Photocatalytic Oxidation of Odorous Compounds using Zr based MOF@TiO_2 Core-Shell Structured Particles

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Background

Photocatalytic technology is considered a promising method for removing odor from livestock and poultry farms. However, the currently used titanium dioxide (TiO_2) photocatalyst has low light utilization efficiency and poor adsorption performance for pollutants such as sulfur compounds including dimethyl sulfide. The combination of metal-organic framework (MOF) and inorganic semiconductors can construct a charge transfer path, improve the utilization efficiency of electrons and holes, thereby improving photocatalytic performance.

Material and Methods

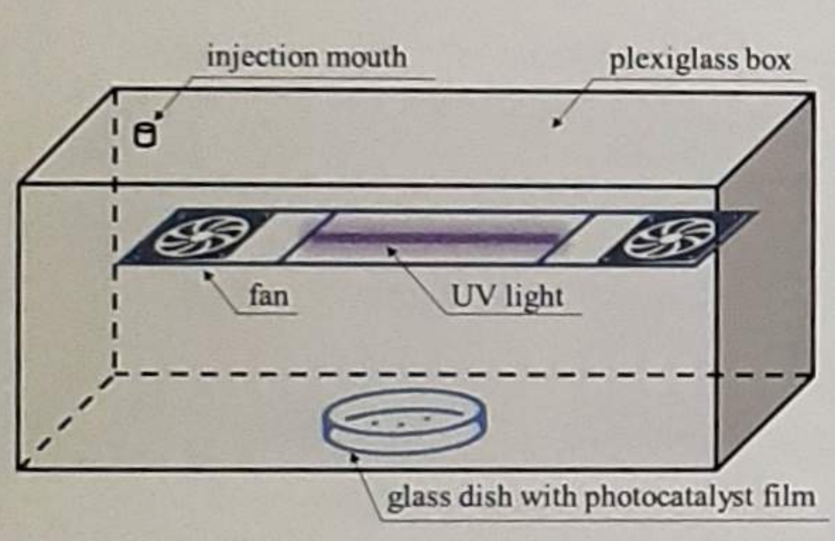


Fig. 1 Experimental setup

In this research, zirconium-based metal-organic framework (UiO-66) was prepared by hydrothermal method and coated with TiO_2 layer on its surface to prepare UiO-66@TiO_2 catalysts, and its photocatalytic degradation performance on odor compounds was investigated.

Results

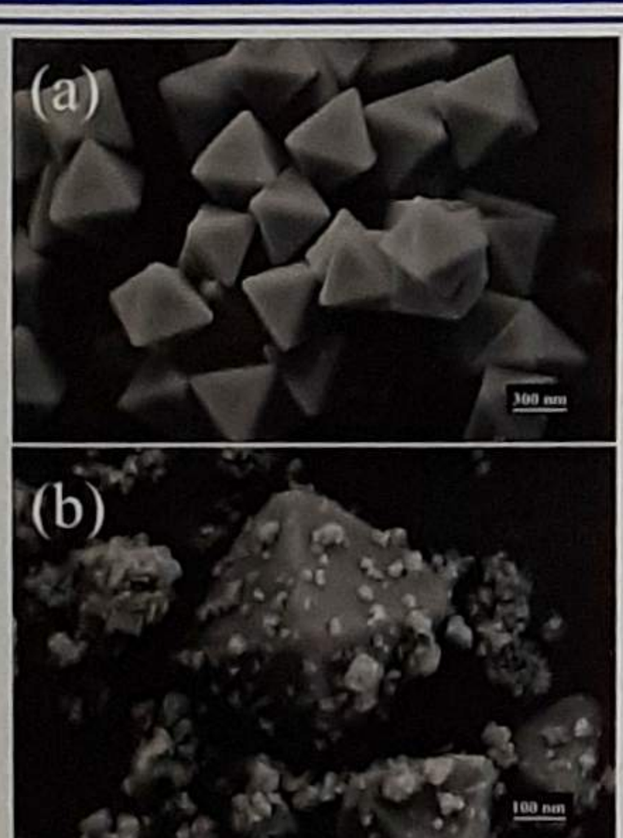


Figure 2. SEM images of (a) UiO-66, (b) UiO-66@TiO_2.

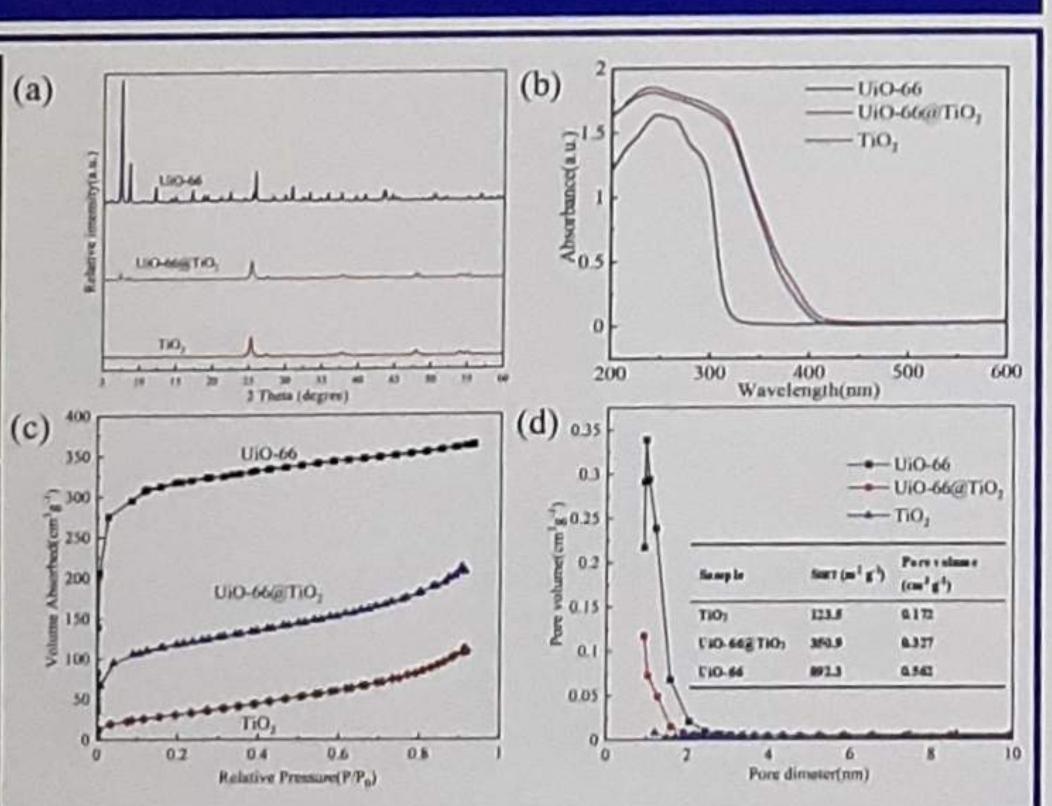


Figure 3. XRD (a), UV-vis (b), N_2 adsorption-desorption isotherms (c) and pore size distribution curves (d) of UiO-66, TiO_2, and UiO-66@TiO_2 composite material.

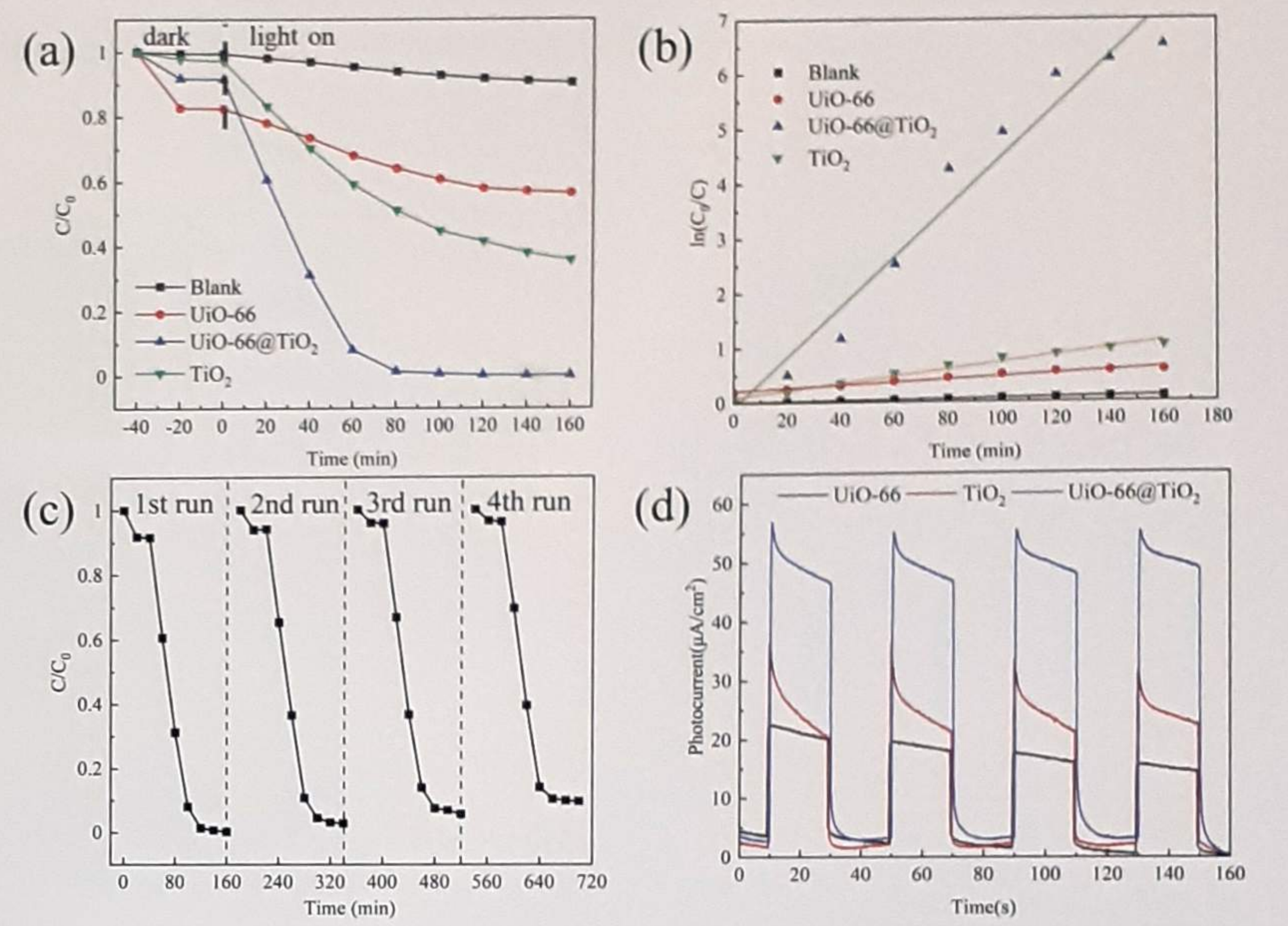


Figure 4. Photocatalytic degradation of DMS (a), and the fitting results of the pseudo-first-order kinetics of DMS degradation (b), recycling test for DMS degradation over UiO-66@TiO_2 (c), and transient photocurrent response of the prepared photocatalytic material (d).

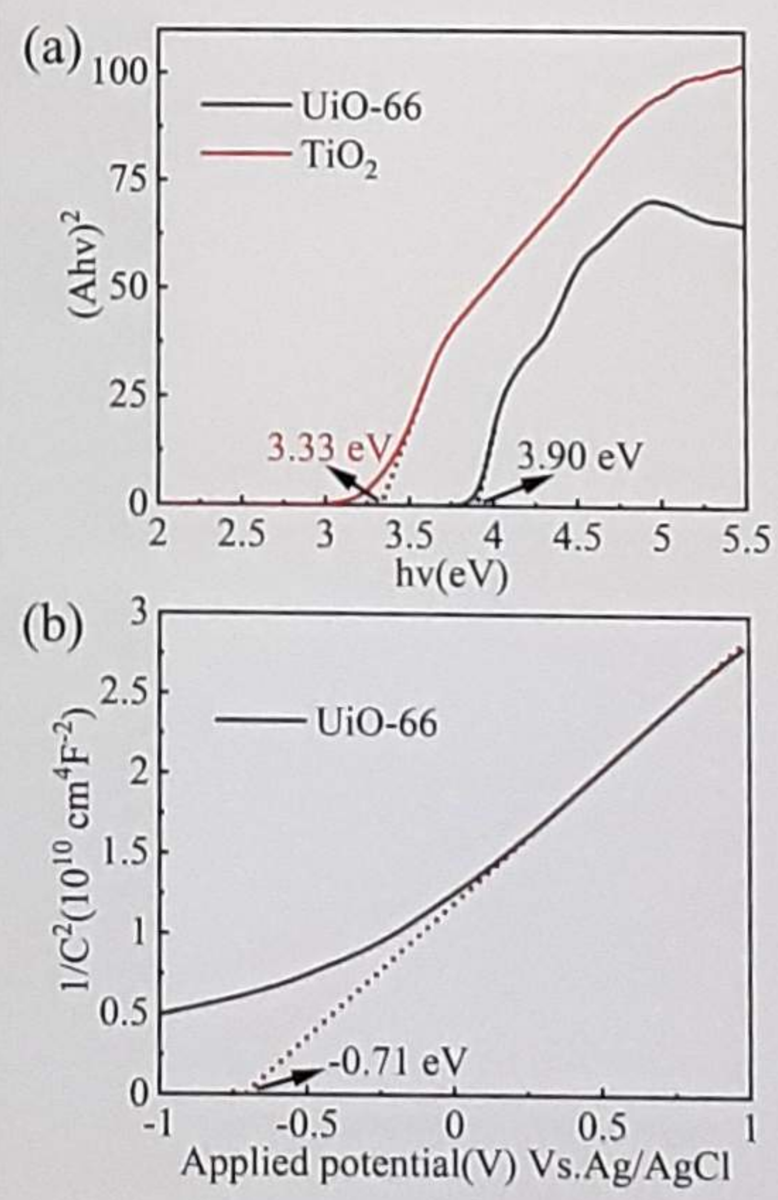
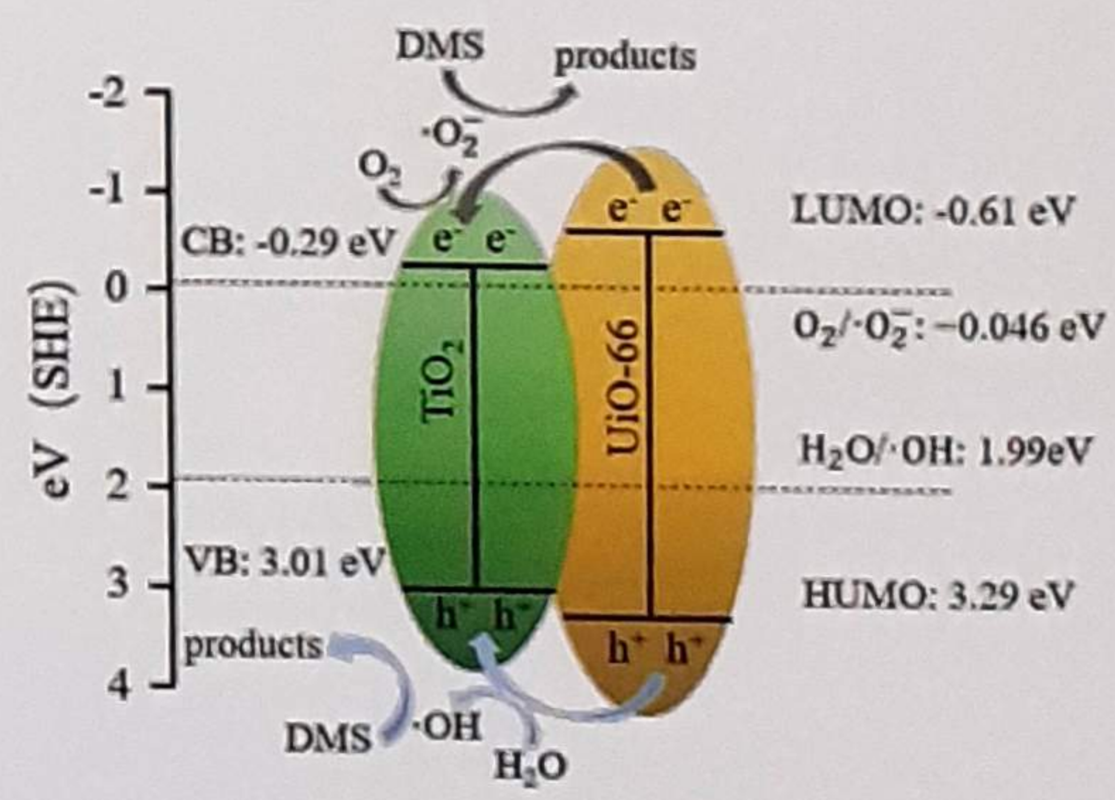


Figure 5. (a) The converted Tauc plot of $(\alpha h\nu)^2$ versus photo energy ($h\nu$); (b) The Mott-Schottky diagrams of UiO-66.



Scheme 1. Proposed degradation mechanism of DMS over UiO-66@TiO_2.

Conclusions

Acknowledgement /

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UiO-66@TiO_2 had the best performance, and the DMS degradation efficiency could reach 99% in 80 min and was 17.8 times higher than that of UiO-66 alone. Thanks to the super large specific surface area of UiO-66, the prepared catalyst can effectively adsorb pollutants and intermediate products to achieve the purpose of deep mineralization. In addition, the TiO_2 layer and UiO-66 form a heterojunction, which can effectively broaden the light absorption range and improve the utilization of photo generated electron-hole pairs. This research can provide reference for the design of core-shell structured MOF@TiO_2 and photocatalytic purification of odor gas from livestock.