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# Stoneley Waves Propagation Through rot. YX-$LiNbO_3$/SU-8/Si Structures

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**Summary:**

Interface acoustic waves (IAWs), also known as Stoneley waves, are theoretically and experimentally investigated in a multilayer platform consisting of Y-rotated, X-propagating $LiNbO_3$, an SU-8 guiding layer, and a silicon substrate. Two distinct IAW modes with different phase velocities are identified for specific Y-rotated cuts of the $LiNbO_3$ half-space. These modes propagate faster than conventional surface acoustic waves and slower than leaky surface acoustic waves on bare $LiNbO_3$. Numerical simulations and experimental measurements confirm the efficient electroacoustic excitation of the Stoneley modes. **Keywords:** $LiNbO_3$, interface, Stoneley waves, IDT.

## Background, Motivation an Objective

Interest in interface acoustic waves (IAWs) stems from their ability to enable packageless electroacoustic devices, overcoming the size and cost limitations of conventional SAW-based technologies. By confining acoustic energy at the interface between two bulk media, IAWs eliminate the need for an acoustic cavity while remaining compatible with standard IDT fabrication. In microfluidic applications, where Rayleigh SAWs on 128° YX-$LiNbO_3$ suffer strong attenuation under PDMS microchannels, IAWs—supported in rotated YX-$LiNbO_3$ with appropriate overcoats—offer an efficient alternative for particle manipulation.

## Description of the Method

3D FEM study was carried out by Comsol Multiphysics software to evaluate the main characteristics of the IAWs in rot. YX-$LiNbO_3$/SU-8/Si such as phase velocity, propagation loss, electromechanical coupling coefficient ($K^2$), and displacement components. Figure 1a shows the frequency vs. the $LiNbO_3$ Y-rotation angle curves of the two IAWs. The performed study shows that rot. YX-$LiNbO_3$/SU-8/Si can support the propagation of two IAW modes with $K^2$ as high as about 7% and 24% (shown in figure 1b). The calculations informed the design of the devices selected for fabrication and experimental validation.

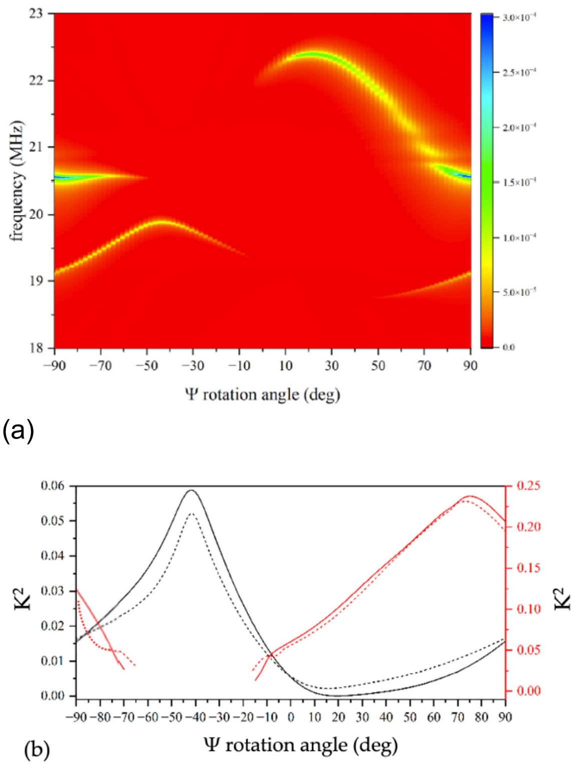


Fig. 1. a) The frequency vs. the $LiNbO_3$ Y-rotation angle curves of the two IAWs. The coloured bar represents the absolute value of admittance $Y_{11}$. b) The $K^2$ for the SAW and LSAW propagating on the bare piezoelectric substrate (black and red continuous lines) and for lower and upper IAWs (black and red dashed lines vs the rotation angle [1].

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## Results

Delay lines with 330-nm-thick Pt interdigital transducers and an acoustic wavelength of 200 µm were fabricated on the surface of 128° and 90° Y-X $LiNbO_3$ substrates**.** Subsequently, an SU-8/Si overcoat was deposited over the entire delay line—including both IDTs and the acoustic propagation path—and cured under pressure for 10 min at 95 °C**.** The resulting SU-8 layer thickness was 15 µm (the device is shown in Figure 2) [1,2].

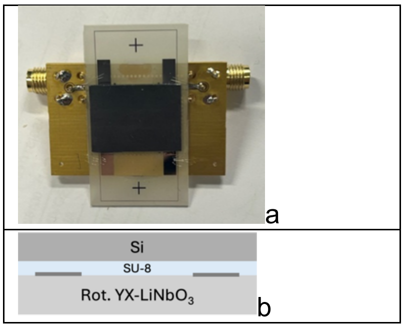


Fig. 2. a) The photo of the IAW-based delay line; b) the schematic of the cross section of the device.

The measure of the delay lines scattering parameter $S_{21}$ vs frequency curves revealed the propagation of two (the upper and lower IAW) and one IAW in 90° and 128° rot. YX-$LiNbO_3$/SU-8/Si structures, respectively, as shown in figure 3.

## Conclusions

The experimentally excited IAWs propagate at velocities in good agreement with the values predicted by the 3D FEM simulations. The excitation of two modes at distinct frequencies and with different polarizations—namely elliptical and quasi–shear-horizontal—opens promising perspectives for the development of compact and multifunctional devices, including filters, encoders, and advanced sensors. In particular, fast IAW modes alleviate the high-frequency limitations of conventional SAW resonators, thereby enabling enhanced signal-processing capabilities. Moreover, the availability of IAWs with different polarizations makes these devices especially suitable for both robust sensing in harsh environments and actuation in microfluidic systems.

## References

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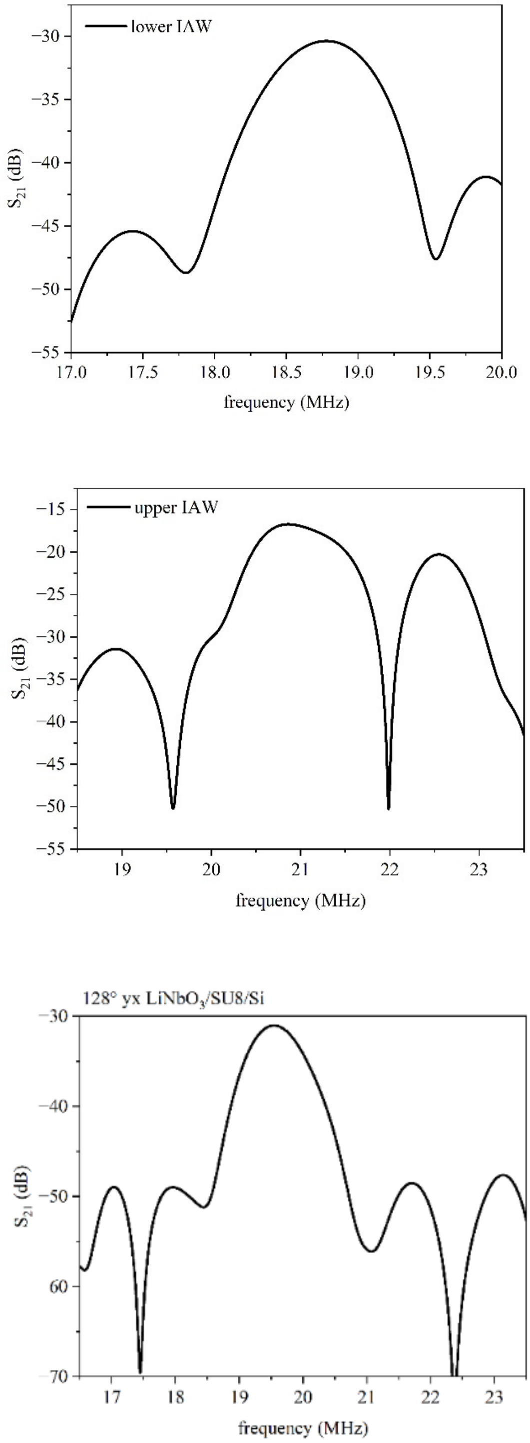


**Fig. 3.** The $S_{12}$ vs. the frequency curves for the 90° (upper and lower IAW) and for 128° YX-$LiNbO_3$/SU-8/Si structure [1, 2].