**Electronic Supplementary Information**

![XRD and FTIR spectra](image)

Fig. S1 XRD patterns (a) and FTIR spectra (b) of the dehydrogenated Mg(NH$_2$)$_2$-2LiH under different conditions.
Fig. S2 Dehydrogenation curves of the Mg(NH$_2$)$_2$-2LiH-0.08KF samples as a function of time and temperature.
Fig. S3 MS-NH$_3$ of the Mg(NH$_2$)$_2$-2LiH and Mg(NH$_2$)$_2$-2LiH-0.08KF samples.

Fig. S4 MS-NH$_3$ of the Mg(NH$_2$)$_2$-2LiH-0.08KF samples with different treatments.
Fig. S5 Hydrogenation curves of the cubic and orthorhombic Li$_2$MgN$_2$H$_2$. 
Fig. S6 SEM images of the Mg(NH$_2$)$_2$-2LiH-0.08KF samples dehydrogenated at different temperatures.
Fig. S7 SEM images and EDS mapping of K for the Mg(NH$_2$)$_2$-2LiH-0.08KF samples dehydrogenated at 130 and 250 °C.
Fig. S8 SEM images of Mg(NH$_2$)$_2$-2LiH-0.08KF hydrogenated at different temperatures.
Fig. S9 Kissinger’s plots of the Mg(NH$_2$)$_2$-2LiH-0.08KF samples.
Fig. S10 Isothermal dehydrogenation curves (a) and the corresponding Ginstling-Brounshtein’s plots (b) of the Mg(NH$_2$)$_2$-2LiH-0.08KF samples.

Fig. S11 SEM images and EDS mapping of K for the Mg(NH$_2$)$_2$-2LiH-0.08KF samples hydrogenated at 140 and 210 °C.
Fig. S12 SEM images of the post-milled Mg(NH$_2$)$_2$-2LiH-0.08KF samples before and after cycling.