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メタほう酸ナトリウムの水素プラズマ処理を用いた循環型高密度水素キャリアの生成

Synthesis of Recycling High Density Hydrogen Carrier by Hydrogen Plasma Treatment of Sodium Metaborate

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1. Introduction

Hydrogen attracts attention as a new energy source. However, it is a problem that the costs of hydrogen transportation and storage are high. To solve the problem, hydrogen carriers for transporting and storing large quantities of hydrogen are required. We focused on sodium borohydride ($NaBH_4$) which can generate a large amount of hydrogen stably and easily by reacting with water as shown in reaction equation:

$$NaBH_4+2H_2O \rightarrow 4H_2+NaBO_2 \quad (1).$$

$NaBH_4$ generates sodium metaborate ($NaBO_2$) which is a by-product during the hydrogen generation reaction. Since $NaBH_4$ deprives hydrogen from water during the hydrogen generation reaction, the amount of hydrogen generation is extremely high. In addition, $NaBH_4$ has a higher energy density than a hydrogen carrier such as ammonia, methane, cyclohexane. However, traditional manufacturing processes which have been applied to commercial production of $NaBH_4$ are very complicated. In this study, we attempted to synthesize $NaBH_4$ from $NaBO_2$ powder by hydrogen plasma treatment.

2. Experimental Methods

The plasma reactor for $NaBO_2$ powder consisted of a rectangular parallelepiped vacuum chamber with a microwave (MW) launcher and a 2.45 GHz MW generator. $NaBO_2$ (Kojundo Chemical Laboratory Co., Ltd: NAF42XB) powder alone or mixed powder with Mg (Hayashi Pure Chemical Ind., Ltd: J161109001) was treated with H_2 plasma. The mixture mass ratio of $NaBO_2$ and Mg was $NaBO_2$: Mg = 0.3:0.2 g. The sample was put at z = 60, 115 and 175 mm from quartz plate of MW launcher. The H_2 gas pressure was 9 Pa.

In order to measure the storage hydrogen of plasma treated $NaBO_2$ powder, the powder was reacted with water of 15 mL in a sealed bag. After the reaction with water, the amount of generated hydrogen was measured using a gas sampler (Gastec GV-110S) and a hydrogen gas detection tube (Kitagawashiki gas detection tube H_2 type U).

3. Results and Discussion

Figure 1 shows the results of the amount of generated hydrogen of plasma treated $NaBO_2$ and the relative mass ratio between berfore and after plasma treatment. The plasma treatment time was 30 min. The amount of generated hydrogen increased as the sample position moved downstream. Since the hydrogen ion density clearly decreased downstream, it is speculated that the higher ion density may disturb the formation of $NaBH_4$. The decrease in mass is mainly due to etching. As the incident energy of ions and radicals higher than the dissociation energy of $NaBO_2$ attack the sample surface, sodium atom may easily dissociate rather than the reduction to $NaBH_4$.

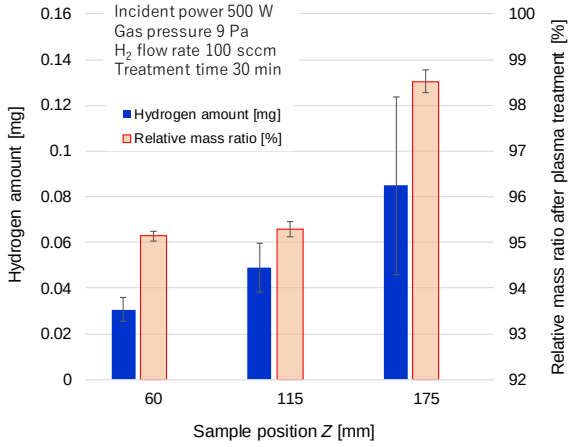

Fig. 1. Hydrogen amount and relative mass ratio of $NaBO_2$ powder after H_2 plasma treatment.