High Efficient Photocatalytic Activity of Type-II SnO/Sn_3O_4 Heterostructures via Interfacial Charge Transfer

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Supporting Information

Contents:

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S1. XRD patterns and TGA

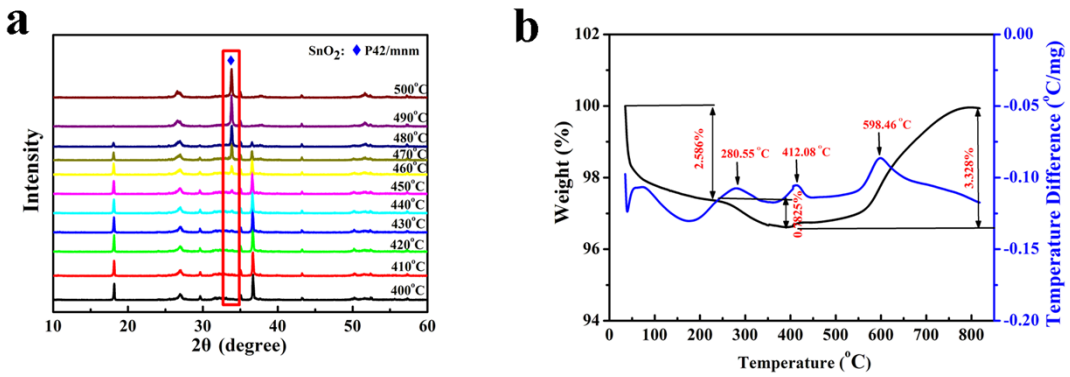

Figure.S1 (a) XRD patterns of tin oxide-base powders characterized at different temperatures (400, 410, 420, 430, 440, 450, 460, 470, 480, 490, 500 °C), respectively. (b) TG and DTG profiles of the thermolysis of tin oxide-base powders.

In order to get insight the overall phase transformation as function of annealing at temperatures from 400 °C to 500 °C , in suit powder XRD measurements and TGA were used to characterized the powder treated at various preset temperature. The stacked XRD patterns of the as synthesized powder after annealing at different temperature are depicted in Figure. S1(a). From the sequence, it is clearly evident that the major diffraction peak of SnO_2 ($2\theta = 39.97^{o}$ (101) plane) monotonically increases with increasing annealing temperature beyond about 460°C. The thermal decomposition process from SnO/Sn_3O_4 to SnO_2/Sn_3O_4 was also studied by performing TGA in flowing air, which was shown in Figure. S1(b). The representative TG and DTG profiles exhibits three distinct regions of weight changes, one showing a loss in the initial weight of the sample followed by a steeper loss with transition onset at ~200 °C. The first weight loss of ~2.59% occurring in the temperature range from RT to 200 °C corresponds to the removal of physically adsorbed water. The second weight loss step observed from 200 to 400 °C is probably due to the degradation of bound hydroxyl (-OH) groups from the surface of synthesized products. The final transition on the thermogram accompanied with the slight gain in weight (~3.33%) with an onset at ~420 °C signifies a phase change occurring in the oxidation process from SnO/Sn_3O_4 to SnO_2/Sn_3O_4. The increase in sample mass can be associated with addition of oxygen, associated with the complete phase transformation of SnO into SnO_2. The results of TGA analysis are good for our XRD observations as discussed in the preceding section (Figure. S1(a)).

S2. Raman spectra

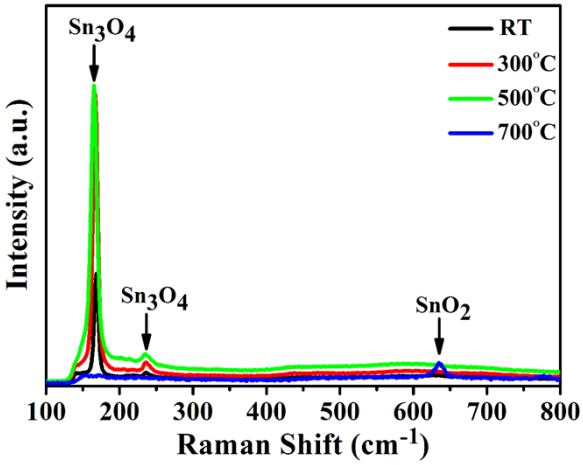

Figure.S2 Raman spectra of tin oxide-base powders characterized at 300, 500, 700 °C, respectively.

Moreover, to confirm the existence of Sn_3O_4, Raman spectroscopy was performed to clarify the crystalline compositions and structures of the above-mentioned samples. As shown in Figure. S2, two fundamental Raman peaks are detected at 170 and 238 cm^{-1}, corresponding to peaks of phonon modes of Sn_3O_4, consistent with the literature.[1-2] With further increase of the annealing temperature to 700°C, a weak band peaking at 633 cm^{-1} was detected and can be assigned as A_{1g} phonon modes of SnO_2.[3] The result of Raman analysis is good for our XRD observations as discussed in the preceding section.

S3. SEM and TEM images

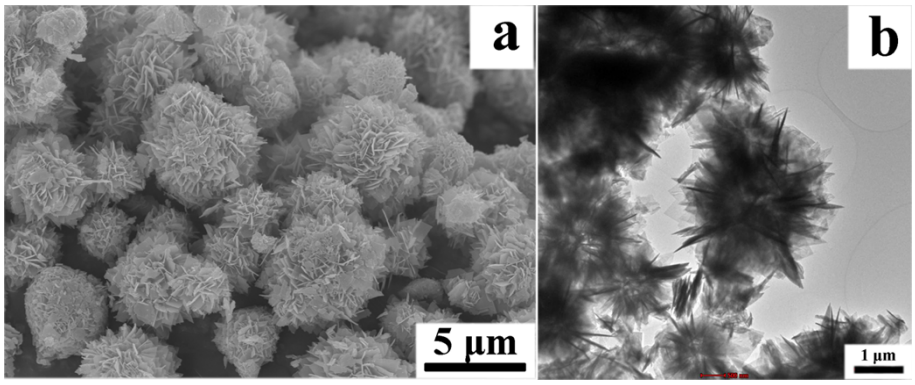

Figure.S3 SEM and TEM images of as-synthesized tin oxide microspheres afrer five-cycle photocatalytic test.

Reference

[1] He, Y. H.; Li, D. Z.; Chen, J.; Shao, Y. Sn_3O_4: a novel heterovalent-tin photocatalyst with hierarchical 3D nanostructures under visible light. RSC Adv. 2014, 4, 1266–1269.

[2] Wang, F. P.; Zhou, X. T.; Zhou, J. G.; Sham, T. K. Observation of Single Tin Dioxide Nanoribbons by Confocal Raman Microspectroscopy. J. Phys. Chem. C. 2007, 111, 18839–18843.

[3] Chen, Z. W.; Lai, J. K. L.; Shek, C. H. Insights into microstructural evolution from nanocrystalline SnO_2 thin films prepared by pulsed laser depositio. Phys. Rev. B. 2004, 70, 165314-165321.