# Effect of pH value on photocatalytic performance of bismuth vanadate powder synthesized by solvothermal method

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**Abstract:** The most important factor affects photocatalytic performance of a photocatalyst is pH treatment condition. In this work, characteristics and photocatalystic performance of bismuth vanadate powders synthesized at various pH values were deeply studied and discussed in their relation. The results showed that crystalline structure and morphology were significantly depended on pH values. The highest effective photocatalyst for photocatalytic methyl orange degradation was pH 7 with single phase of monoclinic, rod-like particle and large specific surface area. In addition, V–O bond distance analyzed by X-ray absorption spectroscopy was also found to be another interesting factor for photocatalysis under visible light.

**Keywords:** Bismuth vanadate, Photocatalysis, pH.

## 1. Introduction

Photocatalysis is a clean chemical reaction for energy productions and environmental treatments. This reaction is initiated by light absorption of a photocatalyst. Bismuth vanadate ($BiVO_4$, BVO) is a very well-known visible-light active photocatalyst which has been developed for the photocatalysis [1-2]. It has been reported that pH condition in BVO synthesis process is an important factor affects its photocatalytic activity[3]. In this work, effect of pH values on physical properties and photocatalytic activity of the BVO were studied and discussed.

## 2. Experimental

BVO was synthesized by solvothermal method. Ammonium metavanadate ($NH_4VO_3$) solution was added dropwise into bismuth nitrate ($Bi(NO_3)_3{\cdot}5H_2O$) solution with the mole ratio of V: Bi = 4:1. Then, pH value of the suspension was adjusted to 6, 7 and 8 before adding ethanol (50%v/v of total volume). After mixing well solvothermal reaction was performed at 200 ˚C for 4 h. Finally, obtained powder was washed several times by water and dried in oven under ambience condition. Characteristics of the BVO powders were studied by X-ray diffraction spectroscopy (XRD), field-emission scanning electron microscopy, UV-vis diffuse reflectance spectroscopy, surface area analysis and X-ray absorption spectroscopy (XAS). Furthermore, photocatalytic performances of the obtained BVO powders were evaluated by observation of photodegradation of methyl orange.

## 3. Results and discussion

Characteristics of BVO powers were changed by pH adjustment in synthesis process[4-5]. XRD patterns of pH 6 were fitted well with tetragonal and monoclinic BVO structures while the pH 7 and 8 were a single monoclinic structure. Figure 1 showed effects of pH on physical properties and photocatalytic performance of BVO powders. In neutral condition, BVO with the largest specific surface area (SSA) and smallest crystalline size (D) could be obtained. However, band gap energy ($E_g$) was negligible changed by pH. Additionally, local structures of BVO powders were analyzed by XAS providing data of the first shell positions of nearest atoms from V atom then V–O bond distances were calculated. V–O bond distance of BVO synthesized at pH 6, 7 and 8 were 1.25, 1.29 and 1.31 Å (no phase shift has been applied), respectively.

It was obviously that changes of crystalline structure and local structure depended on pH which affected the formation of BVO crystals[6-7]. In case of monoclinic structure, the highest photocatalytic activity could be obtained from the BVO with the shortest V–O bond[4].

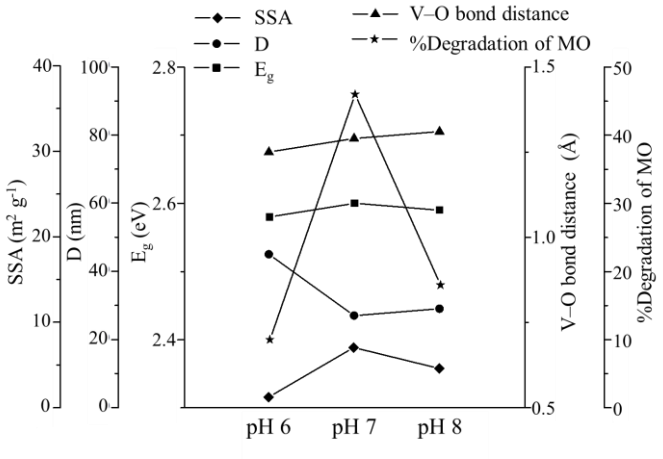


**Figure 1.** Effects of pH on physical properties and photocatalytic performances of bismuth vanadate powders.

## 4. Conclusions

In summary, photocatalytic performance of BVO powder could be controlled by adjusting pH condition. Moreover, the highest photodegradation of methyl orange was obtained by using BVO powder with pure monoclinic structure, large SSA, small crystalline size and short V–O bond distance. Base on the result, we suggest local structure as an important factor that should be consider for a higher photocatalysis.

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