Artificial Photosynthesis: Novel Visible Light Response and Formic Acid Generation from Carbon Dioxide Using Tantalum Oxide/Tantalum Plate

Wu, Huiyi (School: Timber Lake High School)

In order to realize a sustainable society, artificial photosynthesis has been gaining attention and has been widely studied in recent years. This research focused on tantalum oxide, which can be used to catalyze the reduction of carbon dioxide. In this study, it was found that tantalum oxide/tantalum plate responds to visible light, and this is a novel phenomenon. The objective of this research was to investigate the mechanism of this phenomenon and to make tantalum oxide/tantalum plate with a high energy conversion efficiency. The study consisted of four experiments, as follows: (i) a tantalum plate was heat-treated while varying the time, temperature, and type of gas, (ii) the voltage and electric current were measured under optical irradiation, (iii) the wavelength dependence was checked using visible light, (iv) the electric potential of the conduction band was measured using a potentiostat, and the reduction of carbon dioxide to formic acid by tantalum oxide/tantalum plate was checked. Three primary results were obtained: (i) the visible light response was not due to nitrogen doping but to other impurities in the metal and to the surface of tantalum oxide/tantalum plate, (ii) the thickness of tantalum oxide film was an important factor influencing the energy conversion efficiency, and (iii) formic acid was successfully generated from carbon dioxide. In future experiments, the ability of tantalum oxide/tantalum plate to reduce carbon dioxide efficiently using sunlight will be examined. The energy conversion efficiency will be improved and the material will be applied as a practical solution to environmental problems.

Awards Won:

Second Award of $2,000