Photochemical Hydrogen Evolution using Inorganic Catalyst

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Recent interest of researchers is conversion of the almost unlimitedly available energy of sunlight into non-fossil-based energy carriers such as hydrogen using water as the hydrogen source. The photoinduced cleavage of water using visible light is under intense investigation with the aim to develop an efficient method for converting solar radiation into a convenient and sustainable fuel. Photocatalytic water splitting into hydrogen and oxygen has inspired researchers all over the world to develop novel and economical photocatalysts for this reaction [1-3]. Due to complexity of the multi-electron processes during water reduction and/or oxidation, the two half reactions water oxidation and water reduction can be studied separately employing sacrificial reagents (SR) that donate or accept electrons in the catalytic system. With respect to the water reduction catalysts (WRCs), to date most work has focused on noble metals such as rhodium, palladium, or platinum. Notably, cobalt-based WRCs with different oxime ligands resulted in high TONs up to 2100 in a Pt PS/Co WRC system and Rh WRC employing an Ir PS impressive turnover number (TON) of 5000 was reported [4].

Herein, we report first hetero polyoxometal as an efficient system for homogeneous reduction of water to hydrogen using Co₅POM; as simple, cheap, readily available, and abundant metal for WRCs; and EDTA as SR. Clearly, the development of cobalt-based catalysts as a substitute for noble metals is a major topic in catalysis. This complex is a hydrolytically stable homogeneous water reduction catalyst that synthesis by hydrothermal method in water from salts of earth abundant elements (Co, W and P) and characterized with different methods (x-ray, Ft-IR, UV-vis, TGA and elemental analysis). With [Ru(bpy)₃]³⁺ (bpy = 2,2’-bipyridine) as the photo synthesizer, methylviologen as relay, we observe quantum efficiency 13 for H₂ production. Extensive spectroscopic and electrochemical studies and also reusability firmly indicate that catalyst is stable under catalytic turnover conditions also neither hydrated cobalt ions nor cobalt particles form in situ.

REFERENCES