3-D Imaging Using Row-Column-Addressed Arrays With Integrated Apodization: Part II: Transducer Fabrication and Experimental Results

This paper demonstrates the fabrication, characterization, and experimental imaging results of a 62×62 element λ/2-pitch row-column-addressed capacitive micromachined ultrasonic transducer (CMUT) array with integrated apodization. A new fabrication process was used to manufacture a 26.3 mm by 26.3 mm array using five lithography steps. The array includes an integrated apodization, presented in detail in Part I of this paper, which is designed to reduce the amplitude of the ghost echoes that are otherwise prominent for row-column-addressed arrays. Custom front-end electronics were produced with the capability of transmitting and receiving on all elements, and the option of disabling the integrated apodization. The center frequency and -6-dB fractional bandwidth of the array elements were 2.77 ± 0.26 MHz and 102 ± 10%, respectively. The surface transmit pressure at 2.5 MHz was 590 ± 73 kPa, and the sensitivity was 0.299 ± 0.090 V/Pa. The nearest neighbor crosstalk level was -23.9 ± 3.7 dB, while the transmit-to-receive-elements crosstalk level was -40.2 ± 3.5 dB. Imaging of a 0.3-mm-diameter steel wire using synthetic transmit focusing with 62 single-element emissions demonstrated axial and lateral FWHMs of 0.71 mm and 1.79 mm (f-number: 1.4), respectively, compared with simulated axial and lateral FWHMs of 0.69 mm and 1.76 mm. The dominant ghost echo was reduced by 15.8 dB in measurements using the integrated apodization compared with the disabled configuration. The effect was reproduced in simulations, showing a ghost echo reduction of 18.9 dB.

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