Prefaces

Preface to the First Edition

The design of new materials is one of the most important tasks in promoting progress. To do this efficiently, the fundamental properties of the simplest forms of solids, i. e., single crystals must be understood.

Not so long ago, materials science implied the development, experimental investigation, and theoretical description, of primarily construction materials with given elastic, plastic and resistive properties. In the last few decades, however, new materials, primarily crystalline, have begun to be viewed differently: as finished, self-contained devices. This is particularly true in electronics and optics.

To understand the properties of a crystal device it is not only necessary to know its structure but also the dynamics of physical processes occurring within it. For example, to describe the simplest displacement of the crystal atoms already requires a knowledge of the interatomic forces, which of course, entails a knowledge of the atomic positions.

The dynamics of a crystal lattice is a part of the solid-state mechanics that studies intrinsic crystal motions taking into account structure. It involves classical and quantum mechanics of collective atomic motions in an ideal crystal, the dynamics of crystal lattice defects, a theory of the interaction of a real crystal with penetrating radiation, the description of physical mechanisms of elasticity and strength of crystal bodies.

In this book new trends in dislocation theory and an introduction to the nonlinear dynamics of 1D systems, that is, soliton theory, are presented. In particular, the dislocation theory of melting of 2D crystals is briefly discussed. We also provide a new treatment of the application of crystal lattice theory to physical objects and phenomena whose investigation began only recently, that is, quantum crystals, electron crystals on a liquid-helium surface, lattices of cylindrical magnetic bubbles in thin-film ferromagnetics, and second sound in crystals.

In this book we treat in a simple way, not going into details of specific cases, the fundamentals of the physics of a crystalline lattice. To simplify a quantitative descrip-

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tion of physical phenomena, a simple (scalar) model is often used. This model does not reduce the generality of qualitative calculations and allows us to perform almost all quantitative calculations.

The book is written on the basis of lectures delivered by the author at the Kharkov University (Ukraine). The prerequisites for understanding this material are a general undergraduate-level knowledge of theoretical physics.

Finally, as author, I would like to thank the many people who helped me during the work on the manuscript.

I am pleased to express gratitude to Professor Paul Ziesche for his idea to submit the manuscript to WILEY-VCH for publication, and for his aid in the realization of this project.

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Kharkov July 1999 *Arnold M. Kosevich*

Preface to the Second Edition

Many parts of this book are not very different from what was in the first edition (1999). This is a result of the fact that the basic equations and conclusions of the theory of the crystal lattice have long since been established. The main changes ("reconstruction") of the book are the following

1. All the questions concerning one-dimensional (1D) crystals are combined in one chapter (Chapter 1). I consider the theory of a 1D crystal lattice as a training and proving ground for studying dynamics of three-dimensional structures. The 1D models allow us to formulate and solve simply many complicated problems of crystal mechanics and obtain exact solutions to equations not only of the linear dynamics but also for dynamics of anharmonic (nonlinear) crystals.

2. The second edition includes a new chapter devoted to the theory of elastic superlattices (Chapter 5). A new class of materials, namely, phonon and photon crystals has recently been of the great interest, and I would like to propose a simple explanation of many properties of superlattices that were studied before and known in the theory of normal crystal lattices.

3. New sections are added to the new edition concerning defects in the crystal lattice.

Finally, I would like to thank the people who helped me in the preparation of the manuscript.

I am indebted to Dr. Michail Ivanov and Dr. Sergey Feodosiev for their advise in improving the presentation of some parts of the book. I express many thanks to Alexander Kotlyar for his invaluable help in preparing the figures and electronic version of the manuscript. The author is grateful to Oksana Charkina for assistance in preparing the manuscript. I would like to thank my wife Dina for her encouragement.

Kharkov March 2005 *Arnold M. Kosevich*