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CHARACTERISTICS OF Co-B CATALYSTS FOR HYDROGEN GENERATION FROM ALKALINE $NaBH_4$ SOLUSION

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One of the challenges to commercialization of polymer electrolyte membrane fuel cells (PEMFCs) is hydrogen storage in a high gravimetric and volumetric efficiency as well as in a safe system. Hydrogen can be stored in tanks of compressed or liquefied H_2, or in a hydrogen-storing alloy, or by adsorption on activated carbon and carbon nanotubes. However, at present, any of the methods cannot fulfill the requirements, particularly for portable applications. As a substitute, hydrogen storage in a form of chemical hydride like $NaBH_4$ have been studied with its various advantages: nonflammable and stable in air, easy controlling of hydrogen generation rate, recycling of the side products, and high H_2 storage efficiency [1 -3].
Base-stabilized $NaBH_4$ solution hydrolyzes to hydrogen and sodium metaborate ($NaBO_2$) when being in contact with selected catalysts.

$$NaBH_4(aq) + 2H_2O \xrightarrow{\text{catalyst}} 4H_2 + NaBO_2(aq) + \text{heat}(217\text{kJ}) \quad (1)$$

The previous studies [1-3] employed noble metal catalysts such as Pt and Ru for the hydrogen generation. In this study, a low-cost and high-performance catalyst was developed by chemical reduction method using $CoCl_2$ and $NaBH_4$ solution. The prepared catalyst, whose SEM image is shown in Fig. 1, was found to consist mainly of Co, B, and/or their oxide by XRD and AAS analysis. Fig. 2 presents hydrogen generation from 20 wt% $NaBH_4$ + 5 wt% NaOH solution at 20 ^oC using Ni, Co, Co-B, and Ru catalyst. NaOH was added to the solution as a base-stabilizer. Ni, Co, and Ru catalyst were used in a form of metal powder as received. Volume of generated hydrogen increased linearly with hydrogen evolution time, reflecting the reaction proceeded independently of the reactant concentrations. Hydrogen generation rate was calculated from the slope of the plots to be 25, 40, 1000, and 2200 mL/min·g for Ni, Co, Co-B, and Ru catalyst, respectively. Those results imply that the Co-B compound developed in this study can replace Ru as a catalyst for the hydrogen generation from $NaBH_4$ solution. To optimize the solution condition, effects of solution composition, temperature, and catalyst weight on the hydrogen generation rate were examined using the Co-B catalyst.

References

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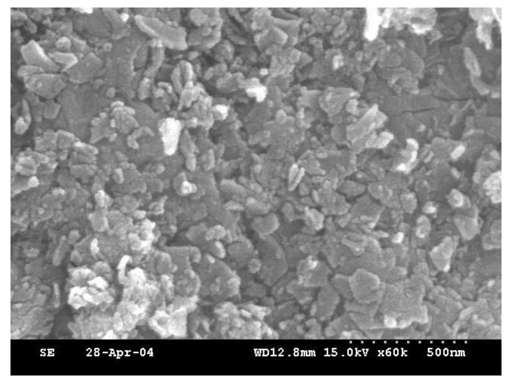

Fig. 1 SEM image of Co-B catalyst made by chemical reduction method.

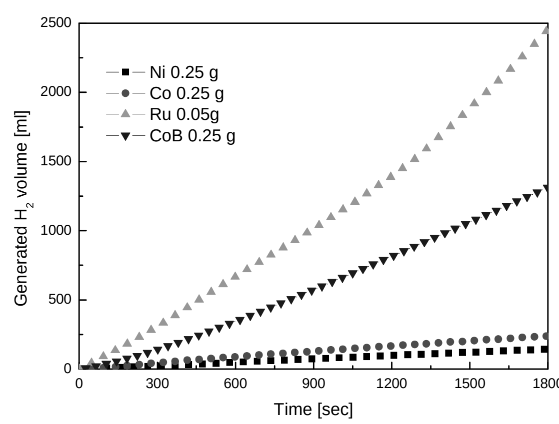

Fig. 2 Hydrogen generation from 20 wt% $NaBH_4$ + 5 wt% NaOH solution at 20 ^oC with Ni, Co, Co-B, and Ru catalyst.