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Piezofibre composite transducers for next generation 3D USCT

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At KIT a 3D USCT is under development. The system is optimized for SAFT imaging and has a multistatic setup of 2041 transducers with approx. 1MHz 3dB bandwidth and 36° 3dB opening angle for 2.5MHz. The USCT groups transducers in a semi-elliposoidal aperture surrounding a ROI of 10x10x10cm^3. To increase the ROI for a next USCT generation, the opening angle of a future transducer design should be increased to approx. 60° while other characteristics should be preserved or even improved.

(2) Material and Methods

The fundamental connection between an ultrasound transducer's emission and reception sensitivity in the azimuth and elevation angle space is the tranducer's aperture size. Simulations showed that approx. half the side length of current generation transducer is required. A circular instead of the current rectangular aperture would results in additional homogenicity. The established Fraunhofer IMT piezo-fibre composite technology provide circular fibres of required dimensionality.
In this work a transducer design is presented which utilizes individual and reproducible dimensioned piezo fibres. The fibres were fabricated from PZT powder using the polysulfone spinning process.

(3) Results

13 fibres were positioned by a mechanical mask and filled with a matrix of epoxy, curing to a rod of 18cm length and 2.3cm diameter. From this rod discs were sawed, defining the main resonance frequency by thickness, and then uniformly polarized. Connectivity was achieved by manual wiring via heat curing glue on top and bottom printed circuits. A transducer array (TAS) was finalized in a cylindrical housing by filling with PU backing material. TAS prototypes were assembled with a matching and backing and individual electrical connections. Electrical characterization was performancd with a phase-impedance analyzer for all piezo fibres. Ultrasound characteristics were evaluated quantitatively with a hydrophone in a 3-axis water tank.

(4) Discussion and Conclusion

The presented assembly process fullfills the expectation of repoducible positioned transducer arrays, regarding disc thickness and fibres position and size. The relative variation of the the second resonace frequency varied among the 265 samples by a standard deviation of 2.48% only.
The previously noticed effect of greatly varying single fiber piezo fibre performance could to be vastly reduced in a second batch of discs. This is under ongoing analysis and further build up prototypes.

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