Adaptive Ultrasonic Transducers Fabricated Based on 3D Printing technology

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Background, Motivation and Objective

The adaptive transducers with multi-element and complex-geometry tectonics are urgent for novel ultrasonic technology and developing direction. But these transducers are very difficult to process directly due to the brittle piezoelectric ceramic. The 3D printing technology is a rapid prototyping process that play an effective role in geometrical flexibility without module. However, the piezoelectric ceramics fabricated by 3D printing have disadvantages of their low density and properties which can hardly meet the demands of high-performance ultrasonic transducers.In this work, the suspensions with different PZT weight content were prepared for the PZT ceramic fabrication based on the stereolithography apparatus(SLA) technology. Besides, the microstructure, piezoelectric properties of the 3D-printed ceramics were characterized. Furthermore, an ultrasonic 2D array (8x8) was fabricated to further estimate the ceramic properties and suggest the potential application of this fabrication technique.

Statement of Contribution/Methods

The PZT ceramic suspensions was prepared with different content powders and photocurable resin using ball milling under 350 trs/min for 2h. The three-dimensional models of green body were built by computer-aided design software. Then the ceramics suspensions were spread out on the resin container by the scrapper of SLA system, the software for 3D printing sliced the models. Then the green body was debinded at 650°C and sintered at 1250°C, respectively. Then the transducer was fabricated based on the sintered ceramic. The transducer performance was measured by a conventional pulse-echo response measurement method.

Results/Discussion

Fig.1(a) shows the photo of the 3D-printed piezoelectric ceramic 2D array, Fig.1(b) gives the SEM micrograph with high density, Fig.1(c)shows the P-E loops of different PZT content. The measured pulse-echo waveform and frequency spectrum are shown in Fig.1(d). The 2D array with center frequency of 2.24MHz exhibits a -6dB bandwidth of 35%, which is comparable to a normal PZT ceramic transducer array (31%). These results indicate that the 3D-printed ceramics had good potential for the ultrasound transducer applications.

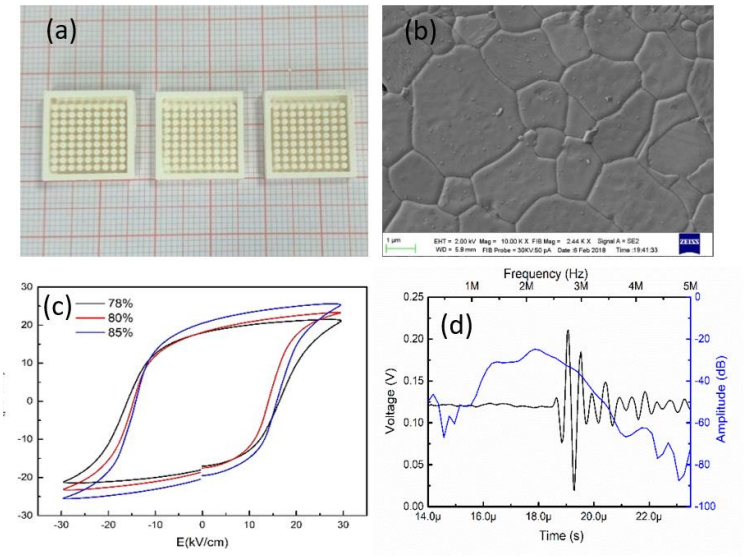

Fig.1 the photo of the 3D-printed piezoelectric ceramic array(a), SEM micrograph(b),P-E loop of the ceramics with different PZT content(c),measured pulse-echo waveform and frequency spectrum of 2D array(d).