SNS COLLEGE OF TECHNOLOGY

(An Autonomous Institution)

COIMBATORE-35

DEPARTMENT OF MECHANICAL ENGINEERING

19MEZ402 Solar Photovoltaics Fundamentals And Technology

Unit 1-INTRODUCTION TO SOLAR PHOTOVOLTAICS

Electrical characteristics of the solar cell

The electrical characteristics of a solar cell are critical in determining its performance and suitability for various applications. Below are the key electrical parameters and characteristics:

1. Open-Circuit Voltage (Voc):

- **Definition:** The maximum voltage available from a solar cell when the circuit is open, meaning no current is flowing.
- **Significance:** Voc is determined by the material properties of the solar cell, particularly the bandgap of the semiconductor. Higher Voc values are generally better, indicating more efficient energy conversion.

2. Short-Circuit Current (Isc):

- **Definition:** The current that flows when the solar cell's terminals are shorted, i.e., when the external load resistance is zero.
- **Significance:** Isc is proportional to the amount of sunlight hitting the cell and the cell's ability to convert light into electricity.

3. Maximum Power Point (Pmax):

- **Definition:** The point on the I-V (current-voltage) curve where the product of current (I) and voltage (V) is maximized, indicating the maximum power output the cell can deliver.
- **Significance:** Pmax is critical for determining the efficiency of the solar cell.

4. Fill Factor (FF):

- **Definition:** The ratio of the maximum power output (Pmax) to the product of Voc and Isc. It is a measure of the "squareness" of the I-V curve.
- **Formula:** FF=PmaxVoc×IscFF = \frac{P_{max}}{V_{oc} \times I_{sc}}FF=Voc×Isc Pmax
- **Significance:** A higher fill factor indicates a more efficient solar cell. Typical values range between 0.7 to 0.85 for good-quality cells.

5. Efficiency (η):

- **Definition:** The ratio of the electrical power output to the incident light power on the cell.
- **Formula:** η=PmaxIncident Light Power\eta = \frac{P_{max}}{\text{Incident Light Power}}η=Incident Light PowerPmax

- **Significance:** Efficiency is the most important parameter for comparing solar cells. It indicates how well the cell converts sunlight into usable electrical energy.

6. Series Resistance (Rs):

- **Definition:** The resistance within the solar cell and its connections, which impedes the flow of current.
- **Significance:** Lower Rs values are desirable as high resistance reduces the overall efficiency of the solar cell.

7. Shunt Resistance (Rsh):

- **Definition:** A parallel resistance to the diode in the equivalent circuit of the solar cell.
- **Significance:** High Rsh values are desirable because low shunt resistance can cause leakage currents, reducing the efficiency.

8. I-V Characteristics:

- **Definition:** The current-voltage relationship of the solar cell, which is typically plotted as a curve.
- **Significance:** The I-V curve provides a visual representation of the solar cell's performance under different conditions. Key points on this curve include Isc, Voc, and the Maximum Power Point (MPP).

9. Temperature Coefficient:

- **Definition:** The change in Voc and Isc with temperature. Voc typically decreases with an increase in temperature, while Isc may increase slightly.
- **Significance:** Solar cells generally perform better at lower temperatures. This coefficient is important for understanding performance under different environmental conditions.

10. Quantum Efficiency (QE):

- **Definition:** The ratio of the number of charge carriers collected by the solar cell to the number of photons of a given energy incident on the cell.
- **Significance:** QE provides insight into how effectively the solar cell converts light into electricity at different wavelengths. It is closely related to the cell's overall efficiency.

Understanding these characteristics helps in optimizing the design and application of solar cells for various uses, from small-scale devices to large solar power plants.