Materials for energy conversion and storage need to combine several functionalities, such as light absorption, electronic and ionic transport, mass transport, catalytic efficiency and selectivity. The development of novel synthesis techniques is a key ingredient towards a successful exploitation of new materials with performances beyond the state-of-art.

Gas Phase Condensation (GPC) technique is a bottom-up physical growth method in which nanoparticles (NPs) are formed on the-the-fly by condensation of supersaturated gas vapors in a gas phase atmosphere, either inert pure He or mixed with O_2 or H_2. By tuning evaporation parameters, one can obtain pure metal, alloys, oxides and hydrides NPs as well as nanocomposites. Here we present an overview of the technique and some obtained results.

As an application of GPC, we present Mg-based materials for Hydrogen solid-state storage. MgH_2 is an attractive material because of its high H-storage capacity and low cost. The main drawbacks are the too high stability and slow sorption kinetics.

A new strategy was developed to grow small Mg-Ti-H nanocomposites in which TiH_2 and MgH_2 coexist at the single NP level. The presence of TiH_2 permits the achievement of fast kinetics at temperature previously inaccessible without the addition of Pd as a catalyst. The method developed is compatible with scale-up and opens a new temperature/pressure window for H reversible storage in Mg.