Solar Asia 2018 Int. Conf. National Institute of Fundamental Studies, Kandy, Sri Lanka, 4-6 January 2018

SOLAR CELL RESEARCH: CONCEPTS AND MATERIALS

K. TENNAKONE*[1], A.G.U. PERERA [1], L.A. DE SILVA[2] AND G.R.A. KUMARA[3]

[1]*Department of Physics, Georgia State University, Atlanta GA 30303, USA*
[2]*Department of Physics, University of West Georgia, Carrollton, GA 30118, USA*
[3]*National Institute of Fundamental Studies, Sri Lanka*

Corresponding author, e-mail: *ktenna@yahoo.co.uk*

ABSTRACT

Solar cell research evolves in two directions, different concepts to achieve uphill charge separation and drive an electric current through an external circuit and finding new materials to improve the designs. Goal has been either to enhance the efficiency or reduce the cost of production developing cheaper environmentally benign procedures.

Discovery of photoelectric effect and its explanation was the beginning of photovoltaic science. Since then the materials sector moved from selenium to cuprous oxide and cadmium sulfide. Having understood the mechanism of the photovoltaic diode, the thermodynamic efficiency of a single junction cell was derived and new materials, silicon, gallium arsenide cadmium telluride paved way for higher efficiencies. Alternative approaches, photoelectrochemical cells and their dye-sensitized versions and organic photovoltaics received fresh attention, when the urgency of preparation for a future energy crisis was widely anticipated. The next development was solar cells adopting nano-structured materials and extensive investigations to boost the efficiency and stability of the titanium dioxide based dye-sensitized solar cell. The concept of the dye-sensitized solid-state solar cell, suggested earlier to the popular electrochemical version gained serious consideration once functioning models based on cuprous iodide and cuprous thiocyanate were demonstrated. The next conceptual advancements, was extremely thin absorber solar cell first demonstrated with selenium as light harvester and subsequent use of organic lead iodide perovskites absorbers achieving landmark laboratory efficiencies. The concurrent developments in the area of bulk heterojunction and quantum dot systems also invoked new ideas and nano –structuring of materials. Despite worldwide research effort, none of the so-called nano-solar cells have reached the level of widespread commercialization. Contenders are still single crystalline silicon and polycrystalline cadmium telluride and costly gallium arsenide for limited advanced application. Problems of nanostructured solar cells and possibilities of remedying them will be discussed, highlighting fundamental constraints and practical issues.