Flexible Capacitive Micromachined Ultrasound Transducers Based on a Sacrificial Release Process

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Background, Motivation and Objective

Wearable ultrasound transducers could open up new possibilities for cardiac ejection fraction monitoring, pulmonary hypertension monitoring and monitoring of response to interventions and therapeutics. We introduce flexible Capacitive Micromachined Ultrasound Transducers (CMUTs) based on transfer of devices onto a flexible substrate.

Statement of Contribution / Methods

Our approach uses a sacrificial release process to fabricate CMUTs on a Silicon substrate with Silicon-Nitride isolation layer, polysilicon sacrificial material, aluminum top and bottom electrodes, and Silicon Nitride membranes. We then use subsequent steps to transfer the devices to a flexible substrate. This transfer process includes HMDS, spin-coating a KOH-resistant photoresist, bonding with a glass wafer, thermal treatment, RIE etching of the handle-wafer, KOH etching to fully remove the handle, Aluminum sputtering to create a contiguous backside electrode, followed by PDMS/Polyimide coating. The membranes were released from the glass wafer by disolving the photoresist sandwich layer with acetone. To demonstrate functionality, we utilized a semiconductor characterization system to measure the C-V response in air. Additionally, a vibrometer system was used to measure the dynamic deflection of the membranes under different driving conditions.

Results / Discussion

Fig. 1(a) shows a flexible CMUT die with showing a close-up view. Fig. 1(b) demonstrates the mask designs for making various measurement and testing dies in L-Edit including 6 masks. Fig. 1(c) shows SEM images of fabricated devices and Fig. 1(d) shows vibrometer results illustrating the functionality of the devices. These data demonstrate the feasibility of our fabrication process for next-generation wearable ultrasonic technologies. Ongoing work is aiming to optimize the yield and test robustness for wearable applications.

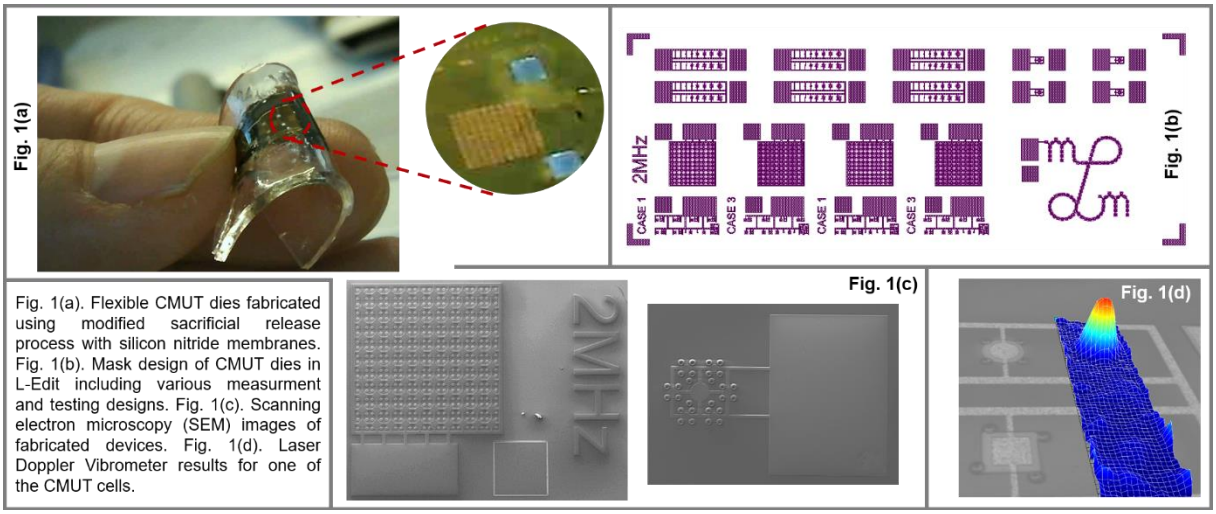

Fig. 1(a). Flexible CMUT dies fabricated using modified sacrificial release process with silicon nitride membranes. Fig. 1(b). Mask design of CMUT dies in L-Edit including various measurment and testing designs. Fig. 1(c). Scanning electron microscopy (SEM) images of fabricated devices. Fig. 1(d). Laser Doppler Vibrometer results for one of the CMUT cells.