—Communication—

Enhancement of the Photocatalytic Activity of CdS Powder by Heat Treatment with Potassium Bromide

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1 INTRODUCTION

In the previous paper¹⁾, we reported that the heat treatment of cadmium sulfide (CdS) powder with potassium chloride (KCl)²⁾ was a useful method to obtain superior CdS photocatalyst for hydrogen production from sodium sulfite solution. We report here that more superior CdS photocatalyst is obtained by heat treatment with potassium bromide (KBr).

2 EXPERIMENTAL

The starting CdS amorphous powder having a specific surface area (S) of 117 m² g⁻¹ was prepared by chemical precipitation and ground to under 100 mesh. It was mixed with KBr powder that had been ground to under 100 mesh and then heated in an electric furnace. After heating, the resulting particles were put into distilled water to remove KBr and dried at 110°C. The S of the samples was determined by using the BET method with nitrogen as the adsorbent.

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A 0.5 g CdS sample was loaded with 2 wt% platinum black by shaking and dispersed into 70 cm³ of 1 mol dm⁻³ Na₂SO₃ solution adjusted to pH 8.0 with boric acid and then deaerated. The magnetically stirred solution containing CdS powder was irradiated using a 400 W xenon arc lamp. The amounts of hydrogen produced after 6 h irradiation were compared to determine the photocatalytic activity. A ferrioxalate actinometer and an interference filter were used for the quantum yield measurements.

3 RESULTS AND DISCUSSION

The dependencies of S and the photocatalytic activity of the samples obtained with a mixing ratio of KBr to CdS of 1.0 and for 2 h

Fig. 1 Dependencies of S (curve a) and the photocatalytic activity (amount of hydrogen gas evolution, curve b) on the heating temperature with a KBr mixing ratio of 1.0 for 2 h heating

heating on heating temperature are shown by curves a and b in Fig.1.

As the temperature increased, S remarkably decreased owing to crystallization. However, the heat treatment at 350°C gave a slight improvement in activity since the temperature was low for inducing the crystal growth reactions. Indeed, the sample obtained at 350°C is amorphous. The heating temperature of 400°C gave a superior activity. A further rise in heating temperature decreased the activity, though samples have a small S and consist of crystallites.

The study for the effect of KBr ratio on the activity showed that the ratio of KBr from 0.75 to 1.25 was effective for superior activity when they were treated at 400°C for 2 h. By increasing the heating time at 400°C with the KBr ratio of 1.0, S decreased. On the other hand, the activity slightly increased at 4 h and then decreased gradually with heating time. During heat treatment at 450°C, S significantly decreased with time and the activity was also reduced.

Figure 2 is the relationship between S and the photocatalytic activity for all samples obtained in this study. The activity has a maximum around $7 \text{ m}^2 \text{ g}^{-1}$. The most active CdS photocatalyst, which was obtained by the heat treatment with a KBr mixing ratio of 1.0 at 400°C for 4 h, showed the quantum yield of 0.31 for 460 nm light. This value is the double of the highest quantum yield for the sample having an S of $0.8 \text{ m}^2 \text{ g}^{-1}$ that obtained by heat treatment using $\text{KCl}^{1)}$ and consisted of micro crystallites.

Reber et al.³⁾ reported that the activity decreased with increasing

Fig. 2 Relationship between S and the photocatalytic activity for all samples obtained in this study.

	KBr ratio, Temp.(°C), Time(h)		
△	0.25	400	2
▽	0.50	400	2
○	0.75	400	2
●	1.0	400	2-10
□	1.5	400	2
◇	2.0	400	2
▼	1.0	350	2
▲	1.0	450	2-10
■	1.0	500	2
◆	1.0	550	2

S and became negligible above $7 \text{ m}^2 \text{ g}^{-1}$. In our result, the activity increased with increasing S up to $7 \text{ m}^2 \text{ g}^{-1}$. This result will be due to the increase of the amount of active center or the decrease of crystal defect which acts as a recombination center. In the higher S region ($>7 \text{ m}^2 \text{ g}^{-1}$), our result agrees with that of Reber et al. A further investigation is necessary to account for this relationship.

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