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Effect of maleic acid on onset temperature and H₂ release kinetics for thermal dehydrogenation of ammonia borane



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HIGHLIGHTS

- Using maleic acid, a high H₂ equivalent from AB was obtained with fast kinetics.
- The onset temperature of dehydrogenation was significantly reduced to ~60 °C.
- Hydrolysis between OH[−] and BH[−] bonds initiated ammonia borane dehydrogenation.
- 2.11H₂ equivalents were achieved at 60 °C by a combination of multiple additives.

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ABSTRACT

Ammonia borane (AB, NH₃BH₃) has received great attention as an attractive hydrogen storage candidate because it has high hydrogen contents and releases hydrogen under mild operating conditions. Despite the favorable properties, AB thermolysis has several drawbacks such as long induction period, slow kinetics, and relatively high onset temperature, compared to hydrolysis approach. In this study, hydrogen release properties from AB were investigated in the addition of maleic acid (C₄H₄O₄, MA). Using thermogravimetric analysis, temperature programmed reaction with mass spectrometry, and FTIR analyses, the solid and gaseous products generated by thermolysis of the AB-MA mixture were characterized to understand the reaction mechanism. It was found that with the addition of MA, hydrogen yield and release kinetics were enhanced, while the onset temperature reduced significantly to ~60 °C. It is likely that the hydrolysis between O–H bonds in MA and B–H bonds in AB was initiated, and the heat released from the hydrolysis triggers the thermolysis of AB. It was also confirmed that a combination of the two additives (MA and boric acid) enables a further increase of H₂ yield while the onset temperature remains at ~60 °C. Our results suggest that MA is a promising additive to improve AB dehydrogenation.

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