

SOLAR CELL: FUNDAMENTAL PERFORMANCE LIMITATIONS

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ABSTRACT

Solar cells are made from semiconductor material that have unique properties. Most of the semiconductor materials have properties potentially suitable for photovoltaic solar energy conversion. But not all types of semiconductor are suitable for solar cells. The fundamental limitations of solar cell is an obstacle for high efficiency solar cell. That is why most of the research in this field is concentrated on material for high efficiency solar panel. The only cells commercially available are prepared from single-crystal or large polycrystalline silicon. The first limitation in solar cells design is charge carrier generation by photon absorption. Only photons of energy equal to or greater than the band gap energy of the semiconductor can generate free electron-hole pair. The second is the current-voltage characteristic that results from the solar cell being a semiconductor device with a potential barrier.

TABLE OF CONTENTS

CHAPTER		PAGE
	Acknowledgement	i
	Abstract	ii
	Introduction	xii
1.0	SOLAR ISOLATION	
	1.1 Solar Spectrum	1
	1.2 Effects of the Earth's Surface	2
	1.3 The Role of Photovoltaic	4
	1.4 Photovoltaic Cost	5
	1.5 Energy Challenge	6
2.0	BASIC CONCEPT OF SOLAR CELL	
	2.1 Solar Energy	8
	2.2 Solar cell concept	9
	2.2.1 Fermi Level	12
	2.2.2 Junction Potential	13
	2.3 Materials for cell	15
	2.4 Cell Junction Types	17
	2.5 Manufacturing Processes	
	2.5.1 Silicon wafer preparation	19
	2.5.2 Epitaxy	20
	2.5.3 Vapour Deposition	21

1.0 SOLAR ISOLATION

The solar cell efficiency depends critically on the spectral distribution of the radiation coming from the sun. The knowledge of the exact distribution of the sunlight energy content is important in solar cell because these cells respond differently to different wavelength of light.

1.1 Solar spectrum

The source of solar energy is the sun. It radiates energy at rate approximately 3.8×10^{20} MW, with diameter about 865,400 miles and mass about 10^{24} tons². At maximum distance between sun and earth 94 % of the light energy reached on the earth's surface. It means that when the sun is closer with earth more light energy is bombarded the earth surface.

The sunlight that reached earth was faced with several obstacles that reduced the quality of the light in term of light power density per area (earth surface). It is called solar constant,

$$SC = 1.353 \text{ kW/m}^2$$

The position of the detector is just outside of the earth's atmosphere. This value is smaller when measured at sea level. Those obstacles such as light absorption by water vapor, ozone, and other constituents (cloud). All these factor reducing the energy density in sunlight at the earth's surface.

The sun is a complex radiator whose spectrum can be approximated by a 6050K black body. In outer space, 98% of the total energy radiated by the sun lies between 0.25 and 0.30 μm . Solar constant is defined as the rate at which energy is received on a unit surface, perpendicular to the sun's direction. The presently accepted value of solar constant is 1.353 kW/m^2 .