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Solar Energy's importance and Role in Advancing Society

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Abstract:
The nation is facing energy crisis at faster rate. To meet this crisis, it is the prime need of the day to seek out an alternative source of energy. Conventional and non-conventional are the two sources for obtaining different types of energy. The conventional sources are fossil fuels such as gases, oils, coals, woods etc. and non-conventional sources are wind, bio-mass, ocean tides, geothermal and solar energy. More attempts are being applied to harness the solar energy by different technologies. This energy is available in vast amount and nonpolluting and harmless to the common creatures. The amount of solar energy received on the earth per sec is 1.353 KW/m^2. This energy is converted into electrical energy by using dry and wet solar cells. The present paper deals with the characteristics of the solar cell which is the major candidate for converting solar energy.

Keyword: Solar energy, conversion efficiency & energy band gap etc.

1. Introduction

All the conventional energies are being consumed at such a faster rate that the world is going to face severe energy crisis very soon. So it is the crying need of the day to search out an alternative source of energy: (i) Conventional (ii) non- conventional. The conventional sources of energy are fossil fuels such as natural gases, oils, coals, woods etc. These are being consumed day to day in our various uses at a tremendous rate with the growth of industries and various technologies being developed in our countries and in the world too. To meet this crisis we have to quest for non-conventional sources of energies. The non-conventional energies are nuclear energy, wind energy, Bio mass energy and vast solar energy. In our country also attempts are being made to recover non-conventional energies from wastes, garbage's, human and animal excreta. Out of various sources, it is easy to harness the solar energy which is available to us in vast amount. It is also non-polluting form of energy. Nearly 1.353 kw/m^2 solar energy is received on the earth. We have to transform solar energy into electrical energy and its further use in chemical and other form of energy. This transfer of energy can be achieved by the help of solar cell and its further use in electro-chemical cell which can be called photo electrochemical (PEC) solar cell. Sun is long term natural resource. The solar cell is considered a major candidate for obtaining energy from sun, as it can convert sunlight directly to electricity with high conversion efficiency. Solar cell can provide nearly permanent power at low operating cost and free from pollution. Recently, research and development of low cost, flat panel solar cells, thin film devices, concentrator system and many

innovative concepts have increased. In near future, the cost of smaller solar power modular units and solar power plants will be feasible economically for large scale industrial use of solar energy. Solar cell was first developed by Chapin, Fuller and Pearson in 1954 using defused Si pn-junction.

2. Ideal Conversion Efficiency

A conventional solar cell, such as pn- junction, has a single band gap (E_g). When the sun is exposed to solar radiation, a photon with energy less than E_g makes no contribution to the cell output. A photon with energy ($h\upsilon$) greater than E_g contributes energy to the cell output, and the excess over E_g is wasted as heat. To derive the ideal conversion efficiency energy band diagram of a pn- junction under solar radiation is considered fig-1. The I-V characteristics of such a device is given by

$$I = I_S (e^{qv/kt} - 1) - I_L \quad \text{----------(1)}$$

For I_L = 100 mA, I_S = 1 nA (T =300^{0}K)

The I-V characteristic curve is plotted as below fig -2

The curve passes through the fourth quadrant and thus, power can be extracted from the device. By properly choosing a load, nearly 8% of the product V_{OC} I_{SC} can be extracted.

V_{OC} = open circuit voltage

I_{SC} =short circuit current

Maximum power output, $P_{out} = I_m V_m$

The ideal convention efficiency (η) is defined as the ratio of maximum power output to the incident power P_{in}

$\because \eta = P_{out}/ P_{in}$

The ideal conversion efficiency (at 300^0 k) is a function of energy band gap.

for E_{g1}= 1.56 eV to E_{g2} = 0.94 eV, η is 50 %.

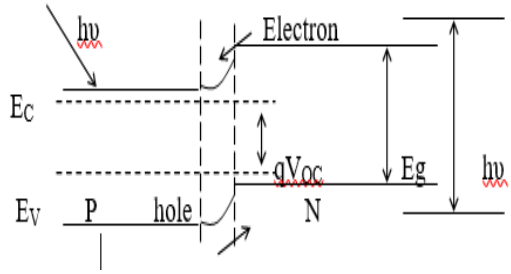

Fig-1 Energy band diagram of a pn-jn solar cell

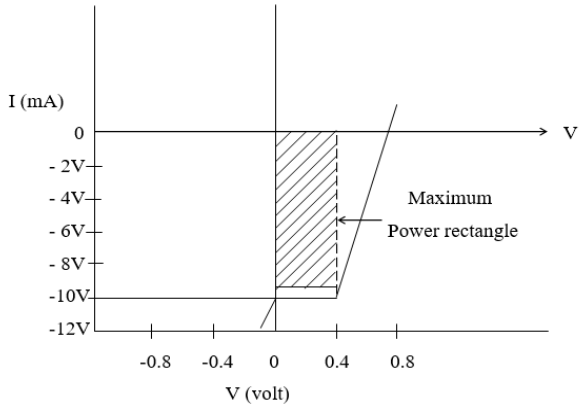

Fig -2 I-V Characteristics of a solar cell

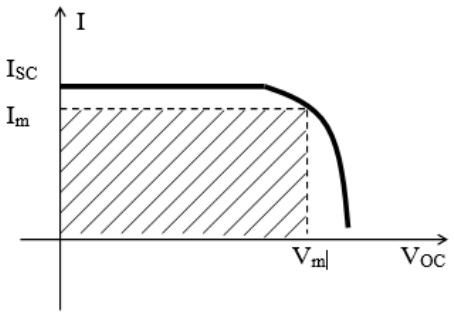

Fig 2.a Inverted I-V Characteristic curve of a solar cell

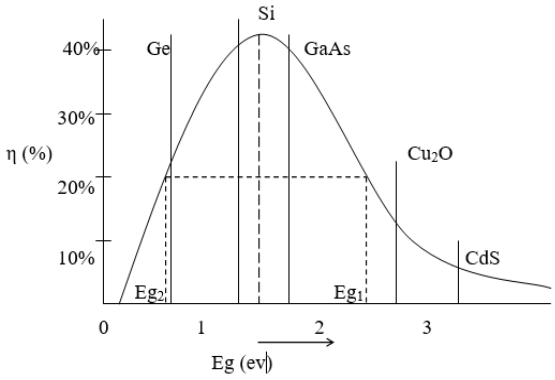

Fig 3 Band gap Efficiency curve

3. Dependence of characteristic factor on energy band gap and conclusion

The characteristic factor (conversion efficiency) depends on energy band gap for silicon and gallium arsenide the efficiency is maximum and minimum for germanium and cadmium sulphide as shown in fig 3. Thus, for designing solar cells selection of energy band gap and materials are very important. This is why silicon solar cell is widely used and technically developed solar device. Silicon is chemically stable and yields long life potential cells on earth having efficiency 10% nearly. The cost of production is also not very high and it can be developed on commercial level for the common people also which will meet the energy crisis.

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