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Facile synthesis of oxygen defective yolk-shell BiO_{2-x} for visible light-driven photocatalytic inactivation of Escherichia coli

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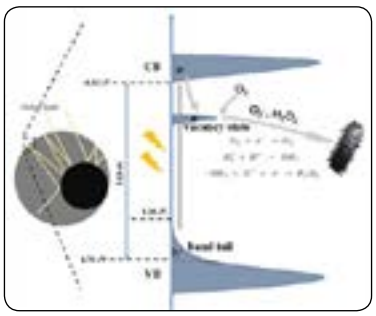
Statement of the Problem: Engineering catalysts with optimal oxygen vacancies is quite significant, as oxygen vacancy sites are efficient electron capture centers. However, bismuth oxide with oxygen vacancy, a promising VLD catalyst, was rarely reported. Besides, morphology dependent photocatalysis has been intensively focused, as the morphology would directly influence the activities by tuning light utilization, electron transfer processes and interfacial reaction. Yolk-shelled materials are emerging as promising candidates, owing to their charming physicochemical properties like enhanced light absorption ability by multiple reflections of incident light within the interior cavities. However, reports towards oxygen defective BiO_{2-x} with various morphologies are limited, inhibiting in-depth studies of defects and morphology dependent activities.

Methodology & Theoretical Orientation: Facile solvothermal method was used to synthesize oxygen defective BiO_{2-x} with yolk-shell structure. Electron paramagnetic resonance and X-ray photoelectron spectral analyses were adopted to verify the existence of oxygen vacancy. Photocatalytic activity was evaluated by bacterial inactivation. Scavenger studies were utilized to find the key active species in the inactivation process.

Findings: Temperature gradient originating from the heating rate caused the variances between the diffusion rate of the core and the formation rate of the shell, resulting in the formation of BiO2-x spheres with different interior structures. Yolk-shell BiO_{2-x} can completely inactivate 7 log E. coli within 3 h, superior than core-shell BiO_{2-x} and commercial Bi_2O_3.

Conclusion & Significance: The oxygen vacancy with a high affinity for molecular oxygen, and the enhanced light absorption ability resulted from multireflection of incident light within the interior voids, contributed to the prominent bacterial inactivation performance. O_2- and H_2O_2 guaranteed the oxidation ability toward bacterial cells. This study would shed light on the design and application of efficient oxygen defective photocatalysts with intricate yolk-shell structures.



Recent Publications:

1. Sun H, Li J, Zhang G, Li N (2016) Microtetrahedronal $Bi1_2TiO_20/g\text{-}C_3N_4$ composite with enhanced visible light photocatalytic activity toward gaseous formaldehyde degradation: Facet coupling effect and mechanism study. Journal of Molecular Catalysis A: Chemical 424:311-322.
2. Jiang Z, Qian K, Zhu C, Sun H, Wan W, Xie J, Li H, Wong PK, Yuan S (2017) Carbon nitride coupled with CdS-TiO_2 nanodots as 2D/0D ternary composite with enhanced photocatalytic H2 evolution: A novel efficient three-level electron transfer process. Applied Catalysis B: Environmental 210:194-204.
3. Wang T, Jiang Z, Chu K H, Wu D, Wang B, Sun H, Yip H Y, An T, Zhao H, Wong PK (2018) X-Structured α-FeOOH with enhanced charge Separation for visible-light-driven photocatalytic overall water splitting. ChemSusChem (Accepted).

Biography

Hongli Sun received her master's degree in 2016 from School of Resources and Environmental Engineering, Wuhan University of Technology. She is currently pursuing her Ph.D. in School of Life Science, The Chinese university of Hong Kong. Her research interests focus on photocatalysis research for energy conversion and environmental remediation, including the synthesis and hybridization of bismuth-based catalysts, and applications in CO_2 reduction, bacterial inactivation, hydrogen evolution, etc.

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