ULTRASONIC SPECTROSCOPY

Ultrasonic spectroscopy is a technique widely used in solid-state physics, materials science, and geology that utilizes acoustic waves to determine fundamental physical properties of materials, such as their elasticity and mechanical energy dissipation. This book provides complete coverage of the main issues relevant to the design, analysis, and interpretation of ultrasonic experiments. Topics including elasticity, acoustic waves in solids, ultrasonic loss, and the relation of elastic constants to thermodynamic potentials are covered in depth. Modern techniques and experimental methods including resonant ultrasound spectroscopy, digital pulse-echo, and picosecond ultrasound are also introduced and reviewed. This self-contained book includes extensive background theory and is accessible to students new to the field of ultrasonic spectroscopy, as well as to graduate students and researchers in physics, engineering, materials science, and geophysics.

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Applications in Condensed Matter Physics and Materials Science

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Preface

The use of ultrasonic methods for the study of materials continues to flourish and evolve. These methods find uses in many areas including fundamental condensed matter physics, materials science, various branches of engineering, geophysics, and applied studies of device-related material parameters. Advancements in experimental methods, especially resonant ultrasound spectroscopy, have enabled quantitative measurements on dramatically reduced specimen sizes, thereby vastly expanding the possibilities for the study of novel materials. The title of the book "*Ultrasonic Spectroscopy*" is taken here to mean simply the investigation of material properties by the use of ultrasonic waves.

A major purpose of this book is to present an in-depth coverage of the main issues underlying the planning and interpretation of ultrasonic investigations of materials. It is intended that the level of the presentation be accessible to dedicated upper-level undergraduate students, but at the same time achieve a depth of coverage useful to graduate students and other researchers. The approach is to present in careful detail a number of topics, with two objectives in mind. One objective, of course, is to educate the reader about basic concepts in the field – concepts that should become familiar to any researcher in this area. A second objective, perhaps more important, is to illustrate theoretical ideas that can be applied to a wide variety of problems. The emphasis is on basic concepts, not specific materials. The goal is to provide a fundamental background for beginning researchers so that – with the help of a good scientific Internet search engine to obtain more focused information – they are able to attack any of the gamut of interesting problems amenable to ultrasonic methods.

The mathematical methods used should be familiar to upper-level undergraduate students. Some knowledge of thermodynamics, statistical mechanics, and solid-state physics is required, but an effort is made to present the key concepts from these subjects as needed, and provide references to more detailed sources.

The book includes one chapter on experimental methods. Both continuous wave and pulse techniques are discussed.

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Most of all, I am especially thankful to my wife, Jeanine Smith Leisure, for her contributions through steadfast support, encouragement, and thought-provoking discussions.