SOLAR ENERGY AND SOLAR CELLS FOR FUTURE ENERGY NEEDS

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Sun is the mass energy producer to the whole planetary system including the earth. Sun's energy is mediated via the solar radiation. It is in the form of heat and light. Sun is a gaseous sphere of hydrogen and helium. These gases are held inside the sphere due to strong gravitational forces exerted by the sun. So these hydrogen atoms tend to fuse into helium by nuclear fusion and by that solar energy is created at the core of the sun as the matter converts into solar energy during the nuclear fusion process. Finally, this energy is radiated into space as electromagnetic radiation as photons [1]. The amount of energy falls on to the earth is given by the **solar constant** which is approximately 1367.7 Wm^{-2}. However, when solar radiation passes through the earth's atmosphere, it acts as a filter absorbing some harmful radiation at the higher end of the electromagnetic spectrum such as gamma, x-rays and ultra-violet energy. Also, some part of the solar radiation is reflected away from the earth by the clouds and the sea leaving about space 1 kWm^{-2} of energy to reach the surface of the earth. However, insolation levels of specific locations of solar radiation depend on the latitude and longitude, time of the year and weather patterns. The countries located near the equatorial belt including Sri Lanka have high insolation levels. Higher the insolation more energy can be generated.

Solar cell is the device which has being used all over the world to generate energy from the solar radiation. It simply takes the photon energy and converts it to electricity by photovoltaic effect. The normal commercial solar modules consist of 72 cells and this number can be varied from manufacturer to manufacturer. These individual cells are connected in series and placed into a frame. Then protecting coating is introduced to the panel and this coating sometimes enhances the efficiency of the panel. Solar panels are rated based on the standard assumption of 1,000 Watts (= 1 kilowatt or 1 kW) per square meter of sunlight strikes the panel perpendicular to the panel (at a temperature of 25˚C) [1]. This rating typically is shown on the manufacturer's data sheet as the maximum power or abbreviated as kWp (where p stands for peak or maximum kilowatts of electricity generated under the standard peak conditions).

The conventional solar cells are fabricated using silicon. Still they are the most abundant solar panels used in residential applications. There are variety of silicon solar panels such as monocrystalline silicon cells, polycrystalline silicon cells and amorphous silicon cells. Out of these solar cells, monocrystalline solar cells perform well giving around 24% efficiency value. But the initial cost is large due to its complex fabrication techniques. Moreover, these solar cells tend to decrease their efficiency values with the increase of temperature. However, the manufacture cost is reduced when it comes to polycrystalline and amorphous silicon solar cells as these solar cells do not need high pure silicon wafers. The efficiency values of these solar cells are lowered compared to monocrystalline solar cells but the durability with temperature is better than the monocrystalline silicon solar cells. Next, thin film solar cells appeared as the second generation of solar cells. Here direct band gap semiconductor materials such as cadmium telluride (CdTe) and copper indium gallium diselenide (CIGS) are used and these thin film solar cells have only a few micrometer thicknesses. The

combination of less material and easy fabrication techniques have reduced the initial cost of this type of solar cells than the silicon based solar cells and their efficiency values are around 16% [2].

The newly emerged dye-sensitized solar cells also play a major role in today's photovoltaic industry as it can be fabricated using simple fabrication techniques using inexpensive materials [3]. Many studies have been carried out all over the world to enhance their efficiency values by introducing new semiconductor materials, new electrolytes and sensitizers. Currently it gives around 12% efficiency value.

As our country has a constant solar radiation throughout the year we have the potential to use solar energy to fulfil our energy needs. By constructing solar panels using easy fabrication techniques and abundant materials such as TiO_2 as used in dye-sensitized solar cells, the government would be able to supply electricity with a reduced cost to rural areas. Therefore, Sri Lanka has to do more studies on solar cell technology in order to face the future energy crisis.

References

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3. B. O'Regan, M. Grätzel, A low-cost, high-efficiency solar cell based on dye-sensitized colloidal TiO_2 films, Nature 353 (1991) 737-740.