NANOSTRUCTURED SOLAR CELLS

Edited by **Narottam Das**

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Nanostructured Solar Cells
http://dx.doi.org/10.5772/62516
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Published by InTech
Janeza Trdine 9, 51000 Rijeka, Croatia

Notice

Publishing Process Manager Iva Simcic
Technical Editor SPi Global
Cover InTech Design team

First published February, 2017
Printed in Croatia
Legal deposit, Croatia: National and University Library in Zagreb

Additional hard copies can be obtained from orders@intechopen.com

Nanostructured Solar Cells, Edited by Narottam Das
p. cm.
Print ISBN 978-953-51-2935-6
Online ISBN 978-953-51-2936-3

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Introduction of Nano-Structured Solar Cells

Narottam Das

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http://dx.doi.org/10.5772/67467

1. Introduction

Over the decades, nano-structured gratings or materials have opened a promising way to future renewable energy sources with high conversion efficiency, especially nano-structured solar cells. The solar cell uses the advantages of nano-structured gratings for the improvement of light trapping or capturing capacity into the substrate. These nano-structures have been employed for different performance or energy conversion enhancement strategies. These devices can harvest the sunlight energy and convert it directly into the electrical energy/power. These new technologies and infrastructures have been developed for the improvement of solar cell conversion efficiency. This is a useful technology and has several features being relative to other renewable energy resources, such as directly generating electricity from sunlight and supplying electrical power in the form of portable panels/modules and having small-scale up to the large-scale power plants, and it is not being restricted to any particular region. These technologies are expected to contribute significantly for a sustainable future for the next generation.

For example, nano-structured grating shapes or profiles could be classified or categorized as follows: (i) rectangular-shaped nano-grating, (ii) trapezoidal-shaped nano-grating with different aspect ratios (i.e., 0.1–0.9), and (iii) triangular-shaped nano-grating (**Figure 1**).

The term aspect ratio (AspR) is defined as the ratio between the top length over the base length of a rectangle, trapezoid, and/or triangle. It depicts clearly from **Figure 1** that the AspR can be represented by the following equation:

$$\text{AspR} = \frac{a}{b} \tag{1}$$

where, "*a*" is the top length and "*b*" is the base length of the geometric shapes (such as, rectangle, trapezoid, and triangle). For a rectangular-shaped nano-grating profile, the AspR is "1" (i.e., the top and base length of the rectangle is equal) and for the triangular-shaped nano-grating profile, the AspR is "0" (i.e., the top length of the triangle is '0' compared to the base length of the triangle). However, for a trapezoidal-shaped nano-grating, the AspR is $0 < (a/b) < 1$, that is, it lies between '0' and '1' (such as, 0.1–0.9). These nano-grating shapes play an important role for the light trapping inside the substrate that affects the conversion efficiency of solar cells. Therefore, an appropriate design of nano-structured grating is essential to reduce the light reflection losses and improve the conversion efficiency of solar cells.

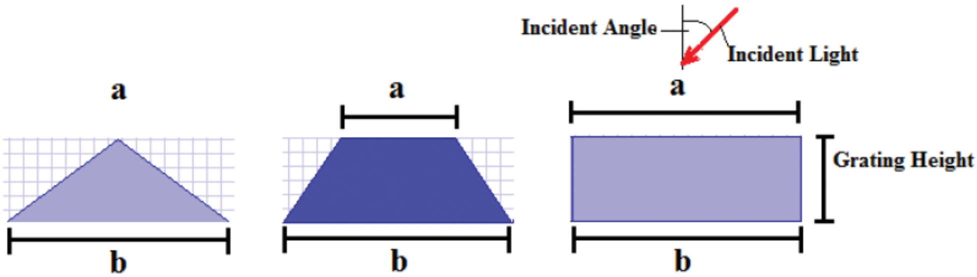

Figure 1. Different types of nano-structured grating shapes or profiles. Where, 'a' is the top length and 'b' is the base length of the geometric shapes (such as, rectangle, trapezoid, and triangle).

The book "Nano-Structured Solar Cells" is divided into four parts.

Part-1 discussed the general concepts of nano-structured solar cells. The requirement to produce solar or renewable energy with low production cost is indispensable dream of avoiding undue reliance on conventional energy systems. The emergence of third generation solar or photovoltaic system is in early stages that can fulfill the requirement of future demand. Solar cells can be considered by dyes, quantum dots, and perovskites for future generations dream.

Part-2 discussed about different junction type nano-structured solar cells. To design a photovoltaic or solar cells, it is essential to understand the background of physics and operation of high-efficiency junction type solar cells. The surface recombination and passivation mechanisms, passivation schemes for cell surfaces are very important. The advanced cell structures and their fabrication schemes are able to achieve high conversion efficiency is demonstrated. These advanced cell design features have become highly active areas of investigation in the photovoltaic or solar energy industry for next generation's renewable or solar energy system.

Part-3 discussed about the organic and thin film nano-structured solar cells. This type of solar cell is one of the new energy sources, and a regenerated energy source is abundant and pollution-free which is environmentally friendly. The organic and thin film solar cell technology represents an alternative way to solve effectively the world's increasing energy shortage problem. The light trapping inside the solar cell is a critical issue for conversion efficiency improvement. Nano-structured gratings, surface plasmons including localized surface plasmons excited in the metallic nano-particles, and surface plasmon polaritons propagating at metal/semiconductor interfaces have great interests in designing the thin film solar cells. The organic and thin film structured solar cells are able to improve the conversion efficiency of nano-structured solar cells for future generations.

Part-4 discussed the perovskite nano-structured solar cells. Perovskite solar cells are the continuation of dye-sensitized solar cell in terms of the sensitization phenomena as occurred in the functioning molecules. Recently, a breakthrough propose has been performed for the sensitization of perovskite solar cell that is a solid-state structure as offered an equivalent sensitizer used in dye-sensitized solar cell. The energy conversion efficiency of those solid-state cells reached about twofold of its initial amount of generation over past several years. The scientists and researchers from different part of the world followed it very actively. They have introduced an improved efficiency about 20% which was originally started from 4%; this growth is just in 4 years of time. Hence, it seems that the new age for solar conversion devices depending on the recent significant improvement on Perovskite solar cells.

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