Energy Science, Engineering and Technology

# THIN FILM SOLAR CELLS

Current Status and Future Trends

Alessio Bosio Alessandro Romeo Editors



#### **Energy Science, Engineering and Technology**

# THIN FILM SOLAR CELLS

**CURRENT STATUS AND FUTURE TRENDS** 

### **Energy Science, Engineering and Technology**

Additional books in this series can be found on Nova's website under the Series tab.

Additional E-books in this series can be found on Nova's website under the E-book tab.

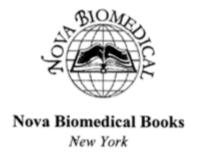


#### **Energy Science, Engineering and Technology**

# THIN FILM SOLAR CELLS

#### **CURRENT STATUS AND FUTURE TRENDS**

# ALESSIO BOSIO AND ALESSANDRO ROMEO EDITORS



**this reserved.** No part of this book may be reproduced, stored in a retrievated in any form or by any means: electronic, electrostatic, magnetic, tall opying, recording or otherwise without the written permission of the Publishe

rmission to use material from this book please contact us:

ione 631-231-7269; Fax 631-231-8175

ite: http://www.novapublishers.com

#### NOTICE TO THE READER

ublisher has taken reasonable care in the preparation of this book, but makes in display damages and assumes no responsibility for any errors or the ty is assumed for incidental or consequential damages in connection with onation contained in this book. The Publisher shall not be liable for quential, or exemplary damages resulting, in whole or in part, from the reacted upon, this material. Any parts of this book based on government reports appright is claimed for those parts to the extent applicable to compilations of

endent verification should be sought for any data, advice or recommendation ook. In addition, no responsibility is assumed by the publisher for any injury rsons or property arising from any methods, products, instructions, idea ined in this publication.

publication is designed to provide accurate and authoritative information wince the matter covered herein. It is sold with the clear understanding that the ged in rendering legal or any other professional services. If legal or an ance is required, the services of a competent person should be sou LARATION OF PARTICIPANTS JOINTLY ADOPTED BY A COMMIRICAN BAR ASSOCIATION AND A COMMITTEE OF PUBLISHERS.

ARY OF CONGRESS CATALOGING-IN-PUBLICATION DATA

## **CONTENTS**

Preface		,
Chapter 1	Status and Perspectives of Thin Film Photovoltaics Arnulf Jäger-Waldau	1
Chapter 2	Introduction to Inorganic Thin Film Solar Cells Francesco Roca, Alessio Bosio and Alessandro Romeo	25
Chapter 3	Co-Evaporation of CIGS and Alternative Buffer Layers for CIGS Devices  Marika Edoff and Charlotte Platzer-Björkman	59
Chapter 4	CIGS Absorber Layers Prepared by Sputtering Based Methods António Ferreira da Cunha and Pedro Manuel Parracho Salomé	89
Chapter 5	Electrical Characterization of Cu(In,Ga)Se2 - Based Thin Film Photovoltaic Devices Pawel Zabierowski	103
Chapter 6	CdTe solar Cells by Low Temperature Processes Alessandro Romeo and Alessio Bosio	135
Chapter 7	Polycrystalline CdTe Thin Films Solar Cells Alessio Bosio, Alessandro Romeo and Nicola Romeo	159
Chapter 8	Thin Film Silicon Solar Cells Paola Delli Veneri and Lucia Vittoria Mercaldo	199
Chapter 9	Organic and Hybrid Solar Cells Thomas M. Brown, Andrea Reale and Aldo Di Carlo	245
Index		283

#### **PREFACE**

The need of more and more energy supply due to increased demand from emerging countries such as India, China and Brazil and the contemporary necessity to preserve the environment has increased the interest to the development of new technologies that make use of solar energy.

In particular photovoltaic solar energy, the direct conversion of solar energy into electricity by means of semiconducting materials, had a very strong development in the last 30 years.

The most important parameter that characterizes a photovoltaic device is the ratio between its conversion efficiency and its cost.

A value less than 0.5 \$/Wp is considered competitive with the electricity obtained from fossil energy sources.

Despite the strong development of photovoltaic devices in the last years, the best result so far obtained is around 1 \$/Wp for CdTe/CdS thin film modules fabricated by "First Solar".

In any case, in order to reach the goal of 0.5 \$/Wp or less, the only way is that of further developing thin film photovoltaics.

In this book, the most recent results concerning thin film solar cells, covering all kinds of relevant materials, are presented by qualified experts in the field. The book is particular important for researchers who are already engaged or intend to start a research in this area.

It could be also useful for the industries who want to invest their money in the new thin film photovoltaic technologies.

Professor Nicola Romeo