



# Determination of suitable types of solar cells for optimal outdoor performance in desert climate

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## Abstract

To choose the most suitable solar cell for desert climate, measurements and analysis of the integrated spectral response (ISR) and the electrical power over 32 spectral bands for monocrystalline, polycrystalline and amorphous solar cells have been carried out in Helwan during several seasons under different environmental conditions. The results of ISR show that while the amorphous silicon solar cell is sensitive in the visible part of the spectrum with maximum sensitivity at wavelength ( $\lambda=0.522 \mu\text{m}$ ), the polycrystalline silicon solar cell shows remarkable sensitivity in the infra-red region with maximum sensitivity at ( $\lambda=0.922 \mu\text{m}$ ) and the monocrystalline silicon solar cell is more sensitive in the near infra-red spectrum with maximum value of sensitivity at ( $\lambda=0.704 \mu\text{m}$ ). Deviations were found in the behavior between the ISR and the electrical output power in the measured bands. © 1999 Published by Elsevier Science Ltd. All rights reserved.

*Keywords:* Integrated spectral response; Solar cells; Desert climate

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## 1. Introduction

Questions about the sensitivity to spectral solar irradiance variations for specific

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solar cells have been addressed in an earlier study [1]. The thermal description and temperature effect [2], of photovoltaic performance have been studied in real outdoor conditions [3], for different types of silicon solar cells. Air pollutants, which are another factor that affects the performance of the solar cells have been found [4], to vary the solar radiation in Cairo between 20% in summer and 10% in winter. These air pollutants are found to decrease the spectral sensitivity of polycrystalline silicon solar cells more than amorphous silicon solar cells [5]. The objectives of this study are to find out the most suitable type of solar cells for desert climate through measuring the integrated spectral response (ISR) and electrical output power over several spectral bands in four clear days representing the year's four seasons. The winter is represented by two days, one of which is a full cloudy day.

Since environmental parameters are necessary for determining the spectral power distribution, which is an important factor in determining the ISR, it is important to calculate the effective variation of each of them on its value. Through this study, information can be obtained about the sensitivity with which each parameter has to be measured in order to choose for each a suitable measuring instrument.

## 2. Experimental setup and measurements

The experimental setup consists of three main parts:

1. A movable table which enables the system to be tracked.
2. Four filter frames each of which contains eight filters that can slide parallel to the solar cells.
3. Metallic frame contains three circular holes of the same diameter as the used filters, in which the three solar cells are installed.

The experiment for determining the integrated spectral response (ISR) for the solar cells over defined spectral bands was carried out with thirty two interference glass filters from Carl Zeiss Jena (Germany) covering the range from ultra-violet to infra-red. With these filters, the ISR of three types of solar cells, namely (1) a polycrystalline silicon solar cell from Telefunken System Technique (Germany), (2) an amorphous silicon solar cell from Chronar (UK) and (3) a monocrystalline silicon solar cell from Mobil Solar Energy Corporation (USA), was investigated.

The reflectance of the top surface of the amorphous and monocrystalline silicon solar cells as a function of wavelength  $R(\lambda)$  has been measured using a spectrophotometer. The measurement of reflectance of the polycrystalline silicon solar cell is very difficult because each grain has a different orientation, area and reflectance. For its measurement, either the whole area of the solar cell has to be illuminated with a monochromatic light and the reflected radiation has to be measured, or an image analyzer or any compatible system has to be used to measure the area and orientation of each grain. The measurement of the reflectance of each grain gives, after the integration of the obtained results over all

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