Synthesis and cycling of MgH_2-TiH_2 nanomaterials for efficient solid gas hydrogen storage

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Principle & Objective

Hydrogen as an energetic vector has to be stored and transported efficiently, so as to reduce its volume

H_2 has the highest energy per mass of any fuel; but, its low ambient temperature density results in a low energy per unit volume

Metal hydrides focus on improving the volumetric and gravimetric capacities, hydrogen absorption/desorption kinetics, cycle life, and reaction thermodynamics

MgH_2 is an outstanding hydrogen store compound (7.6 wt.% H, 109 g_{H2}/L) but is overly stable for room temperature applications and suffers from sluggish kinetics

Meanwhile TiH_2 as an additive apports faster kinetics and stability during cycling process

This work is targeted on:

Optimization and further understanding of the MgH_2-TiH_2 system

The research is focused on minimizing the titanium amount, while keeping good kinetics and cycle-life.

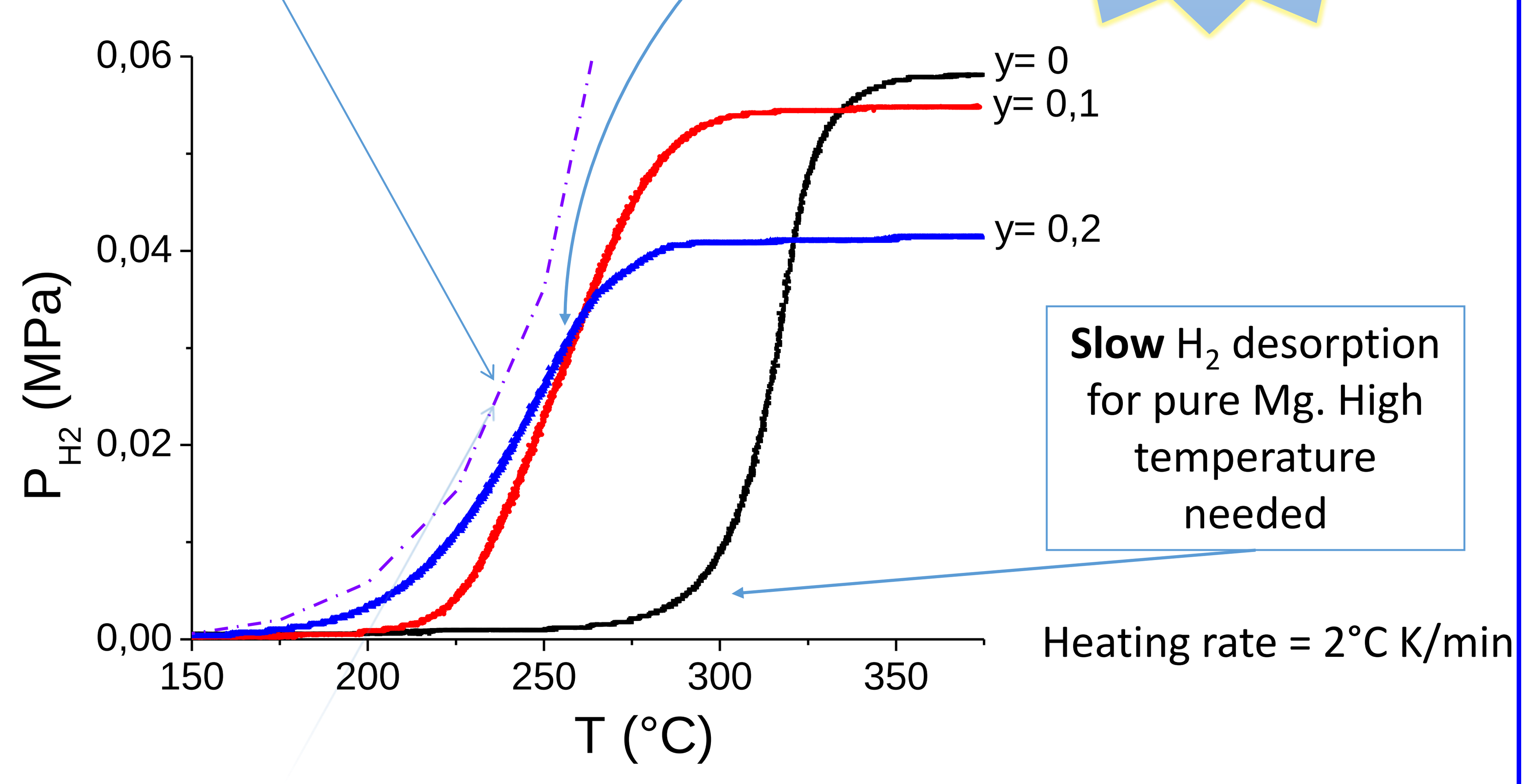
$$(1\text{-}y)MgH_2\text{-}yTiH_2\ (y = 0, 0.05, 0.1, 0.2 \text{ and } 0.3)$$

Composition

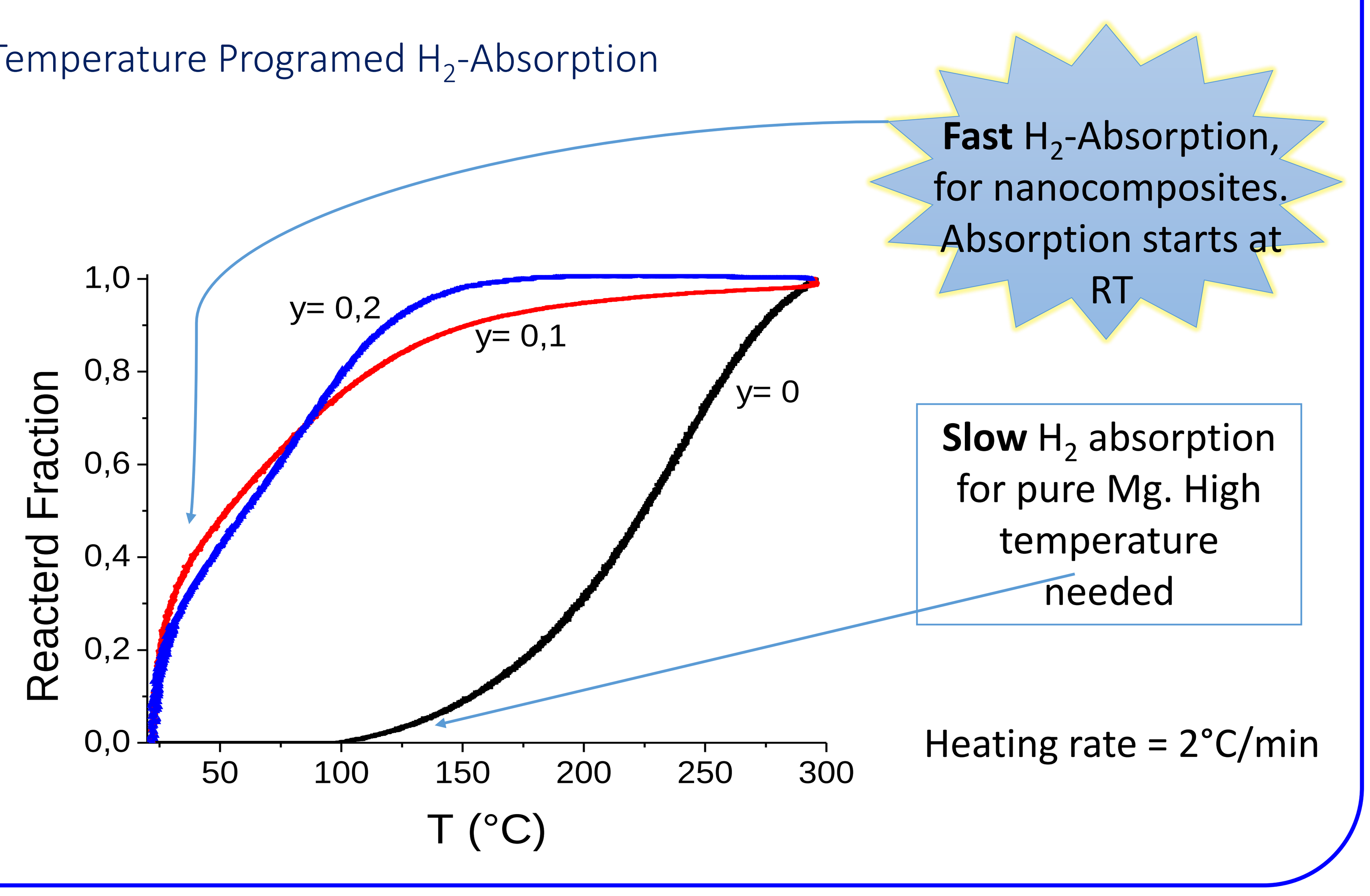
Ti amount

Kinetics:

Temperature Programed H_2-Desorption

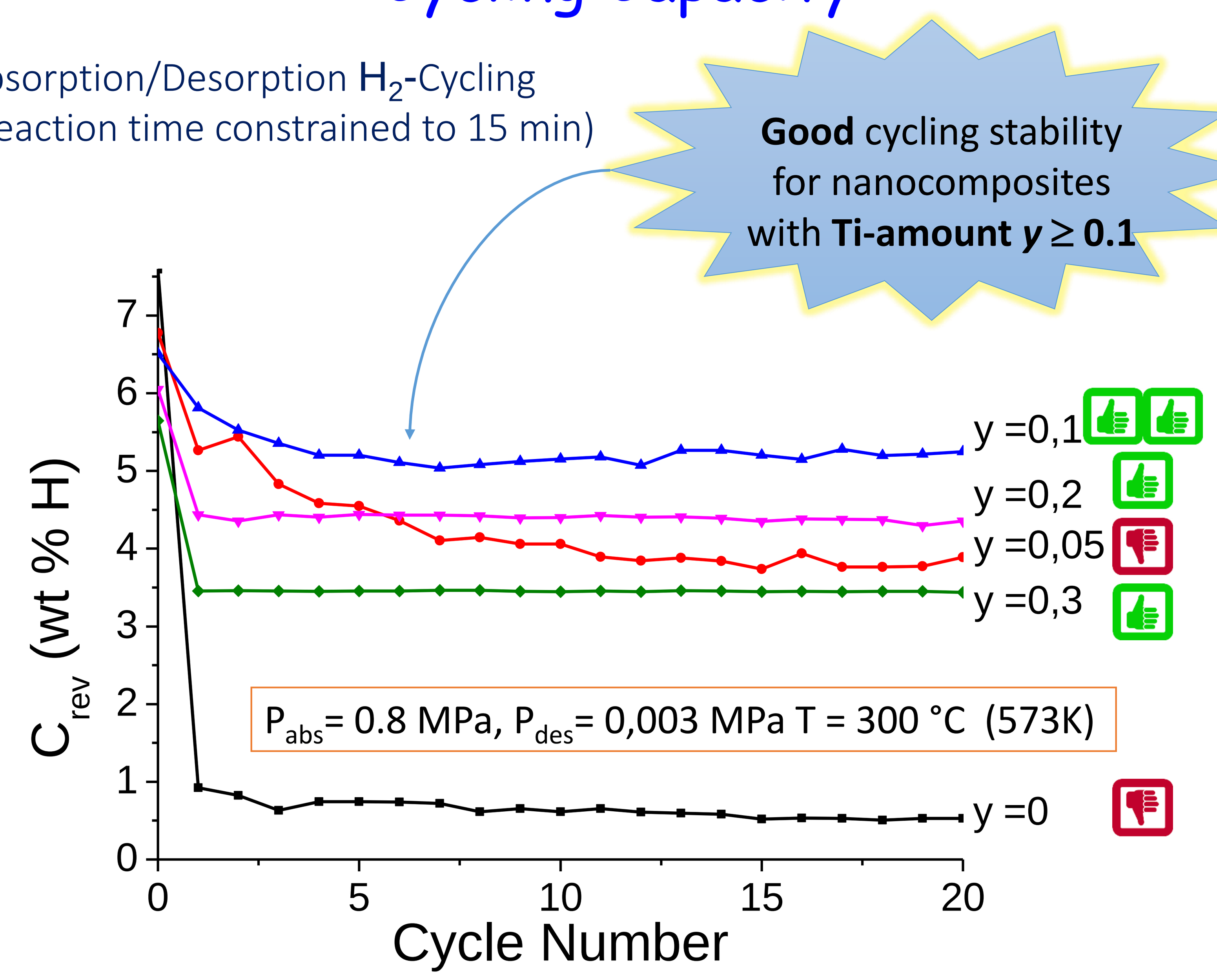


Temperature Programed H_2-Absorption

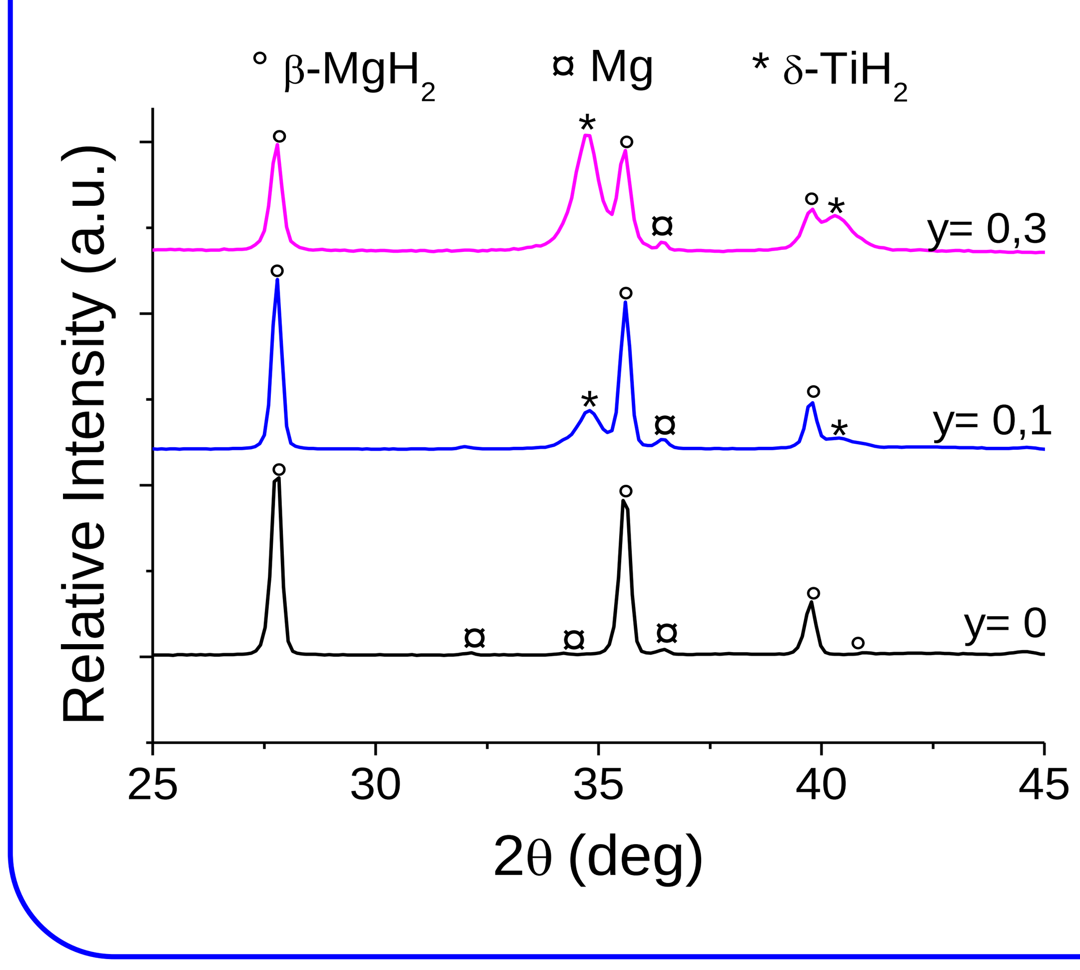


Cycling Capacity:

Absorption/Desorption H_2-Cycling
(Reaction time constrained to 15 min)



XRD after 20 abs/des cycles



As compared to as-prepared composites, diffraction peaks of MgH_2 are narrower after cycling due to crystal growth, whereas those of TiH_2 are unchanged.

Conclusions:

An optimum content of Ti-amount has been found in the MgH_2-TiH_2 system while considering reversible capacity and its retention on cycling:

- The nanocomposite with *y*= 0,1 shows the best long-standing reversible capacity (5.3 wt.% H after 20 sorption cycles)
- This optimum results from the balance between the initial reversible capacity of the composites (H-stored in Mg phase, black dashed line) and the capacity retention upon cycling (red dashed line)
- For low TiH_2 amounts (*y* < 0.1), the capacity retention upon cycling is poor due to the slowing down of sorption kinetics related to severe crystal growth.