A novel chloroplastmimic photovoltaic powered by proton motive force

Gou-Jen Wang
Department of Mechanical Engineering, National Chung-Hsing University, Taiwan
Institute of Biomedical Engineering, National Chung-Hsing University, Taiwan

Abstract

Chloroplasts are regarded as the most effective plants for the conversion of sunlight to energy. They seize energy from the sunlight to produce free energy via photosynthesis which is stored as adenosine 5’-triphosphate (ATP) and nicotinamide adenine dinucleotide phosphate (NADP). Photosynthesis is an important biochemical process by which plants transform light energy from the sun into chemical energy. During photosynthesis, ATP is synthesized by an ATP synthase enzyme by using the chemiosmotic potential across the thylakoid membranes of the chloroplasts. Hydrogen ions formed as a product of the photolysis of water by the chlorophyll contribute to the transmembrane chemiosmotic potential.

In this study we present a novel and very simple chloroplastmimic photovoltaic method. This method operates based upon a photolysis induced hydrogen ion concentration gradient. We are simultaneously able to generate electricity and hydrogen. The proposed photovoltaic device, shown in Fig. 1, is comprised of three components: a water-containing electrochemical bath which acts as the photovoltaic body, artificial chlorophyll which is used to photolyze the water and generate hydrogen ions, and an artificial thylakoid membrane which separates the bath into two cells to produce the hydrogen ion concentration gradient.

Figure 1. Chloroplastmimic photovoltaic device that operates based on the photolysis induced hydrogen ion concentration gradient

The experimental results demonstrate that the proposed simple chloroplastmimic photovoltaics process can produce a photocurrent and hydrogen directly from visible light using only pure water and a photocatalyst.