Synthesis of Topological-Insulator Enhanced Heteronanostructure for Bifunctional Water Splitting

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Hydrogen energy is clean energy that would solve the current ecological problems while it is limited by consumption of noble metals. Transition metal dichalcogenides are very potential for replacement if their conductivity and activity can be well increased. Topological insulator (TI) presents unconventional property due to its nonsymmorphic topological order, leading to insulator in bulk but conductive on surface. To improve their performance effectively, I developed a one-step solution synthetic route via modification of literature and synthesized TI-enhanced van der Waals heteronanostructures of Bi2Se3-MoSe2 typically. The heterostructures were formed successfully through an in situ intergrowth in the route and there was electron injection from Bi2Se3 to MoSe2 besides increase of active site and stability in interface due to entropy contribution, which would be favorable for electrocatalysis. Actually, the heterostructures effectively favored both hydrogen and oxygen evolution reaction. In the same electrolyte, the heterostructures required an applied potential of 1.75 V to maintain current density of 10 mA/cm2, which was largely smaller than that of MoSe2 (1.87 V), Bi2Se3 + MoSe2 (1.92 V) and Bi2Se3 (> 2.50 V). The applied potential can be reduced to 1.66 V with integration of cobalt-component. This study generally reduces complexity in fabrication of heterostructures and is very potential for fabrication of TI-enhanced multifunctional non-noble-metal catalysts. In the next step, I will continuously keen on the improvement of procedures to reduce applied potential and increase efficiency for this new kind of catalysts.