MS.4.P094
MgH_2/TiO_2 nanocomposite for application in solid state hydrogen storage: comparison from powder and pellet.

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The interest in Mg-based hydrides for solid state hydrogen storage is associated to their capability of reversibly absorbing and desorbing large amounts of hydrogen. For this reason, the tailoring of hydrogen sorption kinetics of Mg hydride represents one of the most challenging opportunities for a safe storage and reliable use of hydrogen in on board applications. Furthermore, the low cost, high hydrogen capacity and the light-weight make these materials an interesting perspective for technological application. However, the main limitation is represented by the slow hydrogen sorption kinetic and the high thermodynamic stability, which do not allow an immediate technological use. However, it is known that the nanostructuration of MgH_2-based composite materials obtained by ball milling MgH_2 with different additives such as metals and their oxides [1,2], shows the best results in the direction of practical application due to its action of speeding up the kinetics and lowering both the working pressure and temperature.

Here we report a study of nanostructured composite materials obtained by ball milling MgH_2 with 5wt.% of TiO_2, which focused the attention on the structural and kinetic modifications promoted by long-term H_2 absorption and desorption cycles.
Both the crystalline structures of TiO_2, Rutile and Anatase, were explored on the basis of their different behaviour as additive [3] and in different cycling conditions mainly in term of temperature and H_2 charging and discharging pressure of cycling.

With the view to using this material in tank for hydrogen storage, the ball milled MgH_2/TiO_2 powder was enriched with 5wt.% of Expanded Natural Graphite (ENG) and then compacted in cylindrical pellets. The compaction and the addition of carbon-based additive in fact, increase the volumetric hydrogen storage density and improve the mechanical properties of compacted powders [4,5].
The samples were obtained by cold pressing MgH_2 + 5wt.%TiO_2 + 5wt.%ENG powder in a dye, under different loads and then subjected to repeated hydrogen sorption cycle.
The pellets, compared with the powder, show analogous kinetic performance even if the pressure of compaction revealed to be an important parameter for the efficiency and the mechanical stability of the compacted structure.

Kinetic and thermodynamic tests were performed using a Sievert's type gas reaction controller. Scanning Electron microscopy observations of as-prepared and cycled pellets allowed pointing out the distribution of the catalyst into the MgH_2 matrix and the analysis of the microstructural evolution occurring during and after cycling. The structural characterization before and after cycling was followed by X-ray diffraction.

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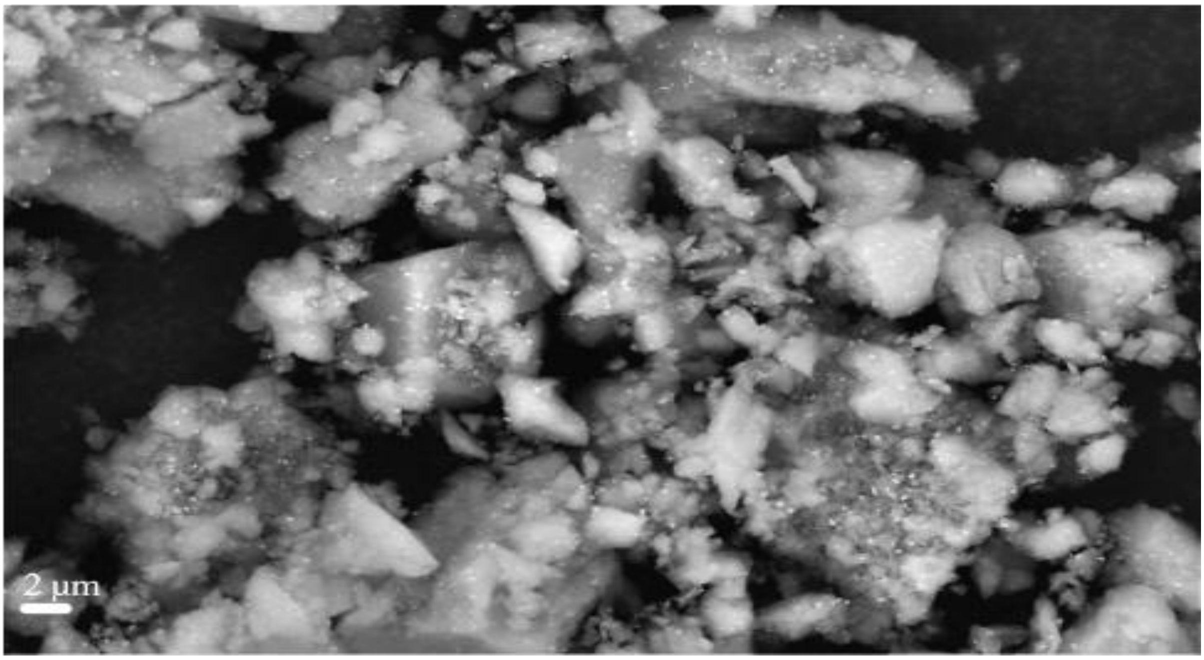

Figure 1. MgH_2 + 5wt.%TiO_2 (Anatase) after ball milling (10h in Ar at 6,0 bar)