Preface

The definition of cavitation is the formation of bubbles/cavities in a liquid or other medium, and the subsequent bubble dynamics. Cavitation has been studied in several scientific areas and used in a wide variety of applications, such as acoustics, hydrodynamics, fluid machinery, biomedicine, chemistry, material science, botany, food science, and petroleum engineering. Cavitation was avoided in earlier studies of fluid machinery and hydrodynamics. However, in recent years, it is increasingly utilized in a wide range of applications, such as ultrasonic cleaning, cell and biomaterial processing, ultrasound imaging and therapy, cavitation-assisted chemical reactions, dialysis, and extraction.

Cavitation is becoming increasingly important in biomedical research and applications. It has been studied in three important categories: (i) Physics where the study of the physical phenomena and biophysical mechanisms has established the foundations of cavitation in biomedicine. This has become more interesting with the introduction of several novel micro-/nano-materials which act as artificial implanted cavitation nuclei; (ii) The development of the principles and engineering techniques in cavitation detection, imaging, characterization, and control has promoted the research and development of biomedical devices and equipment; (iii) Applications of cavitation in biomedical diagnosis and therapy and appropriate of evaluation are the subjects of active research. A deeper understanding of cavitation in biomedicine should bring new opportunities for the medicine of the future.

Cavitation has been the topic of some publications. Most are interested with its physical mechanisms and bubble dynamics. A few have discussed cavitation in non-Newtonian fluids, concentrating on its applications in fluid machinery and biomedicine. Some important applications, such as erosion, laser/ultrasonic surgery, and cell surgery, have been briefly mentioned. Although cavitation has been a "hot topic" in biomedical research, no book has given a comprehensive account of this field. This is not hard to be understood because the study of cavitation in biomedicine is interdisciplinary and covers areas of interest from physics, engineering to the biological and medical sciences. The greatly increased publications on cavitation are widely spread in journals in the fields mentioned above. Thus, the proposed book would provide, for the first time, a systematic understanding of the

engineering principles and techniques of cavitation in biomedicine based on its physics and mechanism.

The fundamentals of cavitation are introduced in Chap. 1. This gives the basic definition, the process, and the threshold of cavitation and then outlines the types of cavitation nuclei and cavitation, and cavitation bubble dynamics are described.

In Chaps. 2 and 3, it describes cavitation characterization under free-field conditions and analyzes the spatial and temporal distributions of cavitation, both qualitatively and quantitatively.

Chapters 4 and 5 presents cavitation-enhanced thermal and mechanical effects and their applications. Although both effects are inseparable, they are discussed in in two chapters separately to help the reader build the complete framework for each effect. Then, the cavitation process control is introduced in Chap. 6 with some specific cavitation control-related applications being discussed.

Addressing diagnosis and therapy monitoring in tissue, cavitation imaging, including active cavitation imaging (ACI) and passive cavitation imaging (PCI), is introduced in Chap. 7.

Some interesting applications of cavitation in biomedicine which are at early stages of research are described in the last section. Based on a deep understanding in laser-induced cavitation, photoacoustic cavitation (cavitation initiated by acoustic pressure and laser energy spontaneously) is discussed briefly in Chap. 8. In Chap. 9, cavitation mechanobiology is considered in a discussion of the bioeffects of ultrasound related to cavitation and the transduction mechanisms induced, with the cascade of cellular and molecular events.

Cavitation research is under rapid development. This book is intended as a combination of reference book for graduate students, and a monograph for scientists and engineers who work with cavitation in biomedicine. It will help students gain a broad and solid foundation in the field. The aim is to create a bridge for the different disciplines involved and to promote the integration of cross-curricular interests, thus encouraging innovations in the scientific research and engineering application.

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