Manipulation of acoustic focusing with FZP transducer

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Background, Motivation and Objective

Manipulation of acoustic focusing with a Fresnel zone plate (FZP) lens has been proposed. However, the previous FZP is made of rigid materials to resist the even or odd zones of the Fresnel half-wave zones. As a result, most of the incident energy is reflected. Here, an active and configurable transducer with FZP made of silicone is proposed to manipulate the waterborne sound focusing, which ensures that most energy get through the plate and converging to the focus.

Statement of Contribution/Methods

The three-dimensional and radial cross-section view of the FZP transducer is shown in Fig. 1(a) and 1(b), respectively. The FZP transducer with the focal length of 18 mm (~10λ) is designed at the frequency of 8 MHz. The phase-difference of the even zones and the odd zones is π/2, as the bulge height of the FZP is 0.136 mm (~0.73λ). Due to the incoherent of even zones and odd zones, the focusing ability come up to the optimal level. The acoustic pressure field, and the amplitudes of the pressure field are simulated by COMSOL multiphysics.

Results/discussion

Based on the expression of the Fresnel zone radii in the case of a plane wave, the FZP transducer with the focal length of 18 mm is designed at the frequency of 8 MHz. The pressure field in the x-z plane as shown in Fig. 1(c). The normalized amplitude of the pressure field along vertical direction and horizontal direction in the focal plane are shown in figure 1(d) and 1(e). The focal length is 18 mm (10λ) as shown in Fig. 1(d), which is agree with our predesigned value. The horizontal resolution is about 0.404 mm (~2.17λ) in the focal plane, as shown in Fig. 1(e). Hence, the concept and results presented in this work provide a flexible and practical method to manipulate acoustic focusing, and may offer potential applications in waterborne ultrasonic imaging or ultrasound therapy.

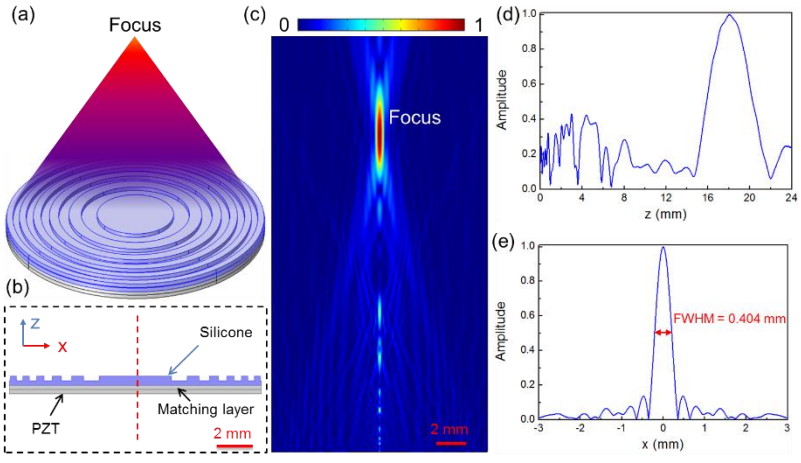

Fig. 1. Three-dimensional view (a), and the radial cross-section view of the FZP transducer (b). (c) The simulated distribution acoustic pressure field. The normalized amplitude of the along vertical direction in the x-z plane (d), and horizontal direction in the focal plane (e).