Fabrication of bismuth-rich $Bi_3O_4Br_xI_{1-x}$ solid solutions for improved photocatalytic N_2 fixation in pure water

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Abstract:

As an alternative to the Haber-Bosch process, photocatalytic N_2 reduction under ambient condition is a reassuring strategy for energy conversion and storage. This work developed a novel bismuth-rich $Bi_3O_4Br_xI_{1-x}$ solid solution photocatalyst for N_2 fixation under ambient conditions. The results show that $Bi_3O_4Br_{0.5}I_{0.5}$ exhibits the best activity, 6.308 mmol/L.g, without using any sacrificial agent. The presence of oxygen vacancies in the fabricated samples was evidenced by XPS spectra. The bandgap of the photocatalysts became narrower by changing the ratio of Br/I from 1 to 0.25 in $Bi_3O_4Br_xI_{1-x}$ samples, and the morphology was shifting nanosheets to nanorods structure. BET and TPD-N_2 analysis show that $Bi_3O_4Br_{0.5}I_{0.5}$ provides not only the higher surface area available for the photocatalytic reaction and but also offers the higher N_2 adsorption and active sites. $Bi_3O_4Br_{0.5}I_{0.5}$ shows better separation of photogenerated electron-hole pairs compared to other samples based on photoelectrochemical analysis. Furthermore, $Bi_3O_4Br_{0.5}I_{0.5}$ shows an excellent structural stability in photocatalytic N_2 fixation. A reaction pathway of the photocatalytic N_2 fixation process was proposed for based on the above analysis. This research opens a new way to develop high-performance photocatalysts for ammonia generation.