

Book Review

Epitaxy, Physical Principles and Technical Implementation

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This book devotes the modern field of epitaxy in 5 parts dealing with Basic Concepts, Technical Implementation, In-situ Analysis of the Growth Processes, Physics of Epitaxy and Heteroepitaxy.

Chapter 1 “Introduction” describes the basic concepts of the epitaxial crystallization process and the five possible growth modes mainly occurring on flat surfaces of substrate crystals. Chapter 2 “Homo- and Heteroepitaxial Crystallization Phenomena” provides a good overview on nucleation as a precursor of crystal growth in connection with crystalline defects like point defects, dislocations and superdislocations as well as misfit dislocations, stacking faults, twins and antiphase boundaries. Chapter 3 “Application Areas of Epitaxially Grown Layer Structures” shows, that important application areas of epilayer structures are defined by solid state electronics, optoelectronics and photonics.

Part II of this book is dedicated to Technical Implementation of Epitaxy and reports the various epitaxial growth methods like Solid Phase Epitaxy, Liquid Phase Epitaxy, Vapour Phase Epitaxy, Molecular Beam Epitaxy and Metalorganic Vapour Phase Epitaxy. During the 70's Liquid Phase Epitaxy (LPE) provided first excellent results for optoelectronic devices like LED's and lasers. Chapter 5 describes in a good and comprehensive way the basic principles of LPE and Liquid Phase Electroepitaxy (LPEE). The various techniques of growing epitaxial layers from vapour are presented in Chapter 6 divided in methods depending on whether the species are transported physically or chemically from the source region to the substrate crystal. Modifications to existing methods like Atomic Layer Epitaxy (ALE) are discussed in a reasonable way. A precise control of beam fluxes and growth conditions may be achieved by Molecular Beam Epitaxy (MBE) (Chapter 7), including different variants like Solid Source MBE (SSMBE), Gas Source MBE (GSMBE), Metalorganic MBE (MOMBE), Hydride Source MBE (HSMBE), etc. In Chapter 7 the reader may find a lot of apparatus details as well. Besides MBE Metalorganic Vapour Phase Epitaxy (MOVPE) can be utilized for growing structures on an atomic scale (Chapter 8). MOVPE is essentially capable of depositing nearly all types of solids. In this chapter gas vapour delivery systems and the design of source molecules, the so called precursor materials are described with specific details. Chapter 8 ends with Non Thermal MOVPE Techniques like PHOTO-MOVPE and a few safety aspects of MOVPE.

Part III deals with In situ Analysis of the Growth Process in particular with the question which species are moving to the surface and participate in the growth process and what are the growth processes on the surfaces. Chapter 9 describes analytical methods like mass spectrometry, optical identification of species, measurements of velocities for the mass transport of species. Methods of In-situ Surface Analysis are the topics of Chapter 10, which includes Scanning Microscopes, Diffraction Techniques like Reflection High Energy Electron Diffraction, RHEED, Reflection Based Optical Techniques (e.g. Ellipsometry, Raman, IR) and other optical techniques like Laser Light Scattering (LLS).

Part IV deals with the Physics of Epitaxy, starting with Thermodynamic Aspects of Epitaxy (Chapter 11) in a form of basic concepts including mass transport in VPE-systems, effusion from solid sources in MBE followed by phase equilibria and phase transitions and self-organisation processes (quantum dots and quantum wires). Chapter 12 “Atomistic Aspects “ and Chapter 13 “Quantum Mechanical Aspects” consider the microscopic behaviour of an epitaxial crystallization.

The last part V of this book, Heteroepitaxy, gives an overview on growth phenomena of epitaxial layers with a chemical composition and usually structural parameters different from those of the substrate (Chapter 14). In this chapter also “Highly Strained Heterostructures”, the “Heteroepitaxial Lateral Overgrowth” and “Graphoepitaxy” are discussed. “Material-Related Problems of Heteroepitaxy” are the content of Chapter 15 as well as “Peculiarities of Heteroepitaxy of Selected Material Groups”, e.g. Group III-Nitrides.

The present book is well written in it’s experimental and theoretical aspects. It represents a good overview on the actual knowledge of the wide-spread field of modern epitaxy. The book may be used by graduate students of physics, chemistry, materials science and electronic engineering. It may be also recommended to scientists and engineers working in the field of semiconductor physics and – technology.

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