Ternary titanium-oxo cluster/CdS/MIL-101 photocatalyst for H_2 evolution

Subject Code: B01

Photocatalytic hydrogen evolution by water-splitting has been recognized as one of the most promising solutions to the global energy and environment crisis, owing to its renewable solar energy source and clean chemical fuel product. Cadmium sulfide (CdS) and TiO_2 (or related polyoxo-titanium clusters) are two of the most widely applied photocatalytic materials for water splitting. However, due to the fast recombination of photogenerated electron-hole pairs, the serious photocorrosion and the lack of catalytic sites, the activities and applications of pure CdS have been greatly obstructed. On the other hand, the applications of Ti-O materials have unfortunately been limited in the UV light range ($<5\%$ of the solar spectrum) due to their large bandgap.

With the support by the National Natural Science Foundation of China, the Research Team of Synthetic Inorganic Chemistry led by Prof. Zhang Jian (张健) and Prof. Zhang Lei (张磊) from the State Key Laboratory of Structural Chemistry at Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, has successfully developed a stepwise-loading strategy to assemble the above two star materials into a porous matrix (MIL-101) to form ternary photocatalysts with improved H_2 evolution activities, which was published in *Advanced Materials* (2017, 29, 1603369). The close synergistic effect between the three components helps to maximize the strength of each, and overcome their respective inherent shortcomings. Under visible light irradiation, CdS nanoparticles produce photogenerated electrons, PTCs transfer the generated electrons to MIL-101, and finally the porous MIL-101 provides plentiful catalytic sites to produce H_2. Attributed to the above catalytic mechanisms, the obtained ternary PTC/CdS/MIL-101 composites show excellent H_2 production activities even in the absence of noble metal co-catalysts. Moreover, the H_2 evolution activities of these ternary photocatalysts can be further tuned by changing the functional organic ligands in PTCs.

This work confirms that polyoxo-titanium clusters can activate the multiplers to effectively improve the photocatalytic activity of the CdS/MIL-101 system, which not only enriches the future applications of polyoxo-titanium clusters but also supplies an efficient molecular tool to enhance and tune physical properties of composite H_2 evolution materials.

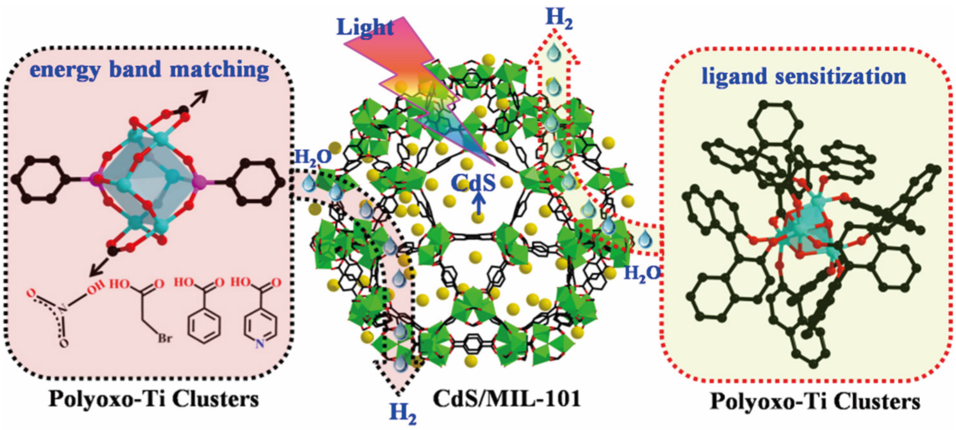

Figure Construction of ternary PTC/CdS/MIL-101 photocatalysts with efficient H2-evolution activities.