Researchers design new coupled shear saw resonator at high frequency

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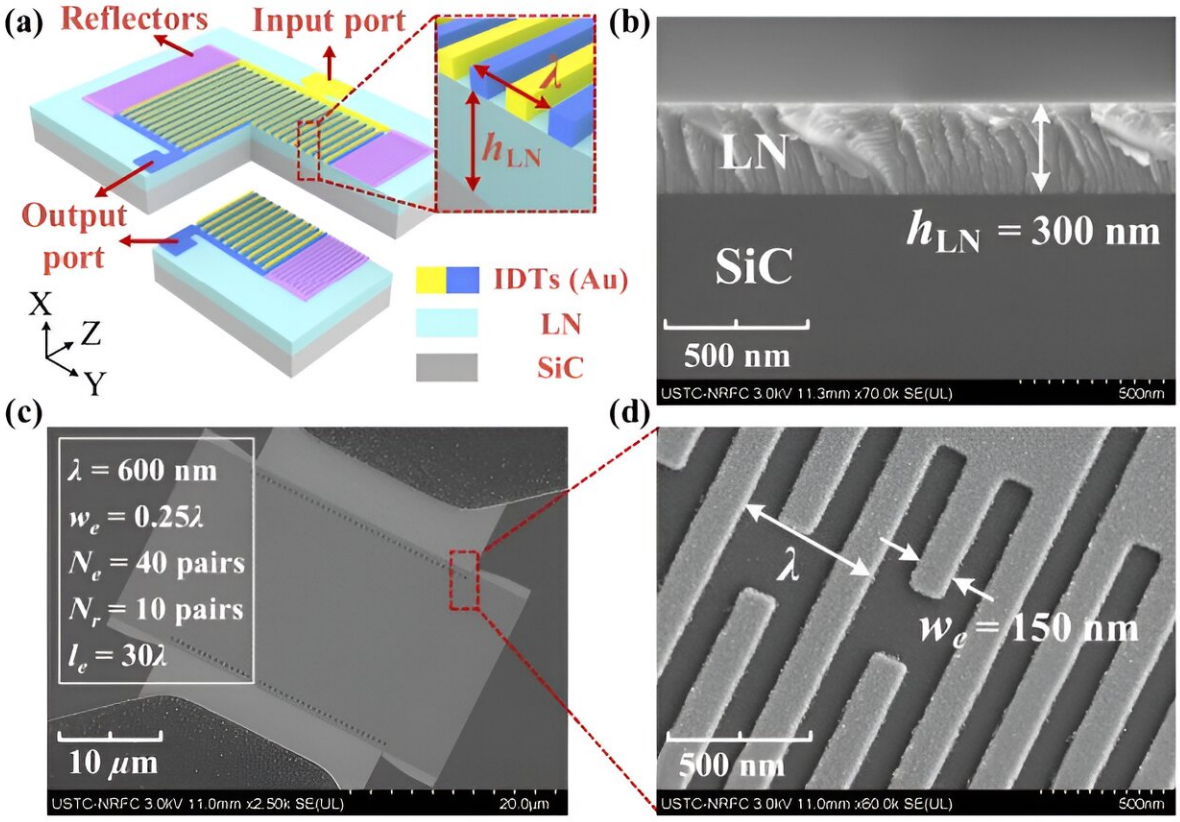

Schematic diagram and scanning electron microscope (SEM) photos of the CS-SAW resonator design. Credit: Zuo et al.

Surface Acoustic Wave (SAW) resonators have been widely used in wireless communication below 2 GHz. However, as wireless

communication evolves into 5G and 6G, with the new frequency bands above 3 GHz and bandwidth exceeding 500 MHz, conventional SAW technology face serious bottlenecks in terms of high frequency (>3GHz), high quality factor (Q value), and high electromechanical coupling coefficient (k^2).

The main limitation of traditional SAW technology is that it has been using single piezoelectric coefficient to achieve the conversion between electrical and mechanical energy. To solve the issue, a research team led by Prof. Zuo Chengjie from the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences (CAS) developed a Coupled Shear SAW (CS-SAW) resonator that utilizes two coupling coefficients of different directions (e_{16} and e_{34}). Their work was published in *IEEE Electron Device Letters*.

The team designed and prepared the CS-SAW resonator based on a $LiNbO_3$-on-SiC (LNoSiC) substrate. By selecting the proper three-dimensional (3D) Euler angle (α) and designing the thickness (h_{LN}) to wavelength (λ) ratio of the $LiNbO_3$ thin film, the horizontal and vertical electric fields simultaneously excite two piezoelectric coefficients (e_{16} and e_{34}), making them coherently coupled in one single vibration pattern.

Results showed that this CS-SAW resonator achieved an unprecedented high k^2 of 34% at 5 GHz and an excellent figure of merit (FoM) up to 221. Compared to all reported SAW resonators above 4 GHz in the recent ten years, the team's CS-SAW resonator working at 5 GHz and 6 GHz have the highest FoM.

This work explored the possibility of coupling two or more piezoelectric coefficients in a single vibration pattern and designed a criterion for realizing such coupled shear modes, opening up a new research path for acoustics devices such as wideband filters, tunable resonators, highly sensitive sensors and so on.

More information: Zhongbin Dai et al, Coupled Shear SAW Resonator With High Electromechanical Coupling Coefficient of 34% Using X-Cut $LiNbO_3$-on-SiC Substrate, *IEEE Electron Device Letters* (2024). DOI: 10.1109/LED.2024.3368426

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