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Microfabrication of Piezoelectric Composite Ultrasound Transducers (PC-MUT)

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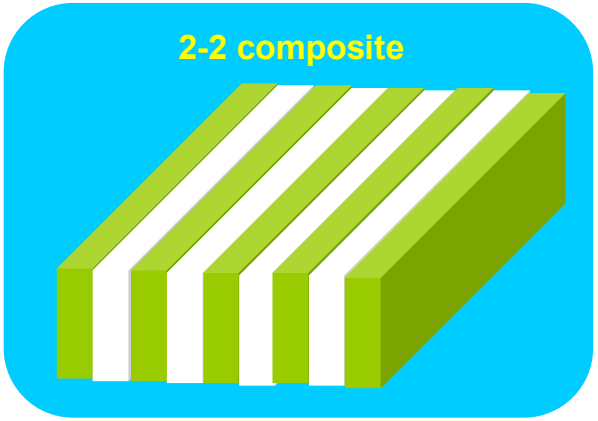
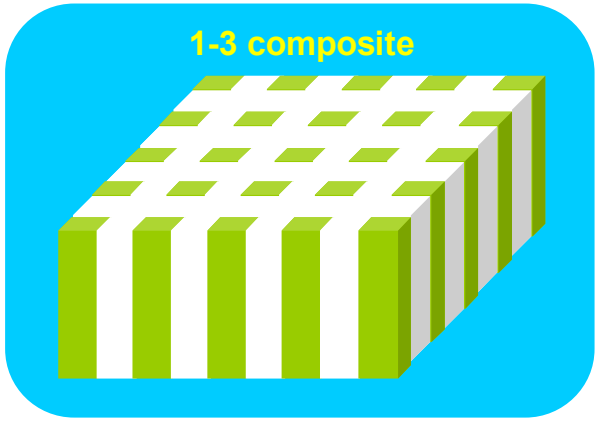
Piezoelectric Composites

Introduction

Piezoelectric composites for Ultrasound Transducer

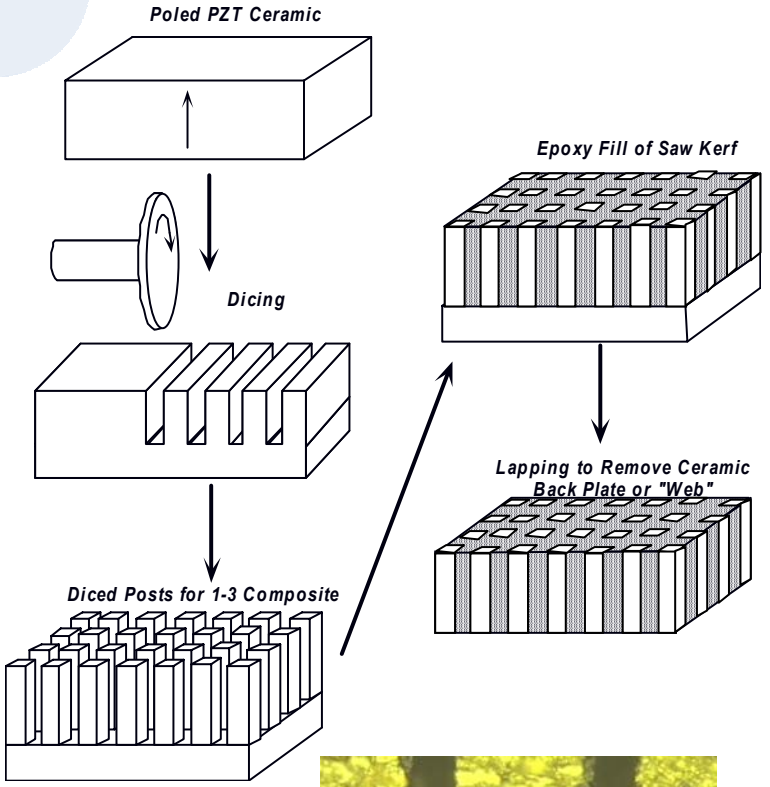
1) High electromechanical coupling;
2) Weak sidelobes;
3) High resolution because of the low-Q induced short pulse;
4) Wide bandwidth;
5) Low acoustic impedance for better acoustic matching.

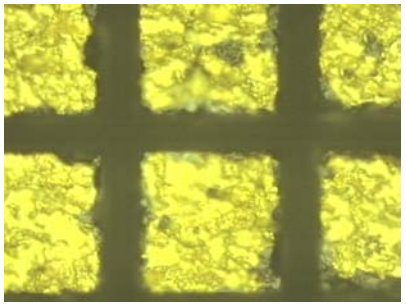




Piezoelectric Composites Fabrication Techniques

Introduction





Dice and Fill Technology

- Well Established
- Limited to < 25 MHz
- Available Saw Blades Not Thin Enough for Higher Frequency
- Common Problems are Chipping and Fracture

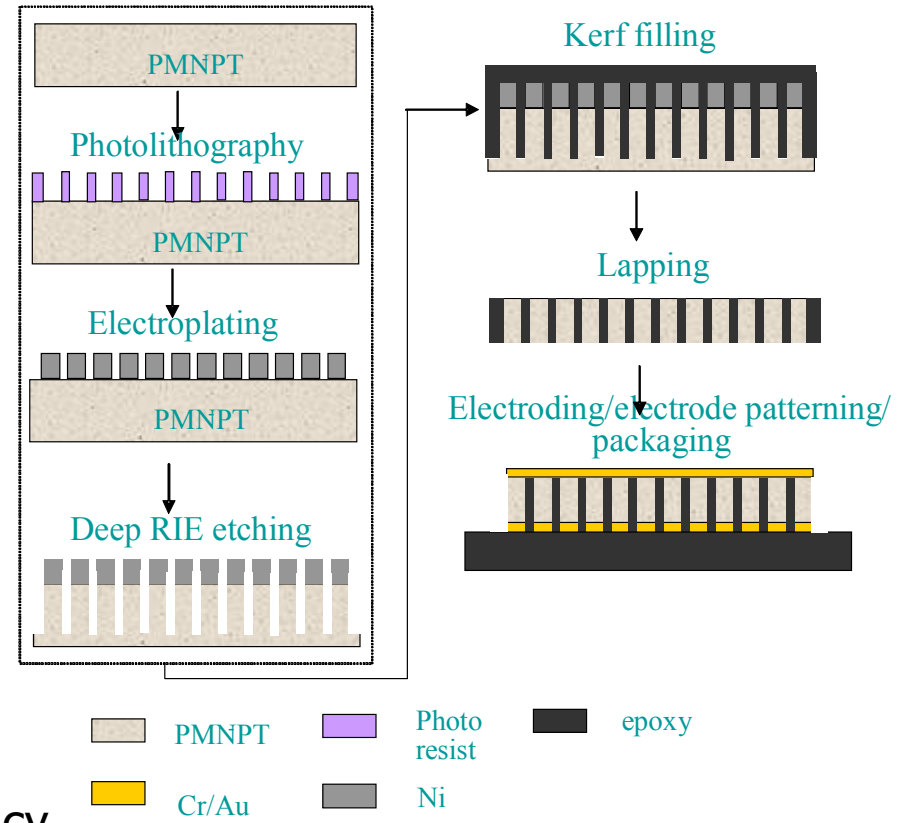
Alternatives:

- Lamination
- c-MUT
- Laser micromachining
- Micro-molding
- p-MUT
- Tape casting

TRS Solution – PC-MUT

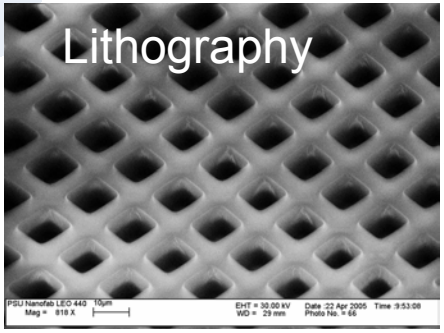
PC-MUT

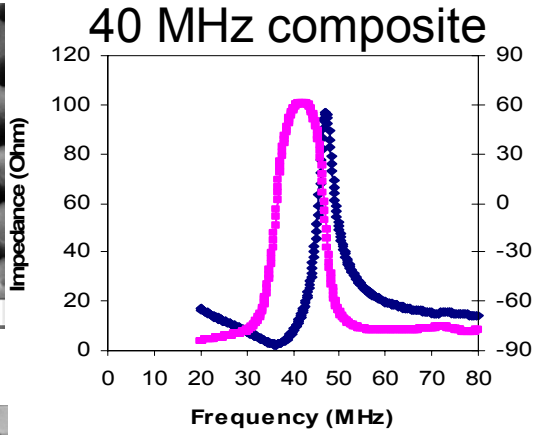
- Use Photolithography & Plasma Etching
- Form Fine Features in High Performance Single Crystal
- High Frequency, High Performance Composite
- Very High Resolution, Broad Bandwidth Single Elements
- Basis for Very High Frequency Integrated Array Transducers

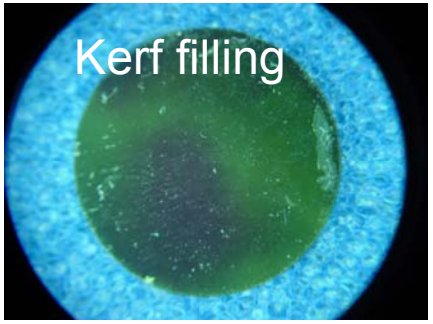


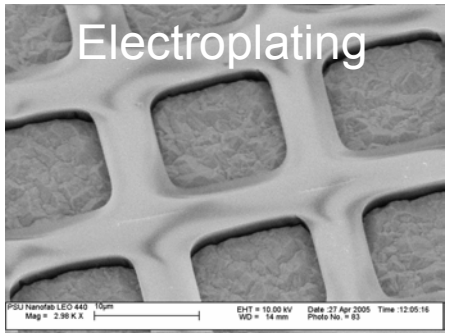
Microfabrication and Composite Characterization

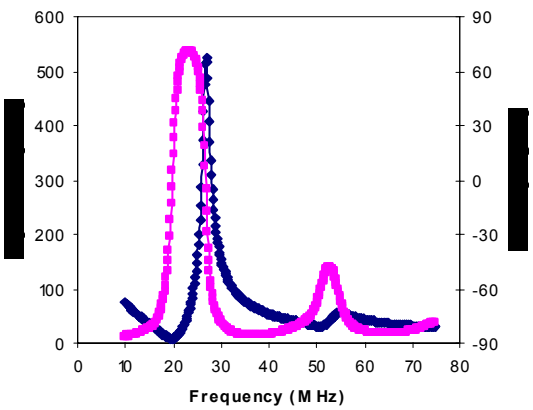
PC-MUT

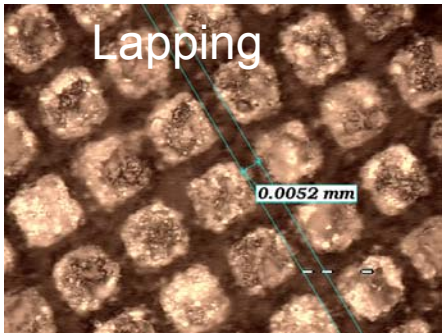


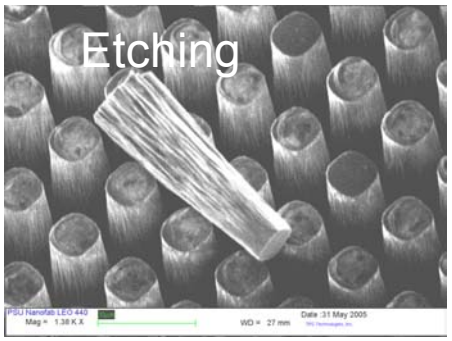


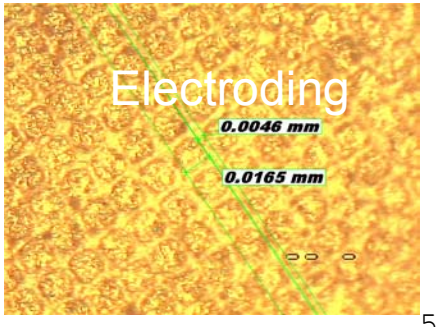






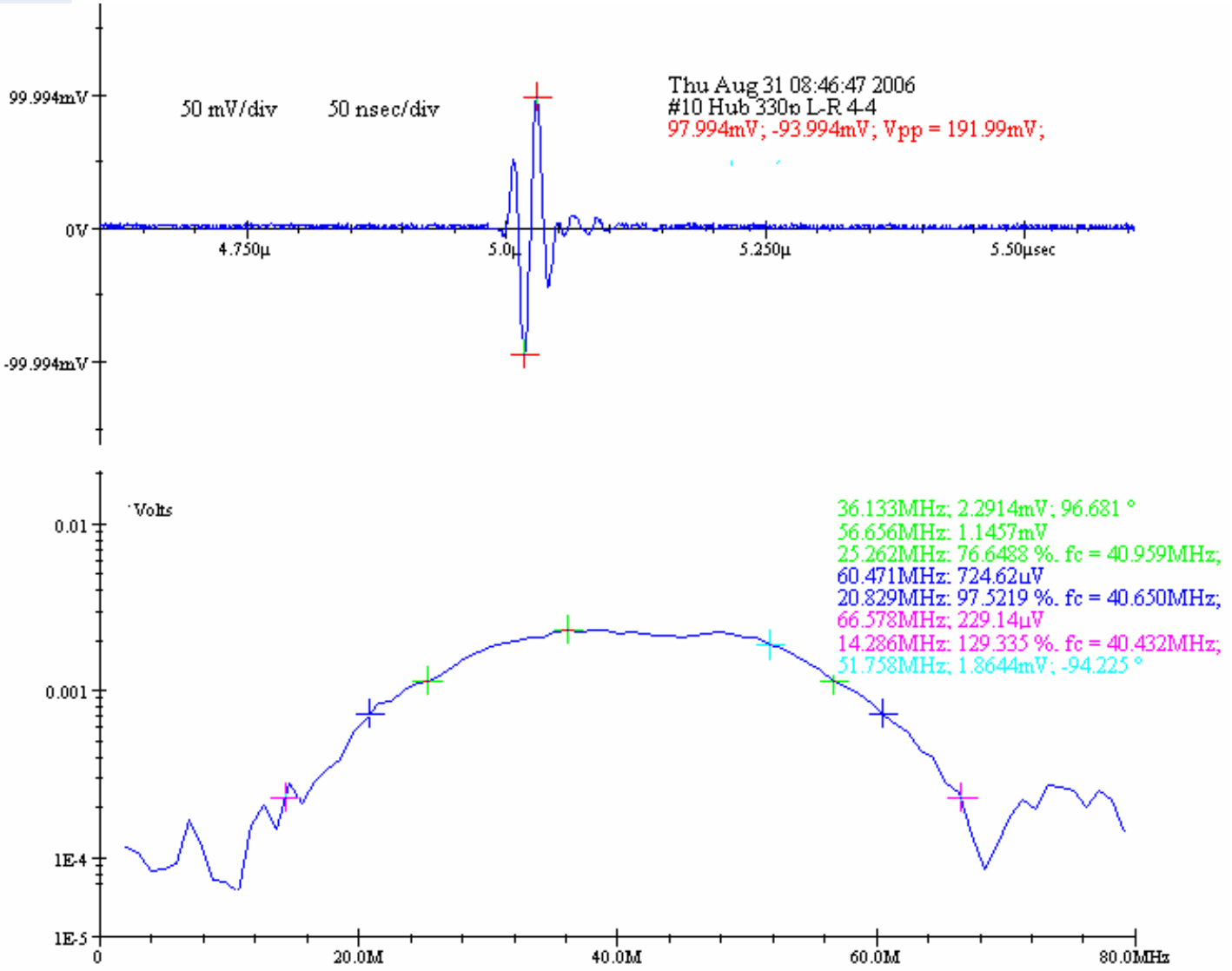






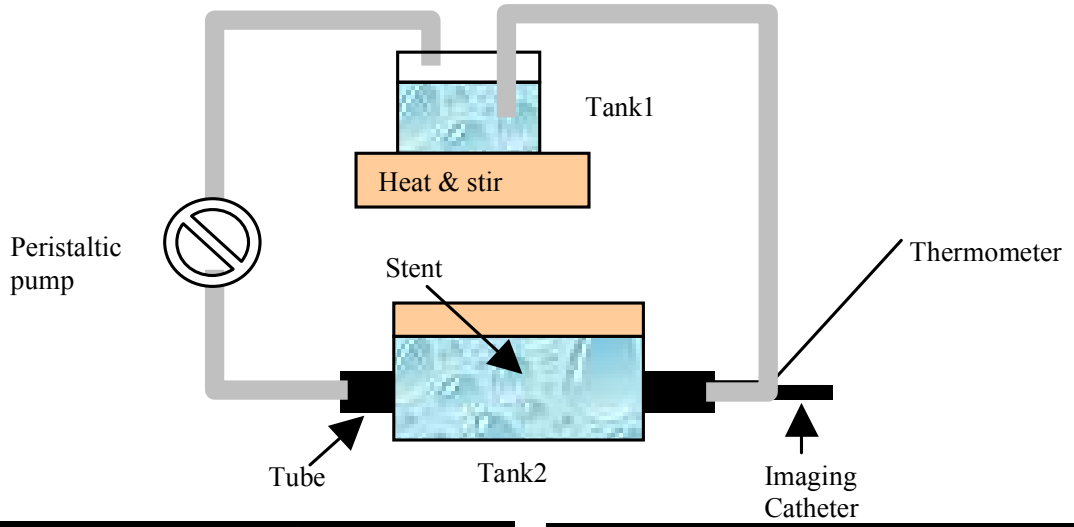
40 MHz PC-MUT Pulse-Echo Test

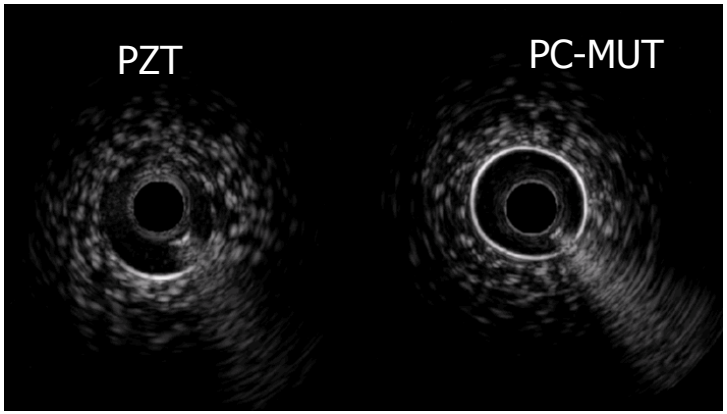
Results



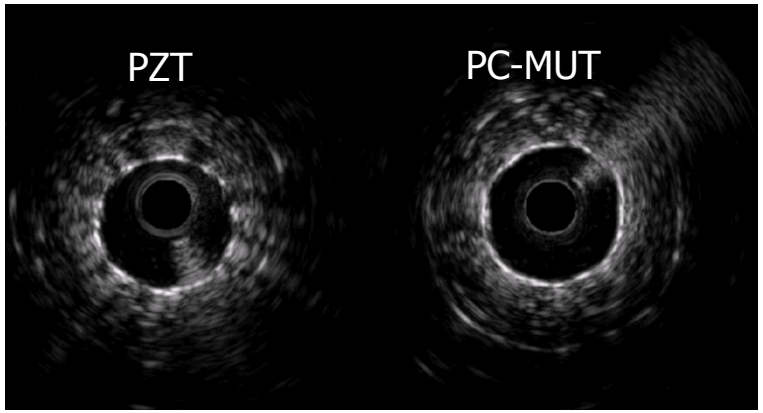
40 MHz PC-MUT Phantom Test

Results





Outside Stent Phantom Image



Inside Stent Phantom Image

Summary

- 20-50 MHz PMN-PT/Epoxy 1-3 composites fabricated using PC-MUT technology showed high electromechanical coupling coefficients (~ 0.72) comparing with other high frequency transducer materials.
- 40 MHz PC-MUT shows significantly improved sensitivity, bandwidth and IVUS imaging quality.
- Piezoelectric composites fabricated using PC-MUT technology are promising for advanced ultrasound imaging.

Acknowledgement

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