Preface

Over the last ten years, photovoltaics has emerged to become an application of recognised potential and has attracted the interest of increasing numbers of students and researchers. The purpose of this book is to provide an introduction to, and overview of, the physics of the photovoltaic cell. It should be suitable for undergraduate physicists and engineers who are interested in this application of semiconductor physics, and to non-specialist graduates and others who require a background in the physical principles of solar cells. The focus is on the basic semiconductor physics relevant to photovoltaics, physical models of photovoltaic devices and how these relate to the design and function of practical devices. It should enable the reader to understand how solar cells work, to understand the concepts and models of solar cell device physics, and to formulate and solve relevant physical problems. Although practical materials and device designs are used as examples, the book is not intended as a comprehensive review of photovoltaic materials and devices, nor of the latest developments in photovoltaics research.

Chapter 1 introduces the solar cell as a simple current generator and defines the performance characteristics which are used to describe and compare solar cells. Chapter 2 describes in general terms how light energy is converted into electricity, comparing the photo*voltaic* converter with other systems and evaluating the limits to efficiency. Chapters 3 and 4 cover the basic physics of the semiconductor, the semiconductor transport equations and the processes of light absorption and carrier recombination. Chapter 5 focuses on the concept of the asymmetric junction, and details the different types of junction which are exploited in photovoltaics. Chapter 6 applies the theory of earlier chapters to a p–n junction, the classical model of a solar cell. Chapters 7 and 8 are concerned with the range of photovoltaic materials and device designs. Chapter 7 deals with monocrystalline p–n junction devices, relating the model of Chapter 6 to practical devices,

using crystalline silicon and gallium arsenide cells as examples. Chapter 8 deals with thin film photovoltaic materials, discussing physical processes and design issues relevant to thin films and focusing on the ways in which the standard model must be adapted for thin film devices. Chapter 9 deals with various techniques for managing light in order to maximise performance, and Chapter 10 covers a range of approaches, mainly theoretical, to increasing the efficiency of solar cells above the limit for a single band gap photoconverter.

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This book is dedicated to the memory of Stephen Robinson and M.V. McCaughan.

Jenny Nelson
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