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QSI-Nano™ Science Chat

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Using Nanotechnology To Produce Clean Energy from Water

As the world population climbs toward 6.5 billion, the demand for energy will only increase over time. Our non-renewable global oil reserve will eventually deplete, forcing us to look for viable alternatives. In addition, environmental impact awareness of burning such fuels has grown, further propelling our search for clean, efficient fuel.

The hydrogen fuel cell is widely viewed as a viable alternative to combustion engines. Hydrogen is a renewable fuel that produces zero emissions when used in a fuel cell. But where does the hydrogen come from? Nearly 50% of the hydrogen currently being produced is made by steam reformation, where natural gas is reacted on metallic catalyst at high temperature. While this process has the lowest cost, four pounds of the greenhouse gasses carbon monoxide (CO) and carbon dioxide ($CO_{2)}$ are produced for every one pound of hydrogen. Without further purification (which can also be costly) to remove CO and CO_2, the hydrogen fuel cell cannot operate efficiently, so we are back to the original problem.

On the other hand, roughly 5% of hydrogen production is from water electrolysis. This reaction is the direct splitting of water molecules to produce hydrogen and oxygen. There are two reactions; the negative electrode produces hydrogen and the positive electrode produces oxygen.

$$2H_2O \longrightarrow O_2 + 4H^+ + 4e^-$$

$$4H_2O + 4e^- \longrightarrow 2H_2 + 4OH^-$$

Note that greenhouse gasses are not produced in these reactions. Unfortunately, this process is currently too expensive to compete with steam reformation. Despite a higher theoretical efficiency than steam reformation, the overall efficiency of an actual system is still low due to the cost of platinum catalyst and electricity.

The cost of water electrolysis can be mitigated by using alternate catalyst systems (QuantumSphere's nanometals and alloys are 80% cheaper than platinum catalyst). Nanometals, by virtue of their tiny size and increased surface area and catalytic activity, can potentially increase the amount of hydrogen produced. Initial studies indicate that QSI-Nano™ Nickel has vast performance enhancement over micron-sized particles. By pressing and heating the nanometal powders into a wafer, a highly porous electrode is produced. Utilizing this 3-D reaction area, water can penetrate the electrode and essentially "sees" more metal surface area

to react upon. A brief diagram of the experiment is shown below. By using nanometal electrodes, larger amounts of pure hydrogen and oxygen are produced, which can be collected by various methods and used directly in a fuel cell.

Here's how the process works: