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Spectroscopic Analysis of Optoelectronic Semiconductors

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Preface

The book is written by two semiconductor physicists, who as experimentalists have used spectroscopic techniques throughout their entire careers. The main goal of their work has been the investigation of the properties of bulk semiconductor materials, epitaxial structures, nanostructures, as well as devices made from these materials. Thus, the text comprises their experience as experimentalists and was written to help experimentalists, e.g. Master or Ph.D. students in physics and engineering, to choose and understand the right analytical spectroscopic technique in order to extract specific information from their samples. It is also useful for people in academia and industry, who have to plan the application of spectroscopic techniques for characterization purposes and have to decide on the purchase the corresponding spectroscopic equipment. Moreover, it can serve as a general introduction to those who are interested in optical spectroscopy.

Thus, the book intends to be a guide to the field of optical spectroscopy. It addresses the potentials and limitations of four groups of spectroscopic techniques that are used for analytical purposes. These are *Raman*, *photoluminescence*, *cathodoluminescence*, and *photoelectrical spectroscopy*, which were selected because of their paramount relevance for the characterization of semiconductors. These techniques give the names to Chaps. 3–6 and make out the main body of this book. There are two additional chapters, Chaps. 1 and 2, which provide the knowledge base for these chapters. Chapter 1 gives an introduction to the subject of the spectroscopy of semiconductors. The basic mechanisms and equations which describe light–matter interaction are outlined and discussed in a textbook-like style. Chapter 2 gives an introduction into the basics of optical spectroscopy from an experimental point of view. Thus, Chap. 2 is like a link between the textbook

knowledge in Chap. 1, which addresses predominantly mechanisms, and the specialized information in Chaps. 3–6. Chapter 2, however, is organized in the same way as the "advanced" Chaps. 3–6. Their structure includes the following elements:

- At the beginning of the chapters *spectra* are presented and it is discussed how they are typically displayed.
- *Samples* and sample geometries are discussed. This leads to the "probed sample volume", to spatial resolution limits of the techniques, and to the question about "information depths".
- The topic of spectroscopic *equipment* is addressed. In some cases, like in Chap. 2, we mainly refer to commercial products. In other cases, as in Chaps. 4 and 6, guidelines are given on how to construct a setup.
- In all chapters, *methodology* is addressed. Parameters that can be varied are discussed. Different approaches, such as steady-state and transient methods are described, and the expected outcome is discussed.
- The *mechanisms* that form the spectra are addressed on the basis of the general knowledge which is provided in Chap. 1. This also includes the link to theory, which is not the topic of this book. This approach leads to the topic of the information that might be extracted from the spectra. This extraction is, of course, the goal of any analysis.
- Related or *derived techniques* are discussed. This includes, in particular, mapping and imaging approaches, i.e. multiple measurements at different locations on the samples. Many special spectroscopic techniques are introduced, as well, and their relationship to the standard techniques is indicated.
- Different *applications* are addressed. This includes cases studies and guidelines on how to analyze complex structures.

Most spectra, which are used in order to illustrate the text, are taken from original papers. This provides the link to current experimental results in the literature. They have been selected from the point of view of clarity and, at least in part, from the point of view of beauty.

Valladolid, Spain | Juan Jimenez
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