PHOTOELECTROCHEMICAL HYDROGEN PRODUCTION PROTOTYPE

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There is a global need for a reliable, renewable source of energy. Currently, conventional energy sources are primarily derived from fossil fuels which are nonrenewable, emit pollution and greenhouse gases, and are largely imported. Therefore, a new source of energy needs to be developed and implemented into society that is renewable, does not emit pollution, and can be created locally. Hydrogen is expected to play a key role in the future of renewable resources. Through the use of fuel cells, energy can be generated from hydrogen with no pollutants and with water as the only byproduct. Although hydrogen is in abundance, it is not easily accessible with today's technology. The purpose of our project is to develop a Photoelectrochemical (PEC) cell that can readily produce hydrogen by only using solar power and water.

We are working on a proof of concept model of a PEC cell. Research has been done on each type of PEC cells. Using this, we have concluded that the model with two streams of water as the input and separate streams of oxygen and hydrogen as the outputs is the most effective model. We have also analyzed all of the components of this specific model. The most common semiconductor in use is a gallium arsenide / gallium indium p-n junction. This is not the optimal semiconductor because it is toxic, corrosive and not commercially available. We have found that there are not any semiconductors commercially available that will meet all the specifications needed for the effective splitting of water (ie, not corrosive, immersible in water, and have the correct band gap). Therefore, it has become necessary to separate the photovoltaic material from the electrolysis portion of the PEC. A photovoltaic cell has been chosen that will hopefully be able to be integrated into the system once the technology of a non-corrosive permeable substrate is developed.

We are also doing research on how nanotechnology can be implemented into a PEC cell. Titanium dioxide is stable in water as a semiconductor; however, it does not have the necessary band gap. It has been found that by doping titanium dioxide with nitrogen, the band gap created is effective for the splitting of water. Nitrogen-doped titanium dioxide nanoparticles will be more efficient (in theory) because of their immense amount of surface area. We are working on perfecting the procedure for synthesizing these particles. In the future, they may be implemented into the PEC as the substrate on the semiconductor that is not corrosive. Furthermore, the properties of these nanoparticles may also lead to a nano-sized system that splits water independently of other materials.

The PEC is part of a larger Photoelectrochemical Hydrogen Production Prototype (PHPP). The components of this system have been determined and will be integrated to create a working system that will ultimately store the created hydrogen. This project will culminate in the optimization of this process to produce hydrogen that is renewable, readily available, and pollutant-free.