

## **Oxygen deficient semiconductors for artificial photosynthesis**

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Photocatalytic solar fuels production represents one of the most potential strategy for replacing the dying-up fossil feedstocks and dealing with the environmental problems caused by the combustion of fossil fuels. However, this technology has not been widely applied because of its low solar energy conversion efficiency which is usually limited by the microstructure and the electronic structure of the semiconductor photocatalysts. After more than 10 years studies on this area, we found well designed defect-rich atomic scale materials have peculiar advantageous as high performance photocatalysts for  $N_2$  or  $CO_2$  reduction under ambient conditions. Here we systematically present a discussion in detail on the relationship between the crystal microstructure, the electronic structure and the photocatalytic performance which is apparently affected by the light response, charge carrier separation/migration, and reactants activation etc. The material is focused on atomic scale bismuth, tungsten, and molybdenum based semiconductor material. Their facile synthesis process will also be introduced.