PHOTOVOLTAIC CELLS AND THEIR ROLE IN ELECTRICAL ENERGY GENERATION

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Abstract: Photovoltaic cells are used to generate electrical energy from solar radiation. They are optoelectronic devices that serve as the main components of solar panels and photovoltaic energy systems.

Keywords: photovoltaic, solar energy, energy generation, optoelectronics, solar cells.

The photoelectric effect, or photoeffect, is a phenomenon that occurs when light or other electromagnetic radiation interacts with matter, causing the energy of photons to be transferred to the electrons of the material.

There are several types of photoelectric effects. Among them, the external photoelectric effect is of particular practical importance. The external photoelectric effect refers to the emission of electrons from a material under the influence of light or other forms of radiation. This phenomenon has found wide application in practice, one example being the photoelectric cell.

A photoelectric cell is an electrical device that absorbs incident light and generates an electric current (photocurrent) or a photoelectromotive force. Its operation is based on photoelectron emission, also known as the external photoelectric effect. A photoelectric cell operating on the principle of photoelectron emission consists of an electrovacuum device containing two electrodes—a photocathode and an anode—enclosed in an evacuated or gas-filled glass or quartz tube. When light falls on the photocathode, photoelectron emission occurs from its surface. If the circuit is closed, a photocurrent proportional to the intensity of the incident light is produced.

In gas-filled photoelectric cells, the photocurrent is amplified due to gas ionization and the formation of a non-self-sustained discharge. Photoelectric cells based on the internal photoelectric effect consist of semiconductor devices with homogeneous p–n junctions, heterojunctions, or metal–semiconductor contacts. In such devices, the absorption of optical radiation increases the concentration of charge carriers and generates an electromotive force[2].

Photoelectric cells are commonly used as detectors of radiation or light. Semiconductor photoelectric cells are employed in solar batteries and photoelectric generators to convert solar energy directly into electrical energy.

Photoelectric cells are widely applied in automation, telemechanics, photometry, measurement technology, metrology, astronautics, photography, cinematography, and many other fields.

Photovoltaic cells (solar cells) are devices used to convert solar energy directly into electrical energy. These cells utilize sunlight, where photons (light particles) excite electrons within the material, generating an electric current. Due to their ability to efficiently harness solar energy, photovoltaic cells are widely used in industrial facilities, residential buildings, and various other sectors.

Photovoltaic cells can be classified into several types, mainly according to the materials from which they are fabricated. Monocrystalline photovoltaic cells offer the highest efficiency and are manufactured from single-crystal silicon structures. They have a long service life and a high capacity for energy production.

Polycrystalline photovoltaic cells have slightly lower efficiency compared to monocrystalline cells; however, their production costs are lower. They are composed of multiple small crystals, which results in somewhat reduced performance relative to monocrystalline counterparts.

Amorphous photovoltaic cells exhibit the lowest efficiency and are typically fabricated as thin-film structures. They are the most economical option and are suitable for use in residential applications and small electronic devices.

Photovoltaic cells play a significant role in energy production. The process of converting solar energy into electrical energy offers several important advantages. Solar energy is a renewable resource that does not harm the environment and produces little to no toxic emissions. Consequently, it provides a clean and environmentally friendly method of electricity generation.

Since photovoltaic cells convert sunlight directly into electrical energy, they represent a sustainable and reliable source of power. The sun rises every day, and its energy can be harnessed for electricity generation in virtually all regions of the world.

At present, extensive research is being conducted to improve the efficiency of photovoltaic technologies. Innovations such as advanced photovoltaic materials and high-performance solar panels have significantly increased the level of energy production and overall system efficiency.

Photovoltaic systems can be easily integrated into existing electrical grids, making them effective in both rural and urban areas. Their implementation contributes to increased electricity generation capacity and improves the reliability of power supply networks.

The development of photovoltaic energy production also helps countries strengthen their energy independence by reducing reliance on imported energy resources. This contributes to greater energy security and economic stability.

In addition, the installation and operational costs of photovoltaic systems have been steadily decreasing, making them more accessible to a broader range of consumers. Continuous technological advancements in photovoltaic energy generation further enhance their economic viability and expand their potential applications.

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