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High Frequency Piezo-Composite Micromachined Ultrasound Transducer Array Technology for Biomedical Imaging

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Series Editors' Preface

Biomedical and Nanomedical Technologies (B&NT)
This **concise** monograph series focuses on the implementation of various engineering principles in the conception, design, development, analysis and operation of biomedical, biotechnological and nanotechnology systems and applications. The primary objective of the series is to compile the latest research topics in biomedical and nanomedical technologies, specifically devices and materials.

Each volume comprises a collection of invited manuscripts, written in an accessible manner and of a concise and manageable length. These timely collections will provide an invaluable resource for initial enquiries about technologies, encapsulating the latest developments and applications with reference sources for further detailed information. The content and format have been specifically designed to stimulate further advances and applications of these technologies by reaching out to the non-specialist across a broad audience.

Contributions to *Biomedical and Nanomedical Technologies* will inspire interest in further research and development using these technologies and encourage other potential applications. This will foster the advancement of biomedical and nanomedical applications, ultimately improving healthcare delivery.

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Abstract

In this monograph, the authors report the current advancement in high frequency piezoelectric crystal micromachined ultrasound transducers and arrays and their biomedical applications.

Piezoelectric ultrasound transducers operating at high frequencies (>20 MHz) are of increasing demand in recent years for medical imaging and biological particle manipulation involved therapy. The performances of transducers greatly rely on the properties of the piezoelectric materials and transduction structures, including piezoelectric coefficient (d), electromechanical coupling coefficient (k), dielectric permittivity (e) and acoustic impedance (Z). Piezo-composite structures are preferred because of their relatively high electromechanical coupling coefficient and low acoustic impedance. A number of piezo-composite techniques have been developed, namely "dice and fill", "tape-casting", "stack and bond", "interdigital phase bonding", "laser micromachining" and "micro-molding". However, these techniques are either difficult to achieve fine features or not suitable for manufacturing of high frequency ultrasound transducers (>20 MHz). The piezo-composite micromachined ultrasound transducers (PC-MUT) technique discovered over the last 10 years or so has demonstrated high performance high frequency piezo-composite ultrasound transducers.

In this monograph, piezoelectric materials used for high frequency transducers is introduced first. Next, the benefits and theory of piezo composites is presented, followed by the design criteria and fabrication methods. Biomedical applications using PC-MUT and arrays will also be reported, in comparison with other ultrasound transducer techniques. The final part of this monograph describes challenges and future perspectives of this technique for biomedical applications.