Design of Surface Acoustic Wave (SAW) Devices for Advanced Radio Frequency Technologies

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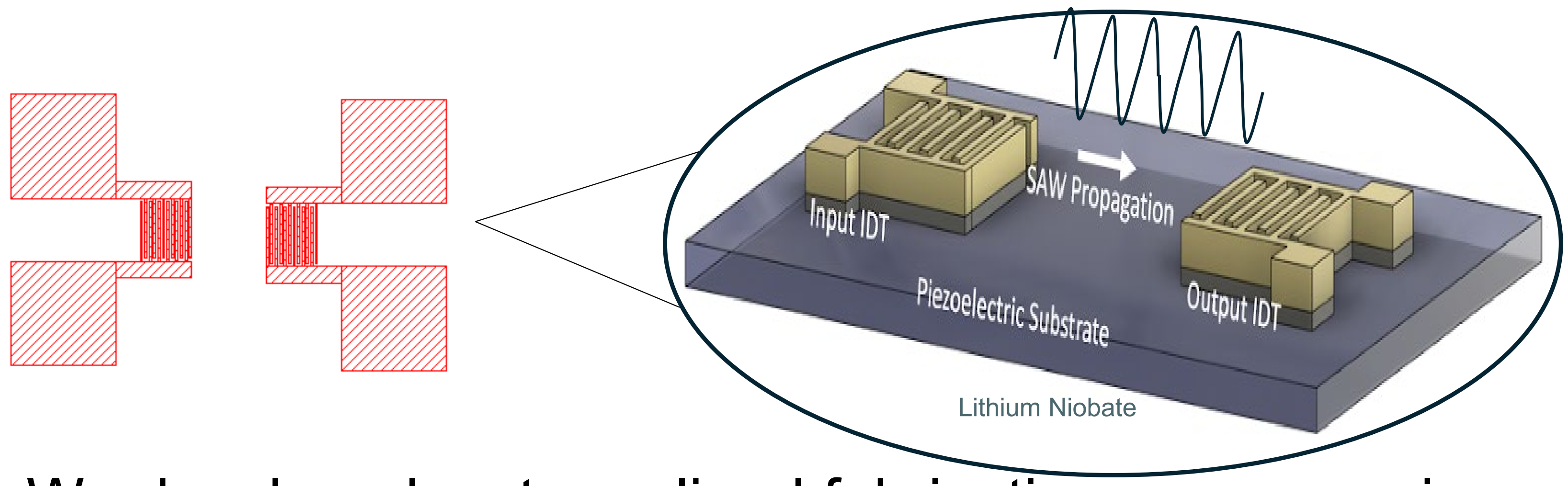
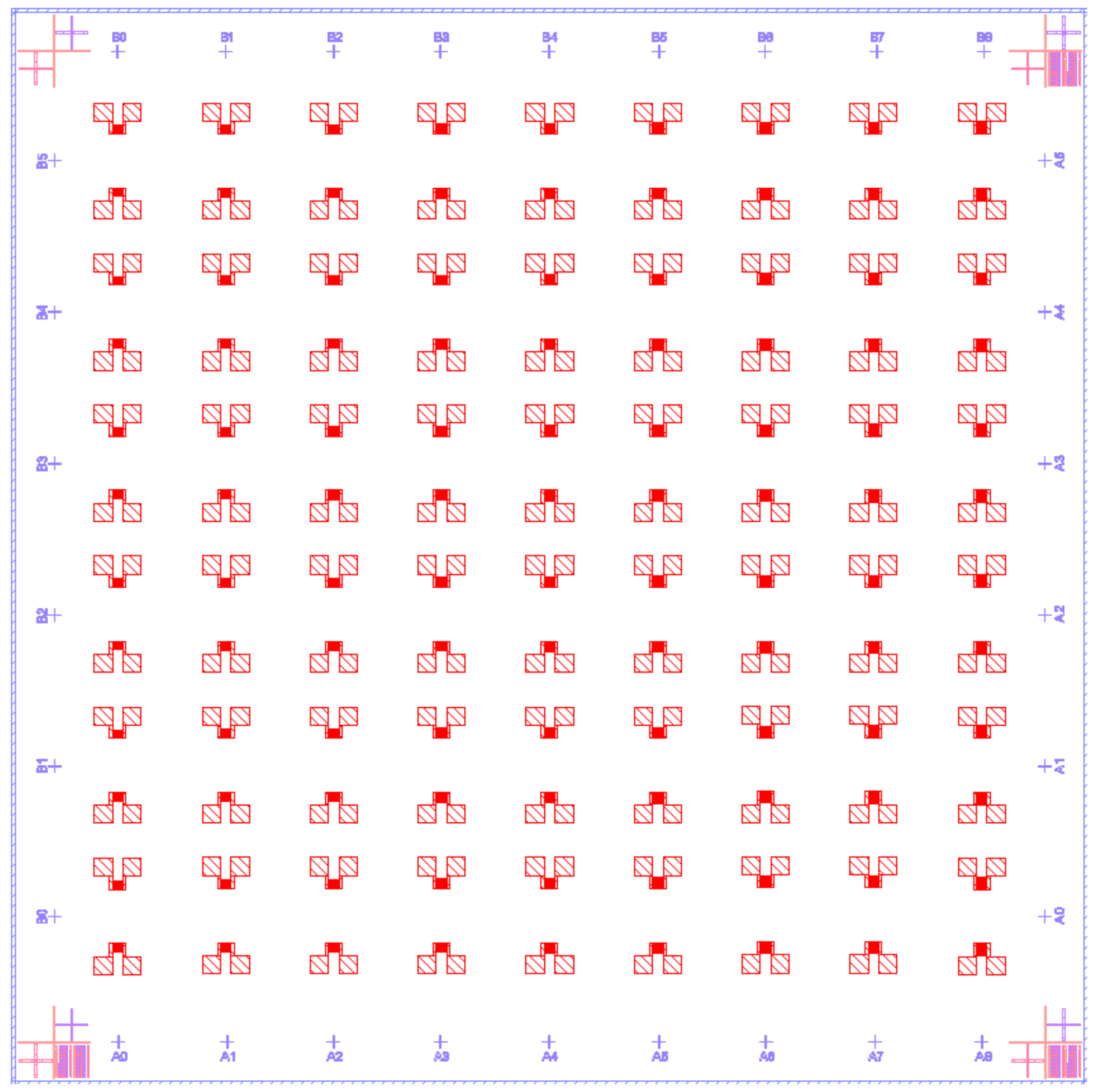
Executive Summary



We developed a streamlined fabrication process using maskless laser lithography, optimized photoresist coating, and e-beam metal lift-off—achieving 16–24 μm feature sizes on 128° Y-cut lithium niobate substrates with over 95% yield. This resulted in high throughput devices operate at 166–248 MHz with 99% electromechanical coupling efficiency. This approach meets current radio frequency (RF) filtering and sensing demands while enabling future scaling to GHz frequencies and straightforward integration of phase-change material (PCM) onto laser-ablated chip regions.

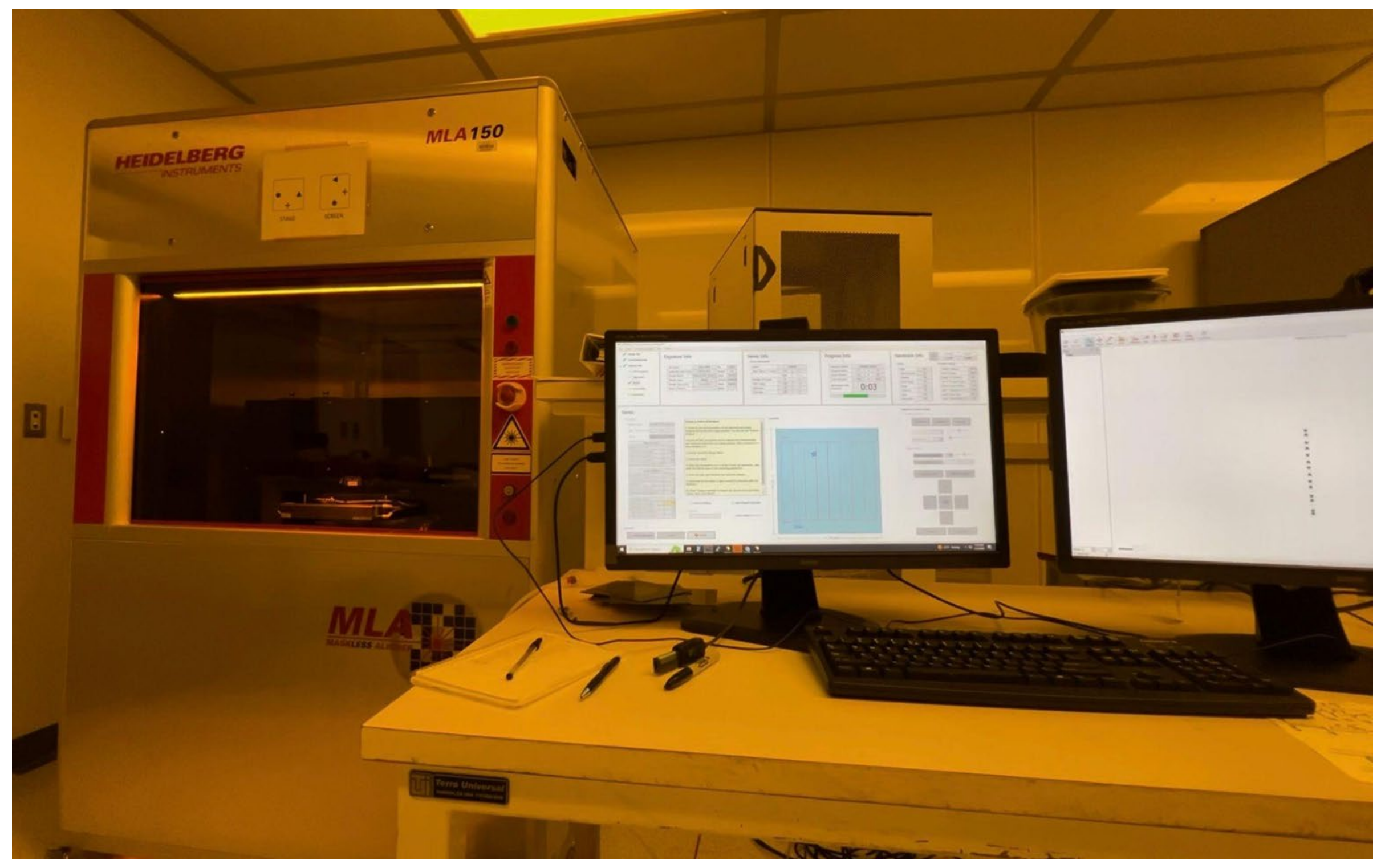
Chip Design



Feature Size(μm)	16	17	18	19	20	21	22	23	24
f(MHz)	248	234	221	209	199	189	180	173	166

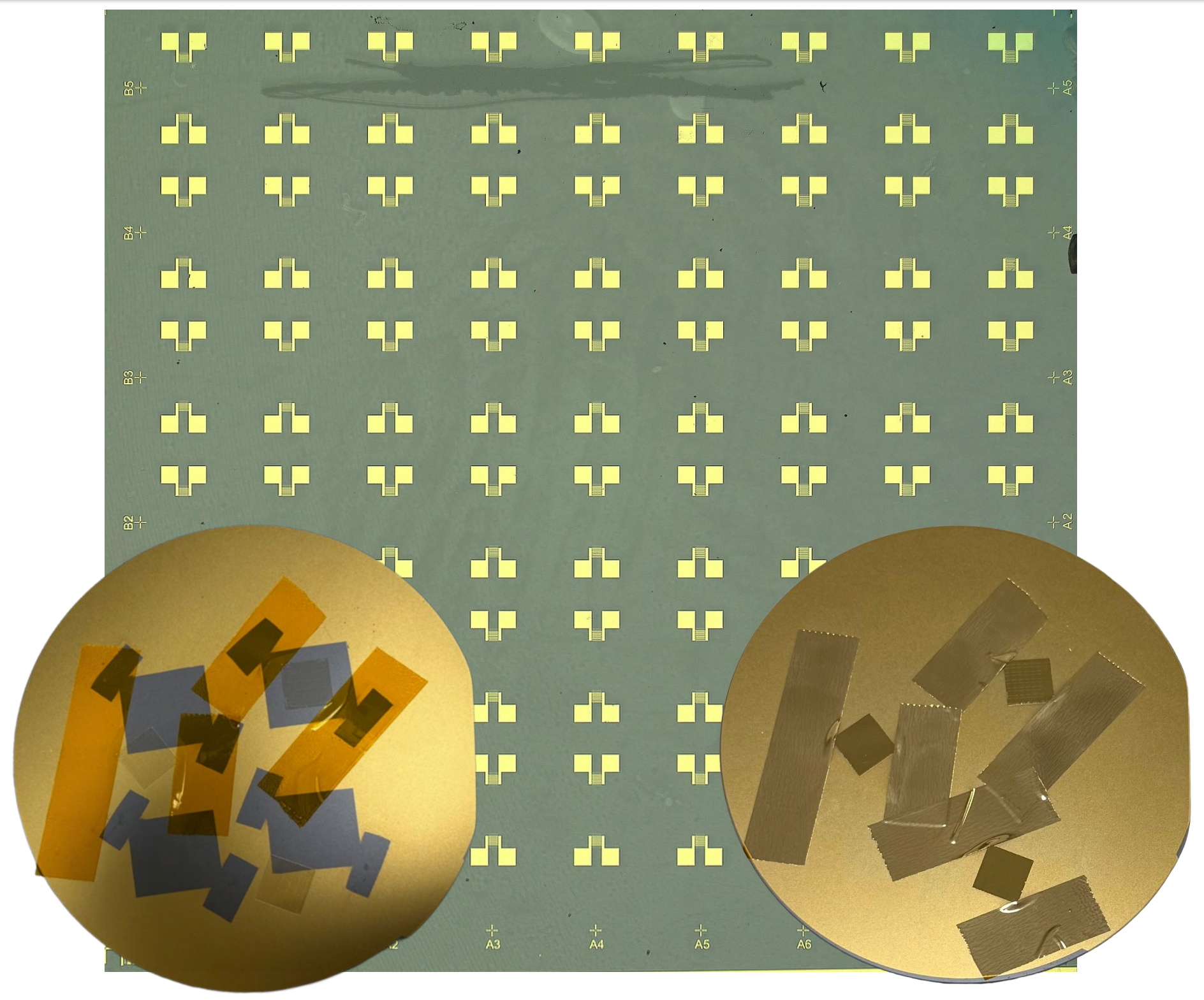
Maskless Lithography Apparatus (MLA)

MLA Tool



- Substrates undergo typical processes e.g., cleaned, spin-coated with photoresist, soft baked, exposed with the MLA, post-exposure baked, then developed.
- The MLA enabled direct, high-precision interdigitated transducers (IDT) patterning necessary for our devices without photomasks allowing for quick turn around time.
- Offers unparalleled flexibility to tweak electrode geometries between runs, fine-tuning filter bandwidths and resonance sharpness without reordering masks.

Temescal E-beam Evaporator

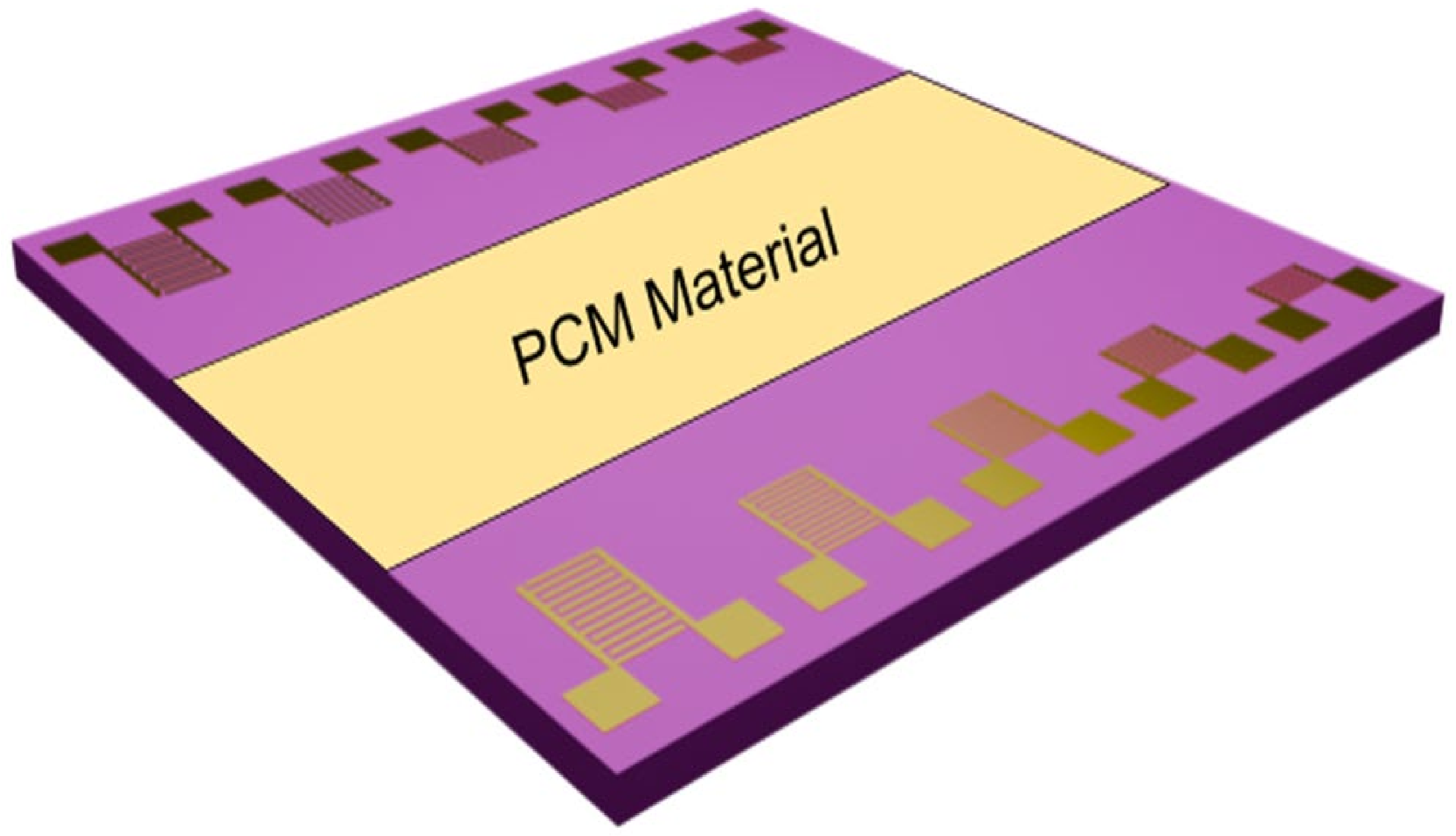


Pre-deposition Post-deposition

- Metal deposition allows for high-purity, contamination-free metal films, making it ideal for applications where electrical performance and surface integrity are critical.
- 10 nm of titanium and 50 nm of gold are deposited on the first set of chips

Future Device Design

PCM Deposition



- The MLA is utilized to create trenches in a layer of photoresist to assist PCM deposition and alleviate potential fabrication difficulties from etching piezoelectric crystals.
- The combination of these techniques can be utilized to ease fabrication difficulties and promote reconfigurable/unidirectional devices.

Conclusion

- Achieved SAW fabrication through a streamlined workflow delivering over 95 % yield with minimal process complexity and enabling rapid prototyping and scalable production.
- Characterization displayed operation across a 166–248 MHz band with a coupling efficiency of 99%, confirming robust device performance.
- Future improvements will focus on decreasing the wavelengths along with the deposition of PCM.

Acknowledgement

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