Supplementary Information on

Generating Airy Surface Acoustic Waves with Dislocated Interdigital Transducers

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1. Simulation

In our simulation, the piezoelectric module in COMSOL Multiphysics was employed to conduct a frequency-domain analysis of the acoustic field generated by the designed dislocated IDTs. Given that the focus of the model was on the acoustic field distribution of SAWs, parasitic wave propagation along the substrate thickness direction was ignored, thereby justifying the use of a two-dimensional model. This approach significantly reduced the computational load. A substrate with the dimension of 5.5 cm × 3.9 cm was defined and assigned with the material properties of lithium niobate ($LiNbO_3$). It was necessary to pay attention to the crystallographic orientation of the $LiNbO_3$ substrate relative to the SAW propagation direction. In this setup, the SAW propagation direction was aligned along the *x*-direction of the 128° Y-X cut $LiNbO_3$ wafer. A perfect matching layer (PML) with a thickness of one wavelength was implemented around the substrate's perimeter to eliminate reflected SAWs at the edges. The designed dislocated IDTs were then positioned at the coordinate (0, 10000), with the SAW propagating along the +*x*-direction. Notably, the dimensions of the dislocated IDTs in the *y*-direction were scaled by a factor of α to enable subsequent parameter sweeping of the IDTs. The model setup is illustrated in Fig. S1a. Floating (Fig. S1b) and grounded (Fig. S1c) electrodes were assigned to the dislocated IDTs, and a 7.98 MHz signal with 20 V_{pp} was applied. Appropriate mesh sizes were defined, and finally, a parameter sweeping of the scale factor α from 9000 to 15000 was carried out to obtain the results.

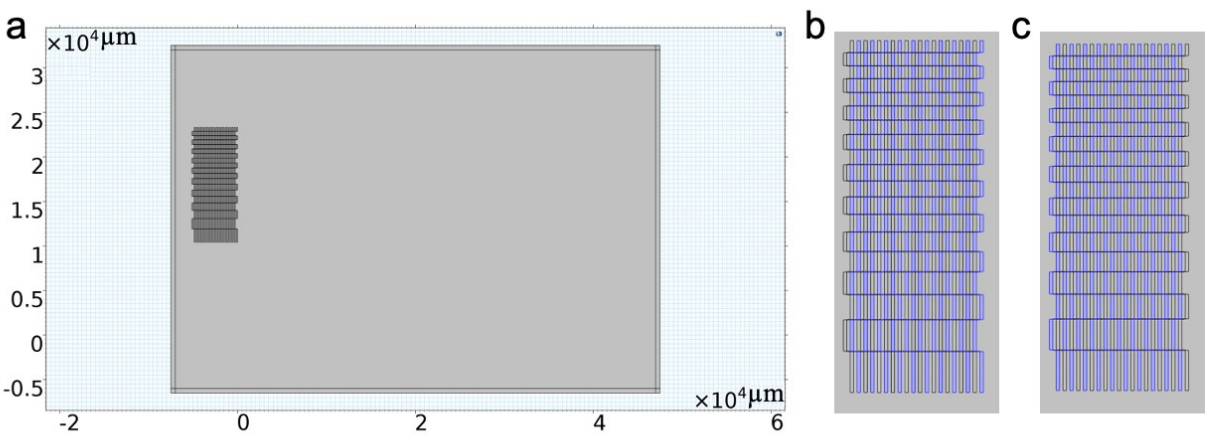

Fig. S1 (a) Schematic diagram of the simulated model; The blue sections were set to (b) floating and (c) grounded terminals.

2. Device characterization

There are connecting wires existing between adjacent dislocated electrodes of IDTs. It is worth noting that excessively narrow connecting wires not only require high-precision fabrication techniques but also result in higher resistance. When the local resistance of the electrodes is too high, it affects the radiation intensity of the SAWs, leading to a low signal-to-noise ratio (SNR) in the LDV-scanned image of acoustic field. To verify this point, dislocated IDTs with connecting wire linewidths of 25 μm, 10 μm, and 5 μm were fabricated, and they were marked as #1, #2, and #3, respectively. The acoustic field distributions corresponding to these dislocated IDTs were measured, as illustrated in Fig. S2. To quantify the quality of the acoustic field, the SNR is calculated on the scanned acoustic field images using the following equation,

$$\mathrm{SNR} = 10\log_{10}\left[\frac{\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}(K(i,j))^2}{\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}(K(i,j)-I(i,j))^2}\right] \tag{1}$$

where $K(i, j)$ represents the pixel value at the position (i, j), $I\,(i, j)$ denotes the averaged pixel value of the image, and m and n are the dimension of the image.

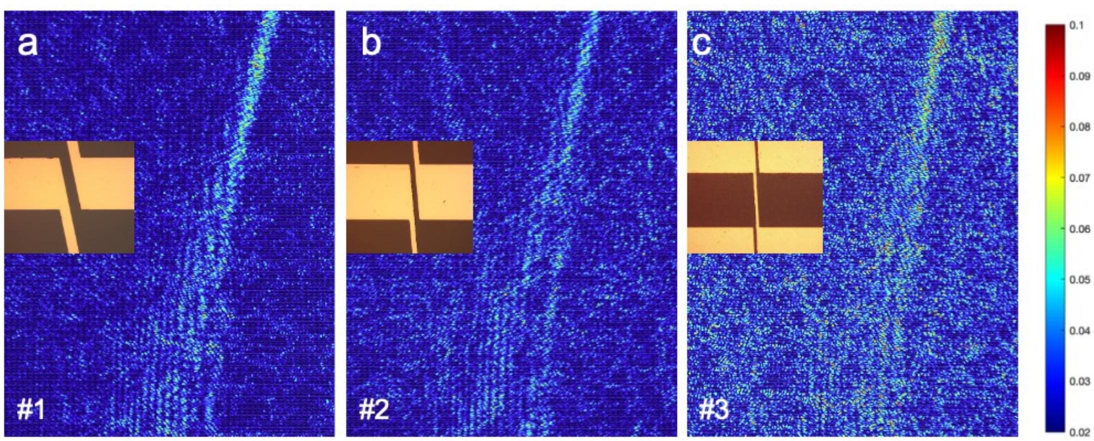

Fig. S2 The LDV-scanned acoustic field distributions of the generated Airy SAWs for dislocated IDTs with connecting wire linewidths of (a) 25 μm, (b) 10 μm, and (c) 5 μm, which are marked as #1, #2, and #3, respectively. Insets are the microscopic images of the local structure of the connecting wires.

The LDV-scanned results for #1, #2 and #3 are shown in Figs. S2a–c, respectively. The calculated SNR values for #1, #2 and #3 are 5.5797, 4.7984, and 2.3942, respectively. These results indicate that as the connecting wire linewidth decreases, the SNR also decreases accordingly. These findings confirm our hypothesis that excessively narrow connecting wires lead to increased local resistance, thereby reducing the output efficiency of the SAWs. Moreover, it is also worth noting that the increased local resistance could also lead to significant electrode heating, which poses a risk of device damage due to overheating during prolonged operation.