

Support Information

Benefits on photocarrier transfer from transition of 3D to 2D morphology

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Sample preparation

The BVO thin films were deposited on YSZ(110) by PLD .the pulse repetition rate was 1 Hz. Target and substrate distance was 65 mm. Energy density of the 42 mj/cm². The substrate temperature was controlled to be 680 °C. Deposited time was 0.5 h and O₂ partial pressure was about 7.8 mTorr during the deposition of films¹⁻³.

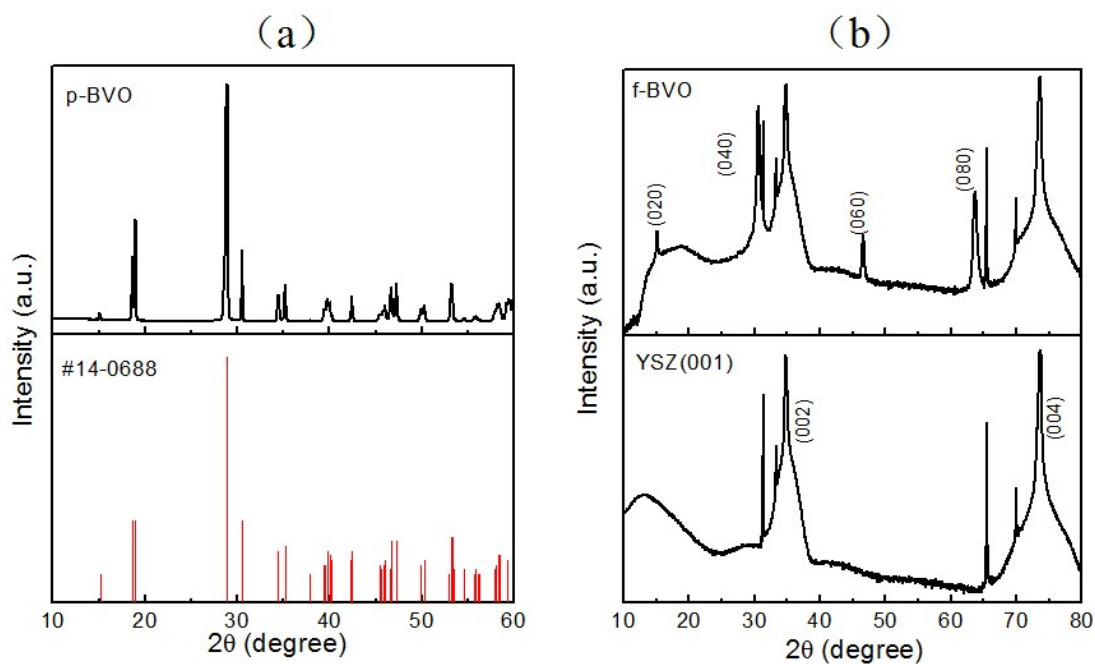


Fig. S1 XRD pattern of (a) p-BVO, (b) f-BVO and YSZ (001).

Table S1 The ratio of Bi and V atoms and the relative area ratio (O1s (adsorbed oxygen)/O1s (lattice oxygen + adsorbed oxygen)) determined by XPS for p-BVO and f-BVO.

samples	Bi:V	relative area ratio
p-BVO	1.08	0.25
f-BVO	1.06	0.59

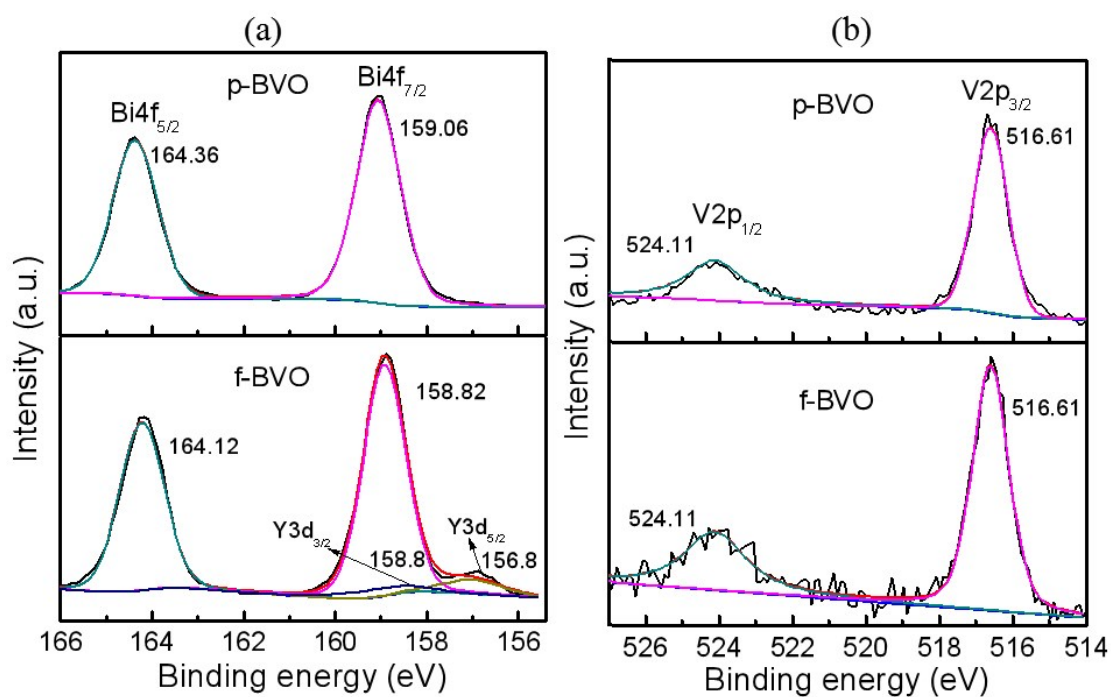


Fig. S2 XPS spectra of (a) Bi 4f and (b) V 2p for p-BVO and f-BVO.

XPS was used to identify the surface chemical composition and chemical valence state of elements. As shown in Fig. 2(a), two peaks of Bi 4f_{7/2} and Bi 4f_{5/2} in p-BVO are observed at 159.06 and 164.36 eV, which indicate only Bi³⁺ exists^{4, 5}. However, compared with p-BVO, the location of two peaks of Bi 4f in f-BVO is slightly shifted to low binding energy, which is due to the presence of more oxygen vacancies on the sample surface⁶. Additionally, two peaks at position 156.8 eV and 159 eV correspond to the Y 3d_{3/2} and Y 3d_{5/2} in f-BVO, confirming that BVO did not completely covered on the YSZ (001) substrates, which is consistent with the topography results in Fig. 3(a) and 3(c) (in the main article). From Fig. S2(b), the core level of V 2p contains two peaks with the splitting value of 7.5 eV which are V 2p_{3/2} and V 2p_{1/2}, respectively. It identifies that valence state of V is V⁵⁺ in p-BVO and f-BVO.

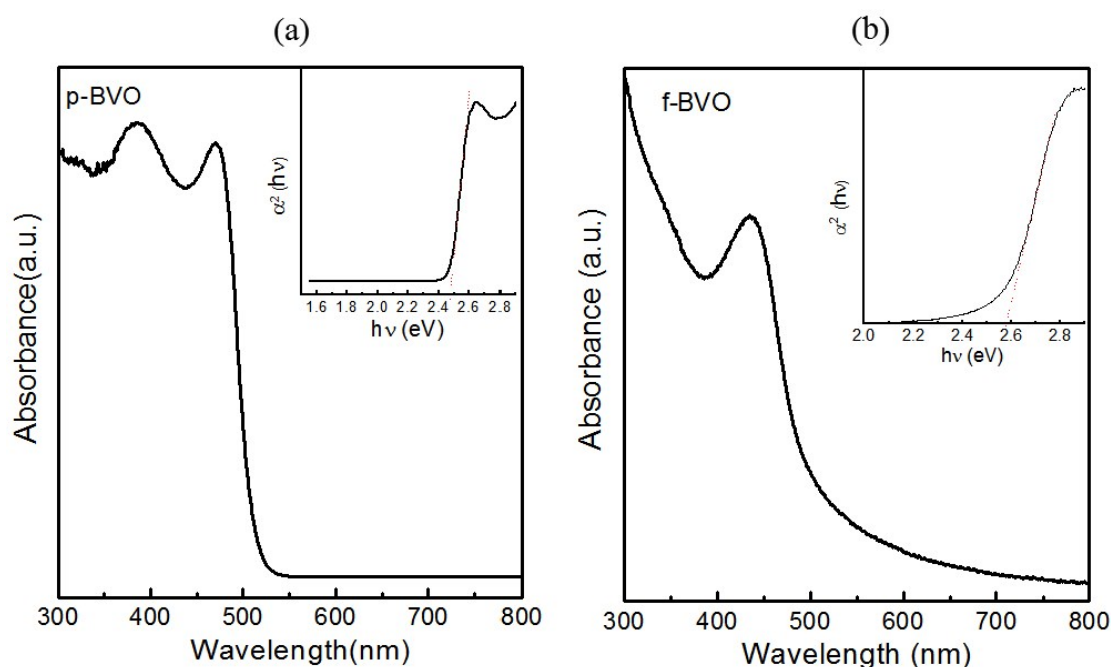


Fig. S3 UV-Vis spectra of (a) p-BVO and (b) f-BVO, insert in the upper right corner show Tauc's plots of the corresponding samples.

In the Fig. S3, for p-BVO and f-BVO, the onset of light absorption is around 515 nm, 495 nm respectively, again corresponding to their band gap energy. And using $a(h\nu)=A(h\nu-E_g)^{n/2}$. Where a , h , ν , A , and E_g represent the absorption coefficient, Planck constant, light frequency, a constant and the band gap energy, respectively. For a direct transition of BiVO₄, the value of n is 1. As shown in Fig. S3(a) and S3(b), insert in the upper right corner, according to the above formula, their band gaps are 2.47 and 2.59 eV, respectively.

References

1. G. Li, S. Kou, F. Zhang, W. Zhang and H. Guo, *CrystEngComm*, 2018, **20**, 6950-6956.
2. G. Li, Q. Shen, Z. Yang, S. Kou, F. Zhang, W. Zhang, H. Guo and Y. Du, *Applied Catalysis B: Environmental*, 2019, **248**, 115-119.
3. S. Kou, Q. Yu, L. Meng, F. Zhang, G. Li and Z. Yi, *Catal Sci Technol*, 2020, **10**, 5091-5099.
4. L. Guang, W. Fei and Z. Xuejun, *Journal of Alloys and Compounds*, 2017, **697**, 417-426.
5. S. Y. Jeong, K. S. Choi, H. M. Shin, T. L. Kim, J. Song, S. Yoon, H. W. Jang, M. H. Yoon, C. Jeon, J. Lee and S. Lee, *ACS Appl. Mater. Inter.*, 2017, **9**, 505-512.
6. L. Wang and R.-T. Gao, *Angewandte Chemie International Edition*, 2020.