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The effect of chromium (III) oxide (Cr_2O_3) nanopowder on the microstructure and cyclic hydrogen storage behavior of magnesium hydride (MgH_2)

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ABSTRACT

High energy ball milling in a Fritsch P6 planetary ball mill was used for the synthesis of the nanocomposite of MgH_2 with 10 wt.% of Cr_2O_3 nanopowder catalyst (particle size <50 nm). After ball milling for 1 h the resulting grain size of β-MgH_2 was equal to ~30 nm. Subsequently, the nanocomposite was subjected to 150 desorption/absorption cycles at 325 °C. A gradual loss of hydrogen storage capacity upon cycling from ~5.2 wt.% after 1 cycle to ~4.6 wt.% after 150 cycles is observed on respective PCT curves obtained at 325 °C after every 25 cycles. The TPD curves temperature maxima are gradually shifted to a higher temperature range with increasing number of cycles which may indicate a lowering of the overall rate of transformation. Thorough microstructural investigations using such techniques as X-ray diffraction (XRD), scanning transmission electron microscopy (STEM) and X-ray photoelectron spectroscopy (XPS) of the samples after 150 cycles of desorption/absorption show profound microstructural changes such as sintering of individual powder particles into agglomerates, increase in grain/crystallite size (>100 nm), segregation of the Cr_2O_3 particles to the interfaces between the sintered Mg particles and some reduction of Cr_2O_3 to Cr and MgO. All these microstructural changes seem to be responsible for the reduction of hydrogen storage capacity upon cycling and lowering the overall rate of transformation.