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Photochemical Growth of Nanoporous SnO_2 at the Air-Water Interface and Its High Photocatalytic Activity

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Electronic Supplementary Information

The formation of SnO_2 was closely related to the ambient atmosphere. To confirm it, the products produced in the air and N_2 surroundings were analyzed, respectively. Because quartz glass absorbs light scarcely, we select quartz tube as a reactor to investigate the influence of ambient atmosphere on the resulting product. Except for the ambient atmosphere, all the reactions were carried on the same conditions as that described in the paper. Fig. S1a shows the photos of different reactors after the irradiation is stopped. The No.1 tube had been purged with nitrogen gas first and then was sealed with Vaseline. The No.2 tube was only sealed and then put in the dark. The No.3 tube was open. Without irradiation, in the No. 2 tube, almost no particles produced. After irradiation for 24h by UV light, much gray particles produced and dispersed in the precursor solution in the No. 1 tube. The XRD analysis shows the gray particles are composed of metallic Sn and SnO_2 (Fig. S1b). However, in the No. 3 tube surrounded with air atmosphere, only primrose yellow products were found and the XRD proved they were only composed of SnO_2, as shown in Fig. 1a in the paper. According to the reaction mechanism discussed in the paper, these phenomena can be explained as follows. In N_2 atmosphere, when UV light irradiating $SnSO_4$ solution, the metallic Sn can produced just like reaction (2) in the paper shows. Owing to absence of oxygen, it can't be oxidized to SnO_2. Though partial metallic Sn can react with H^+ in solution according to reaction (5), the reaction ratio of reaction (5) is slower than reaction (2) in the diluted H_2SO_4 solution. As a result, there is still a lot metallic Sn existing in the reaction system just like XRD analysis shows (Fig. S1b). This confirms that UV light irradiation can initiate the production of metallic Sn from Sn^{2+} according to reaction (1) and (2) in the paper. Moreover, the produced SnO_2 at the N_2 surrounding indicates Sn^{4+} coming from reaction (1) can be converted to SnO_2 according to reaction (6) and (7). In a word, when the reaction system was surrounded with N_2, lots of metallic tin was produced, and the SnO_2 was also obtained due to the concomitant resulting Sn^{4+} hydrolization and dehydration.

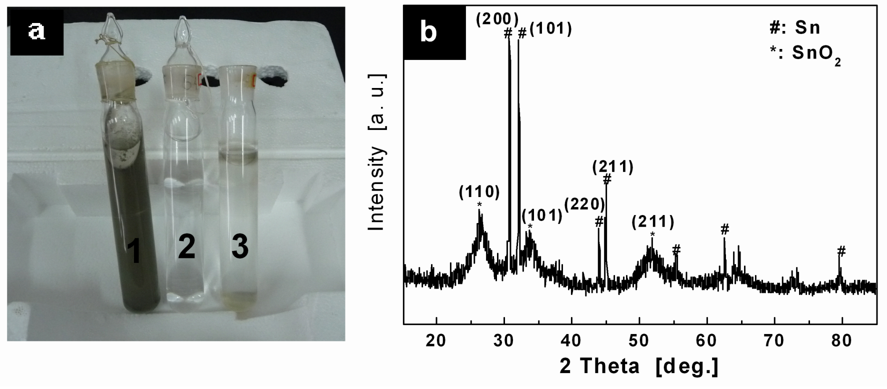

Fig. S1 (a) A digital photo of the precursor solution in different atmosphere after UV irradiation. 1) N_2 atmosphere, after irradiation, 2) in the dark, 3) ambient air, after irradiation. (b) XRD patterns of the obtained sample from a sealed quartz tube in an N_2 atmosphere after UV light irradiation.

The Sn^{2+} in the precursor solution can absorb UV light. As shown in Fig. S2, before irradiation with 254nm UV lamp, there is an evident absorbance band between 350nm and 200nm. After irradiation in the air, the absorbance band changes narrower and shifts toward shorter wavelength with irradiation time increase. This phenomenon attributes to decrease of the Sn^{2+} concentration in the precursor solution because of producing SnO_2 with UV light irradiation. As a result, after irradiation for 24h, the absorption band of the precursor solution disappeared because all Sn^{2+} was changed into SnO_2 and there is almost no Sn^{2+} in the precursor solution. This reflects that in our reaction system, Sn^{2+} can absorb photon to induce a serial photochemical reaction to produce SnO_2.

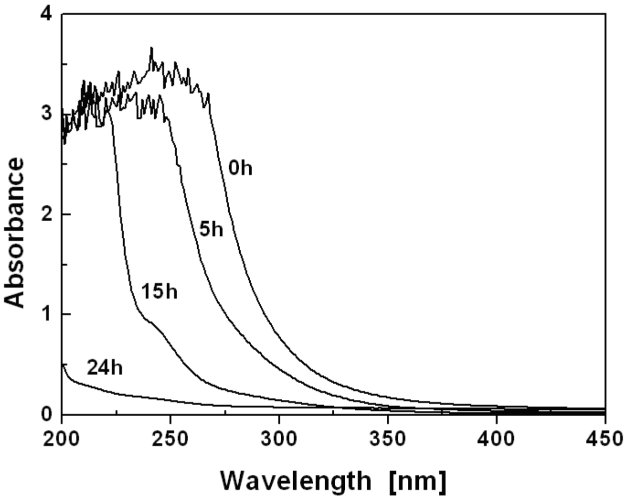

Fig. S2 Absorption spectra of the $SnSO_4$ aqueous solution before and after UV irradiation in the air. The solution contained 1wt.% SnSO4 and 3wt.% sulfuric acid.

In air, the yield of SnO_2 from the precursor solution containing about 3 wt% H_2SO_4 and 1 wt% $SnSO_4$ is relative to irradiation time and light source. As shown in Fig. S3, the blank experiment in the dark shows that light irradiation is necessary in order to obtain SnO_2 from the precursor solution. With the same irradiation time, the 254nm UV light can produce SnO_2 more quickly than other irradiation sources. When irradiated for 24h under the 254nm UV light, the SnO_2 yield is about 100%, and almost all the Sn^{2+} in solution was changed into SnO_2.

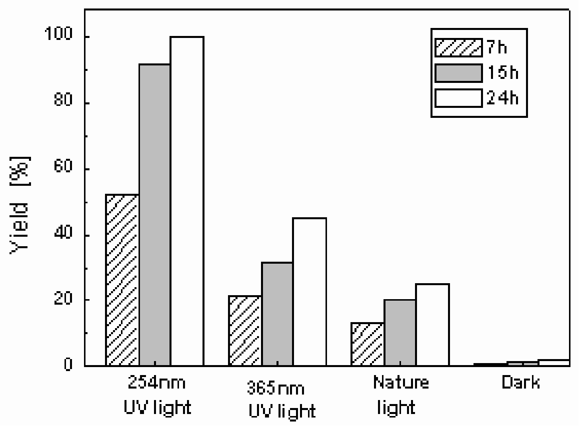

Fig. S3 Dependence of SnO_2 yield on the irradiation light source and irradiation time.