**Literature Review**

Steinfelda, et.al (1998) reviewed the limitations and the benefits of SOFCs in relationship with energy, environment and sustainable development. Steinfelda, concluded at the time that “the generation of energy by clean, efficient and environmental-friendly means is now one of the major challenges for engineers and scientists.” (1998, p.2834).

Explanation at <http://pittayakom.weebly.com/referencing.html>

In order to achieve cheap and efficient fuel production, such as solar hydrogen production or electricity through photochemical solar cells, Kamat suggests three major ways to utilize nanostructures for the design of solar energy conversion devices. These included mimicking photosynthesis with donor−acceptor molecular assemblies or clusters, semiconductor assisted photocatalysis to produce fuels such as hydrogen, and nanostructure semiconductor based solar cells. Kamat (2007, p.2834) concluded that the emergence of nanomaterials as the new building blocks to construct light energy harvesting assemblies has “opened up new ways to utilize renewable energy sources.” Kamat (2007) said there three major ways to utilize nanostructures for the design of solar energy conversion devices. These were “(1) mimicking photosynthesis with donor−acceptor molecular assemblies or clusters, (2) semiconductor assisted photo catalysis to produce fuels such as hydrogen, and (3) nanostructure semiconductor based solar cells.” (Kamat, 2007, p.2834).

 Stambouli and Traversa (2002) developed fuel cells which converted chemical energy of a fuel gas directly into electrical work, and were “efficient and environmentally clean, since no combustion is required.” (2002, p.433). Bicelli and Peraldo (2003) stated that hydrogen has been considered as a “clean” energy source and carrier and discussed in comparison with present day energy sources mainly based on fossil fuels and nuclear energy. (Bicelli and Peraldo , 2003, p.555).

Spivey (2005) concluded, there are essentially three approaches to the use of fossil fuels to meet this challenge: (1) Lower emission technologies: more usable Btu/lb. emission; (2) Higher efficiency: more usable Btu/Btu fuel ;(3) “Renewable” energy: usable Btu without consuming non-renewable fossil fuel. (pp171-180.). Steinfelda, Kuhn, Palumbo, Murray and Tamaura (1998) said that. There is a two-step solar thermochemical cycle and process for the production of hydrogen. The first step is based on the thermal. High temperature highly endothermic reactions that can be driven by concentrated solar energy. The second step involves hydrolysis reactions. (pp767-774.).

From **3.2.4 APA Handbook for Dissertation.pdf** at <http://pittayakom.weebly.com/student-zone.html>

**References**

Bicelli, Peraldo L. (2003). Hydrogen: A clean energy source. *International Journal of Hydrogen Energy. 11(9),* 555-562

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Spivey James J. Y.(2005). Catalysis in the development of clean energy technologies. *Catalysis Today. 100(1-2),* 171-180

Stambouli, Boudghene A., Traversa E. Y. (2002). Solid oxide fuel cells (SOFCs): a review of an environmentally clean and efficient source of energy. [*Renewable and Sustainable Energy Reviews*](http://www.sciencedirect.com/science/journal/13640321)*. 6(5),* 433-455.

Steinfelda, A., Kuhn P., Reller, A., Palumbo, R., Murray, J., and Tamaura, Y. (1998). Solar-processed metals as clean energy carriers and water-splitters. *International Journal of Hydrogen Energy. 23(9),* 767-774.

**Extra notes**

Stambouli and Traversa (2002) Fuel cells convert chemical energy of a fuel gas directly into electrical work, and are efficient and environmentally clean, since no combustion is required. In particular, attention is given to the design and operation of Solid Oxide Fuel Cells (SOFCs), noting the restrictions based on materials’ requirements and fuel specifications. Moreover, advantages of SOFCs with respect to the other fuel cell technologies are identified. (pp433-455.)

Steinfelda, Kuhn, Palumbo, Murray and Tamaura (1998) said that. There are Two-step solar thermochemical cycles and processes for the production of hydrogen. The first step is based on the thermal. High temperature highly endothermic reactions that can be driven by concentrated solar energy. The second step involves hydrolysis reactions. (pp767-774.).

Bicelli and Peraldo (2003) reviewed; hydrogen has been considered as a “clean” energy source and carrier and discussed in comparison with present day energy sources mainly based on fossil fuels and nuclear energy. In particular, the environmental and safety issues, such as those due to nuclear wastes, acid rain and carbon dioxide, have been considered. Conventional as well as advanced methods of hydrogen production have been examined, attention drawn to direct hydrogen production from alternative energy sources. (pp555-562)

Spivey (2005) reviewed catalysis is the development of clean energy conversion processes. There is a clear relationship between energy use and our standard of living, creating an ever increasing demand for affordable energy. At the same time, environmental considerations require that this energy be generated and used with minimal impact on our surroundings.

 Spivey concluded, there are essentially three approaches to the use of fossil fuels to meet this challenge:

(1) Lower emission technologies: more usable Btu/lb emission;

(2) Higher efficiency: more usable Btu/Btu fuel;

(3) “Renewable” energy: usable Btu without consuming non-renewable fossil fuel.

Catalysis can and will play a central role in each of these approaches. (pp171-180)

**Websites**

Kamat, Prashant V. (2007) Nanostructure Architectures for Solar Energy Conversion. The Journal of Physical Chemistry. 111 (7), pp2834–2860.

url: [*http://pubs.acs.org/doi/abs/10.1021/jp066952u*](http://pubs.acs.org/doi/abs/10.1021/jp066952u)

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