Supporting information

Solid state synthesis of nano-sized AlH\(_3\) and its de-hydriding behaviour

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Figure S1. Proposed reagent of the LiH, CaH\(_2\), MgH\(_2\) and AlCl\(_3\) phase as identified by XRD

![XRD patterns of a) LiH phase, b) CaH\(_2\) phase, c) Mg powders milled in hydrogen for 20h, d) AlCl\(_3\) phase.](image)

Fig. S1 XRD patterns of a) LiH phase, b) CaH\(_2\) phase, c) Mg powders milled in hydrogen for 20h, d) AlCl\(_3\) phase,

It is suggested from Fig. S1c that the solid-gas reaction was completed until milling in hydrogen for 20 h. Subsequently, the MgH\(_2\) phase was fully formed. Calculated by Scherrer equation based on the XRD patterns, the average crystallite size of MgH\(_2\)
phase can reach 10 nm.

Figure S2. Proposed reagent of the MgH$_2$ and AlCl$_3$ phase as identified by SEM

![SEM morphology of a) MgH$_2$ phase, b) AlCl$_3$ phase.](image)

Fig. S2 SEM morphology of a) MgH$_2$ phase, b) AlCl$_3$ phase.

Upon milling for 20h, it can be seen from the Fig. 2a that most individual particles of MgH$_2$ were between 1 and 2 µm in size.

Figure S3. The isothermal desorption curves of the MgH$_2$/AlCl$_3$ powders

![Isothermal desorption curves of the MgH$_2$/AlCl$_3$ powders milled at 400 rpm with a ball to powder mass ratio (BPR) of 60:1 for different times.](image)

Fig. S3 Isothermal desorption curves of the MgH$_2$/AlCl$_3$ powders milled at 400 rpm with a ball to powder mass ratio (BPR) of 60:1 for different times.