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Tailored Hydrogen Generation from Borohydride in Ionic Liquids

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PURPOSE OF THE ABSTRACT

The continuous depletion of fossil fuels promotes the development of sustainable energy systems, such as H2, an environmentally benign energy carrier [1]. H2 can be obtained via water electrolysis, using renewable energy sources. After temporary storage of H2, it is fed to a fuel cell, recovering the retained energy, e.g. to charge a phone [2]. The H2 lifecycle is schematically displayed in Figure 1. Especially for portable fuel cell applications, the H2 storage is a key issue [3]. Current H2 storage technologies include pressure tanks, cryo storage or chemically bound H2, such as LiBH4 or NaBH4 with a H2 capacity of 18.4 wt% and 10.6 wt% H, respectively [4, 5]. BH4- hydrolyzes when in contact with H2O, forming H2 and the corresponding borate (Eq. (1)) [6, 7].

BH4- (aq) + 4 H2O (l) => B(OH)4- (aq) + 4 H2 (g) (1)

For the implementation of BH4- in portable electronic applications, a hydrogen storage medium with a melting point below room temperature (RT) and the tailored catalytic H2 release is mandatory. In the present study, we produce H2 from liquid storage materials based on BH4- in ionic liquids (ILs) via hydrolysis under ambient conditions, using various catalysts as releasing agents. For this purpose, various BH4- ionic compounds were synthesized (Figure 2). Our findings indicate that EMIM BH4- 2 and PMIM BH4- 3 with a hydrogen storage capacity of max. 3 wt% H are promising storage media [1].

Subsequently, the BH4- ILs were hydrolyzed with H2O using supported metal as well as acidic catalysts. All hydrolyses of EMIM BH4- and PMIM BH4- with metal/acid catalysts revealed saturation curves, whereas highest H2 yields were obtained in a semi-batch process with continuous acid addition. Additionally, mass transport limitations as well as activation energies of the PMIM BH4- hydrolysis with supported Co catalyst were investigated. A mechanism for the hydrolysis of PMIM BH4- is proposed based on the 11B NMR analysis of the H+ catalyzed hydrolysis of BH4- at various reaction times [1].

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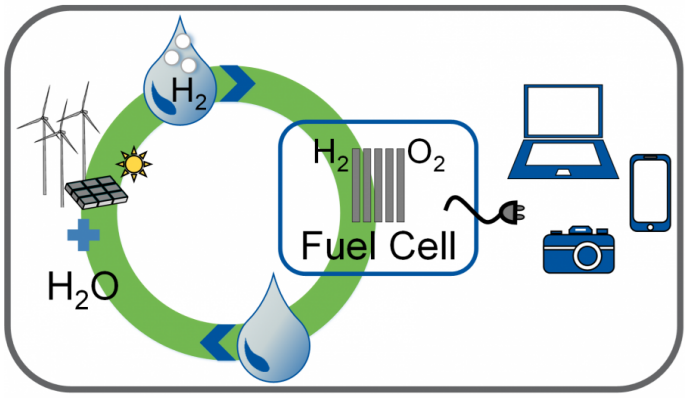
FIGURES



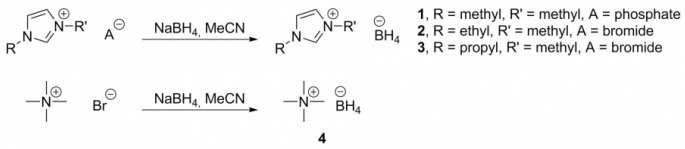


FIGURE 1

H2 Lifecycle

Schematic lifecycle of H2 as energy carrier, including the formation of H2 via water electrolysis with renewable energy and subsequent application of hydrogen as a feedstock for fuel cells.

FIGURE 2

Borohydride Ionic Liquid Synthesis

Synthesis of BH4- ILs.

KEYWORDS

Borohydride | Ionic liquids | Hydrogen Storage | Hydrolysis

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