Preface

Today, the ultrasonic signal is being used for predicting material behavior, characterizing (detecting internal anomalies in) a variety of engineering structures, as well as for inspecting human body parts like tumors, bones, and unborn fetuses. Because of the ever-increasing popularity of the ultrasonic techniques in a wide range of applications, this technology has received a lot of attention from the research community. This book presents some new developments in ultrasonic research for material and structure inspection. Application areas cover both engineering and biological materials.

Some of the recent advances in the science and technology of ultrasonic NDE and other areas of research on ultrasonic technology that go beyond the traditional imaging techniques of internal defects are covered in this book. New inspection and material characterization techniques applied to engineering structures, as well as biological materials, are presented here. Ten chapters cover a wide range of application areas of the ultrasonic technology. From the first chapter the reader will learn various failure mechanisms associated with different types of engineering materials and will get an overview of the current ultrasonic NDE/SHM techniques. This chapter will help to bridge the gap between the materials scientists and the mechanics community in their understanding and approach to the nondestructive evaluation and health monitoring of engineering materials and structures. From the subsequent chapters the reader will learn:

– how to measure and predict the impact damage in composite panels by analyzing the impact damage generated ultrasonic signals: a combined experimental and theoretical study of the Lamb wave propagation and generation by the low velocity impact in composite panels is important for this purpose, and is presented here in the hope that it will eventually develop an impact monitoring system in the future;

– how to measure and interpret the ultrasonic properties of soft biological tissues: scanning acoustic microscopes can measure attenuation and wave speed in

soft tissues. From these properties the biomechanics of the tissues can be assessed that might improve our understanding of diseases from a micro-mechanical point of view;

– how to monitor corrosion and erosion damages in pipelines using cylindrical guided waves, which guided wave mode is most efficient to detect the wall thickness reduction over a long range and how to generate this mode in the pipe;

– how to accurately model the ultrasonic field generated by multiple transducers: in defect detection and health monitoring applications when multiple sensors are used, the accurate modeling of the ultrasonic pressure and velocity fields in the near field region is important. The distributed point source method (DPSM) for modeling the ultrasonic fields including the interaction effects is presented;

– how the ultrasonic wave propagation characteristics, often used for microstructure inspection, are influenced by the texture. The propagation and scattering of ultrasonic waves in textured polycrystals are discussed in Chapter 6. This is important for material microstructure inspection by ultrasonic waves;

– how embedded piezoelectric ultrasonic sensors are used for health monitoring of large plate type structures. A rigorous study of the interaction between ultrasonic Lamb waves and embedded piezoelectric wafer active sensors is necessary for this purpose;

– what is the effect of cracks on the acoustic signal modulation. What material properties, signal characteristics and crack dimensions affect this modulation. This study is important for gaining knowledge about the material damage and geometric non-linearity from the modulation of the signal propagated through the material;

– how to measure the dynamic response of materials using split Hopkinson bars and what issues are important and how to design the experiments for accurately measuring these dynamic properties.

It is my hope that both biological and physical science communities will gain some new knowledge from this book that will stimulate new research resulting in the development of more innovative ultrasonic technology applications.

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Tribikram Kundu
University of Arizona, USA