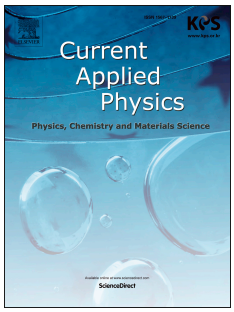
Accepted Manuscript



Enhancement of a photovoltaic cell performance by a coupled cooled nanocomposite thermoelectric hybrid system, using extended thermodynamics

H. Machrafi

PII: S1567-1739(17)30067-6

DOI: 10.1016/j.cap.2017.03.001

Reference: CAP 4462

To appear in: *Current Applied Physics*

Received Date: 22 November 2016

Revised Date: 10 January 2017

Accepted Date: 6 March 2017

Please cite this article as: H. Machrafi, Enhancement of a photovoltaic cell performance by a coupled cooled nanocomposite thermoelectric hybrid system, using extended thermodynamics, *Current Applied Physics* (2017), doi: 10.1016/j.cap.2017.03.001.

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

ACCEPTED MANUSCRIPT

Enhancement of a photovoltaic cell performance by a coupled cooled nanocomposite thermoelectric hybrid system, using extended thermodynamics

H. Machrafi
Université Libre de Bruxelles, Service Chimie-Physique, Ecole Polytechnique, CP165/62, avenue F.D. Roosevelt, 50, 1050 Brussels, Belgium

E-mail : Hatim.Machrafi@ulb.ac.be

Abstract
A new analytical mathematical model is developed, describing a cooled photovoltaic-thermoelectric hybrid system. The thermoelectric material is a nanocomposite where the model takes into account size-dependent non-local thermoelectric properties from an extended thermodynamic point of view. The photovoltaic device powers also the cooling system. The model determines first the optimum thickness of the photovoltaic device, then studies the influence of several size-related parameters on the thermoelectric efficiency (also related to the figure of merit) and finally, coupled to a cooling device, the overall efficiency. For the photovoltaic part, the model is applied to two materials, mono-crystalline and poly-crystalline silicon. The thermoelectric part of the model is applied to an n-leg nanocomposite made out of Sb_2Te_3 nanoparticles in a Bi_2Te_3 matrix and of a p-leg nanocomposite made out of Bi_2Se_3 nanoparticles in a Bi_2Te_3 matrix. An optimal total photovoltaic device size has been found to be around 127 µm and 1.25 µm for the mono- and poly-crystalline silicon, respectively, leading to efficiencies up to 20 %, depending on photovoltaic recombination characteristics. With the cooling device, the overall efficiency was increased by up to an additional 10 % (an increase of almost 50 %), leading to overall efficiencies around 25 %.

Key words: Photovoltaic power output, Thermoelectric element, Cooled hybrid system, Nanocomposite, Extended irreversible thermodynamics

Nomenclature
Latin script

B	Auger recombination coefficient
c	Velocity of light
$c_{p,c}$	Heat capacity
C	Specific heat capacity
CL	Cooling device
d_p	Nanoparticle size
D_i	Characteristic diffusion coefficient of minority carrier *i*
e_C	Elementary charge
E	Electric field
E_i	Energy of a physical entity *i*
G	Photovoltaic generation rate
h	Planck constant
h_c	Heat transfer coefficient between thermoelectric element and cooling device
h_s	Heat transfer coefficient at light side of photovoltaic device
H	Heat generation
$\boldsymbol{I}$	Electric current density flux

Download English Version:

https://daneshyari.com/en/article/5488979

Download Persian Version:

https://daneshyari.com/article/5488979

Daneshyari.com