New Progress in High Resolution Ultrasound Imaging Technique

The high-frequency ultrasound imaging technique (>20 MHz) has gained widespread attention because its high spatial resolution is very useful for basic cardiovascular and cancer research involving small animals. Lately, ZHENG Hairong and coworkers at the Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences have made new progress in developing high frequency ultrasound transducers and electronics.

High frequency transducer is a key device in an ultrasound imaging system. Piezoelectric materials are usually employed for the transducer, but its clamped dielectric permittivity is relatively low in traditional materials. Therefore, the impedance of a small size transducer is not good, which usually leads to bad performance of the transducer.

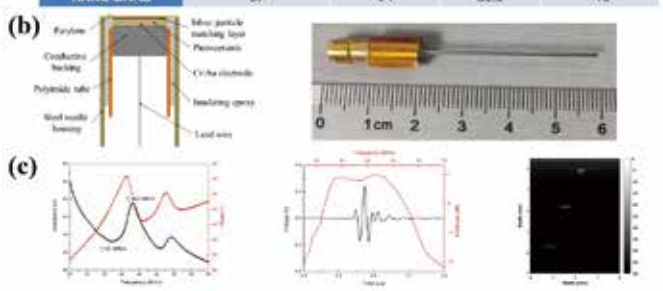
The researchers in Shenzhen proposed a modified Pb(Mg1/3Nb2/3)O3-PbTiO3 (PMN-PT) polycrystalline ceramic with ultrahigh relative clamped dielectric permittivity (εS/ε0 = 3500) and high piezoelectric properties (d33 = 1100 pC/N, kt = 0.55) to fabricate high frequency miniature ultrasound transducers.

They designed and successfully characterized a 39 MHz high frequency ultrasound needle transducer with a miniature aperture of 0.4 mm × 0.4 mm. The fabricated needle transducer had an electromechanical coupling factor kt of 0.55, large bandwidth of 80% at -6 dB, and low insertion loss of -13 dB.

A wire phantom and porcine eyeball imaging study demonstrated good imaging capability of this needle transducer. The transducer performance was proved to be superior to that of other needle transducers with miniature apertures.

(a)

Piezoelectric Material	Center frequency (MHz)	Aperture (mm)	Bandwidth (%)	Insertion loss (dB)
Proposed	39	0.4 × 0.4	80	-13
$LiNbO_3$	45	Φ3	74	-21.3
PZT-5H	45	Φ2	<40	-40
PMN-33PT	44	0.4 × 0.4	45	-15
PZN-7%PT	43	0.4 ×0.56	45	-17
BZT-BCT	30	0.8 × 0.8	53	-18.7
KNNS-BNKZ	37	Φ1	56.8	-16



(a) Comparison with high frequency ultrasound transducer with different materials; (b) The structure and the fabricated transducer; (c) Imaging performance of the proposed transducer.

This modified PMN-PT ceramic based needle transducer is promising for minimally invasive procedures in medical applications.

Their work was published in *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*.

The study involved collaboration with researchers from the University of Southern California, the Pennsylvania State University, the University of Glasgow and Northeastern University in China, with support from the National Science Foundation of China, the Chinese Academic of Sciences, the Innovative and Entrepreneurial Research Team Program of Guangdong Provincial Government, the Shenzhen International Collaboration Program, etc.