High-Resolution 3D Phased-Array Imaging Using 1024-Element 2D Matrix Array Transducers

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Ultrasonic phased array (PA) has been widely used in industrial fields. Most PAs use a linear array transducer, producing 2D images. On the other hand, actual defects can have complex 3D geometries. Although the use of a 2D matrix array transducer for 3D imaging is promising, the number of 2D matrix array transducers has been limited to 256 or less for nondestructive evaluation (NDE) applications. The state-of-the-art studies for medical ultrasonics have used 1024-element 2D matrix array transducers, whereas an appropriate design of a 2D matrix array transducer for NDE applications differs from that for medical applications because of the difference in diagnosed objects and scattering behaviors. On the other hand, we have developed a high-resolution 3D imaging method based on the piezoelectric monolithic transmitter and 2D laser scanning receiver, which is referred to as piezoelectric laser ultrasonic system (PLUS) [Y. Ohara, et al., Appl. Phys. Lett. 117 (2020) 111902]. However, the long acquisition time makes it less pragmatic in a way. In this study, we developed a real-time, high-resolution 3D PA imaging method by fabricating a 1024-element array transducer dedicated to NDE. We first designed the array transducer using a 3D numerical simulation and experimental 3D scattering analysis [Y. Ohara, et al., Sci. Rep. 12 (2022) 8291]. Based on the designs, we fabricated 1024-element piezoelectric array transducers. They were applied to metallic samples with internal defects. We will show some high-resolution 3D imaging results of defects obtained by the 1024ch PA system.