Novel 2D materials as photocatalyst in artificial photosynthesis

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Abstract

Formation of hydrocarbon from carbon dioxide via artificial photosynthesis is a new and developing alternative energy for solving the environmental energy issue which has gradually been emphasized seriously. In this research, the most promising 2D materials transition metal dichalcogenides (TMDs) are used as a photocatalyst for the reduction of CO_2. This experimental was prepared by a two-step synthesis method. First, the thermal evaporation is applied to control the thickness of the tungsten precursor. Second, WS_2 film is formed by chemical vapor deposition. In this study, the characteristics of the elements and optical properties of the WS_2 film were analyzed, and then the gas chromatography flame ionization detector (GC-FID) was used to analyzed the product. The yield of pure WS_2 film was limited.

In order to improve to performance MoS_2 was added to form a heterostructure with WS_2. By this modification, it can effectively separate the electron-hole pairs and suppress the charge recombination. There are more carriers which can diffuse to the surface and involve in CO_2 reduction. It can effectively increase the quantum efficiency of CO_2 reduction reaction by nearly four times. At the same time, the XPS measurement is applied to prove that MoS_2/ WS_2 and WS_2/ MoS_2 heterostructure are both Type-II structures. The band alignment diagram of these two heterostructure systems are also complied by XPS and KPFM. By this study, it can be proved that the use of Type-II heterojunction structure can effectively improve the efficiency of photocatalytic CO_2 reduction.

Keywords - photocatalyst, heterostructure, transition metal dichalcogenides, artificial photosynthesis