Photoelectrochemical Solar Energy Conversion: Principles, Practice and Current State-of-the-Art

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Semiconductor/liquid junctions provide the most efficient wet chemical method presently known for converting solar energy. Using these junctions, solar energy can be converted to either chemical or electrical energy, or even a combination thereof. These devices have been studied for over forty years and significant progress has been made in the attainment of high process efficiencies. This talk will provide a historical perspective as well as a review of the current state-of-the-science in liquid-junction solar cells and photoelectrochemistry. The principles behind the operation of such systems will be first discussed and compared with their solid-state counterparts. Photoelectrolysis cells will be described as well as hybrid devices for converting solar energy and storing it in situ.

Semiconductor/liquid junction cells will be compared and contrasted with other methods that have been considered for solar energy conversion including photogalvanic cells and homogeneous or colloid-based chemical systems. Multi-junction cells, designed to optimize the wavelength response and absorption overlap with the solar spectrum, will be described.

Advances in our fundamental understanding of several of the underpinning aspects of liquid-junction solar cells (e.g. electron-transfer kinetics) will be reviewed. Finally, cells based on mesoporous electrode assemblies and dye-sensitization approaches will be described along with the use of quantum dots for solar energy conversion.

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