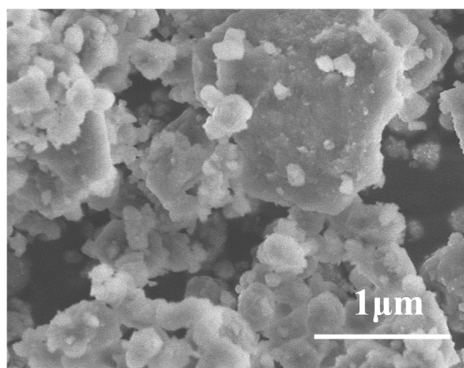
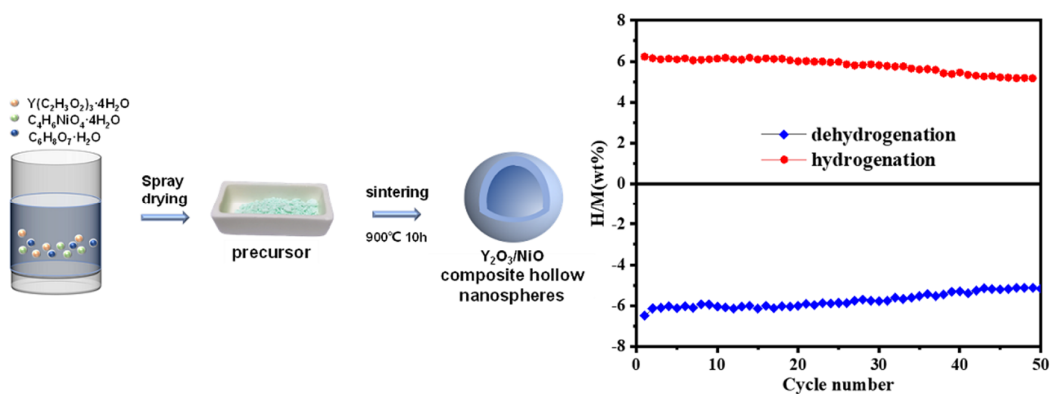
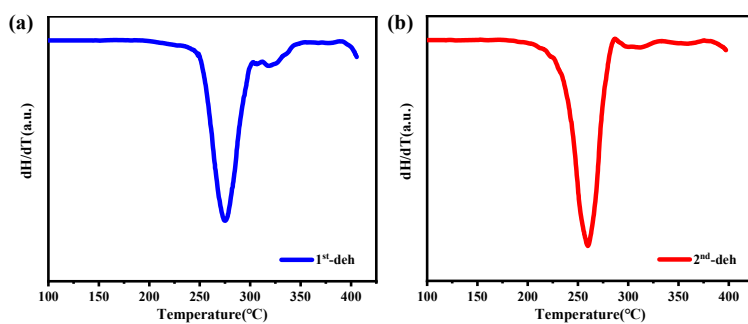


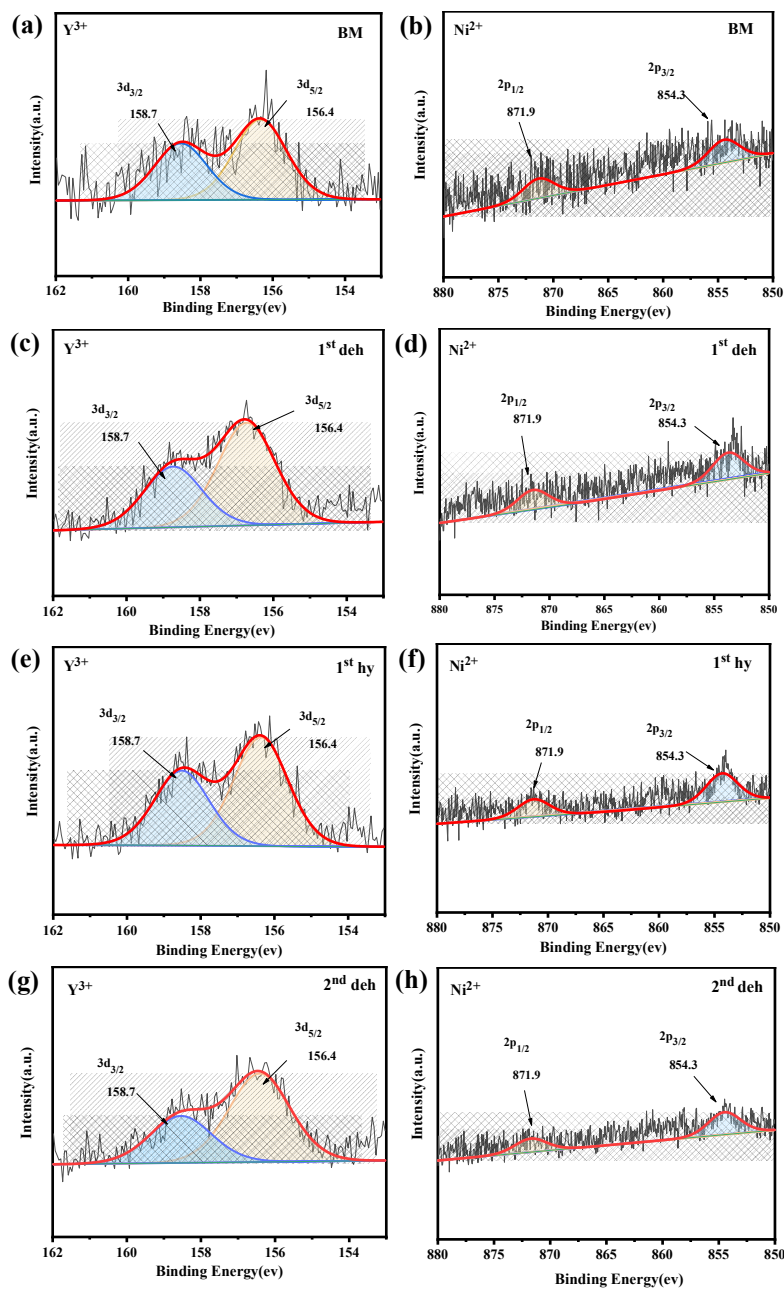
## Abstract picture



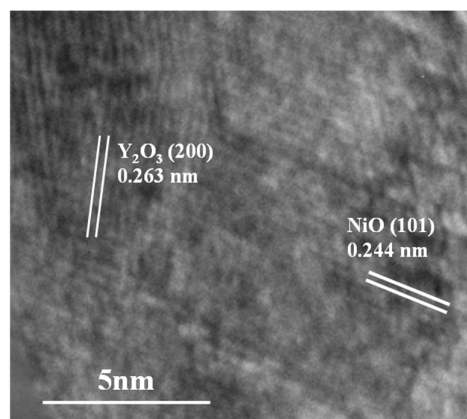
**Figure S1.** SEM image of the as-milled bare  $\text{MgH}_2$ .



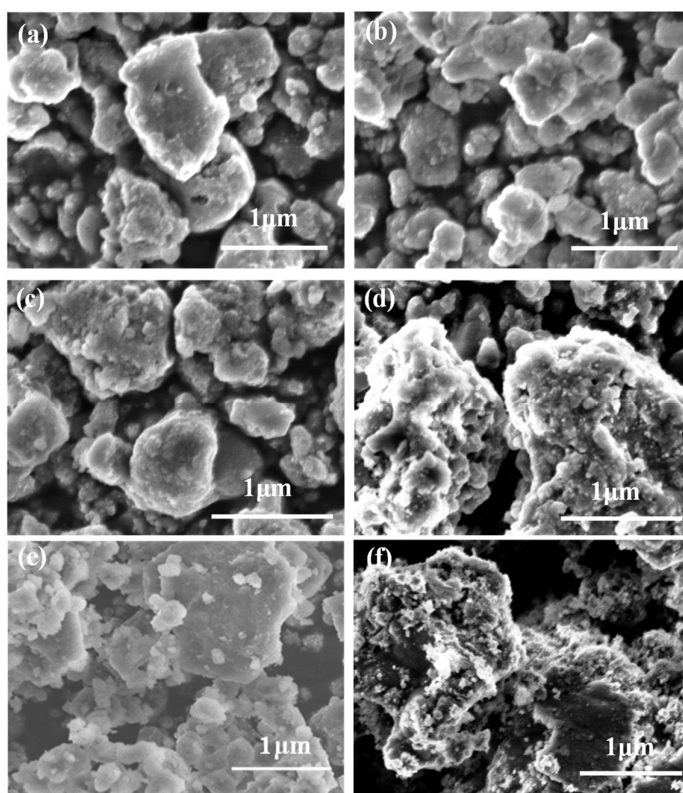
**Figure S2.** The differentiation of the dehydrogenation curves of the  $\text{MgH}_2$ -10wt%  $\text{Y}_2\text{O}_3/\text{NiO}$  system of (a) the first dehydrogenation and (b) the second dehydrogenation.



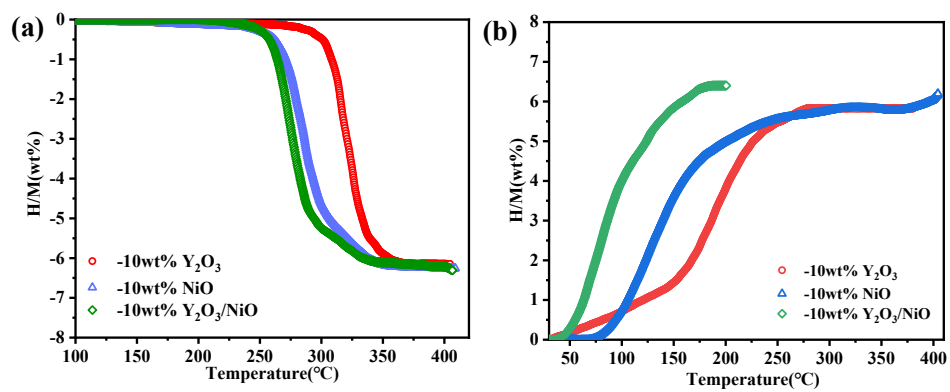
**Figure S3.** XPS spectra of Y 3d and Ni 2p of the products of the ball-milled (BM) sate (a, b), the 1<sup>st</sup> dehydrogenation (c, d), the 1<sup>st</sup> hydrogenation (e, f), and the 2<sup>nd</sup> dehydrogenation (g, h) of the MgH<sub>2</sub>-10wt% Y<sub>2</sub>O<sub>3</sub>/NiO system. The products are by the regime as noted for Figure 4.



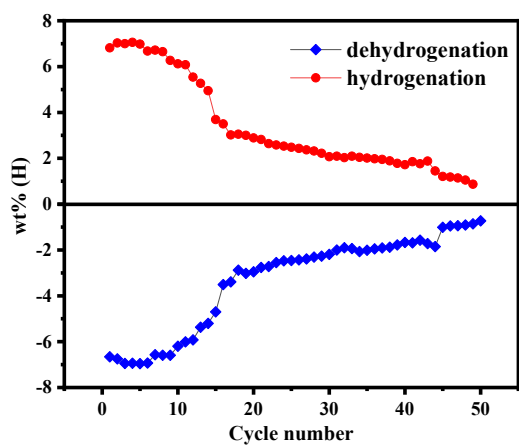
**Figure S4.** HR-TEM image of the dehydrogenated product of the  $\text{MgH}_2$ -10wt%  $\text{Y}_2\text{O}_3/\text{NiO}$  system, performed as Figure 4(b).



**Figure S5.** SEM images of the  $\text{MgH}_2$ -12 wt%  $\text{Y}_2\text{O}_3/\text{NiO}$  system of as-milled (a) and hydrogenated (b); the  $\text{MgH}_2$ -2wt%  $\text{Y}_2\text{O}_3/\text{NiO}$  system of as-milled (c) and hydrogenated (d); the bare  $\text{MgH}_2$  of as-milled (e) and hydrogenated (f). Dehydrogenation and hydrogenation are performed as noted in Figure 4.



**Figure S6.** Comparison of the hydrogen desorption (a) and absorption (b) curves of the MgH<sub>2</sub>-10wt%Y<sub>2</sub>O<sub>3</sub>/NiO system with MgH<sub>2</sub>-10wt%Y<sub>2</sub>O<sub>3</sub> and MgH<sub>2</sub>-10wt%NiO systems.



**Figure S7.** Cyclic dehydrogenation and hydrogenation capacities of the pure MgH<sub>2</sub> with a cyclic regime of dehydrogenation at 320 °C for 60 min and hydrogenation at 320 °C and 5 MPa H<sub>2</sub> for 120 min.