Abstract Title: Development of cMUT transducer array assemblies for medical diagnostics

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Purpose: Significant work in the last 10 years has been directed towards the development of capacitive Micromachined Ultrasound Transducer (cMUT) arrays and associated assemblies for medical imaging. These implementations are intended to address a spectrum of applications including Intra-Vascular (IVUS), Low Cost Portable and large area arrays for breast imaging among others. The close integration of cMUT arrays with associated processing electronics is intended to alleviate a series of issues having direct bearing on product arrays: Electrical loading of the cMUTs during transmit and receive leads to a reduction in round-trip sensitivity as well as increased power dissipation. Large 2D arrays required for real-time volumetric imaging require 10's of thousands of elements resulting in a significant bottleneck for traditional cable-based interconnects. The cost of interconnect and processing channels built using standard techniques in current ultrasound machines when scaled from 100's of elements to 10's of thousands is prohibitive. This talk will examine the issues around close integration and explore the proposed solutions to address these challenges.

Method and Materials: The close integration of cMUT transducers with associated processing electronics promises to yield improvements in image quality, probe manufacturability and reduction in cost for point of care and large area arrays. To date there have been at least three solutions to these issues proposed: i) Fabrication of cMUTs directly on top of the electronic devices, ii) Direct assembly of cMUT chips to the associated electronics, and iii) Double-sided flip-chip assembly of both the cMUT arrays and the electronics to an intervening substrate made of organic or other materials. Each of these methods has associated benefits and disadvantages and these will be reviewed along with the presentation of the results of our work in some of these areas.

Results: To date we have explored the direct attach of cMUTs to electronics as well as double-sided flip-chip attach using rigid interposers. Interposers promis to provide the ability to realize seamless tiling of array modules for fabrication of large array areas for full field of view automated breast ultrasound. However, due to the very large number of interconnects and through substrate vias needed via density remains challenging. We will present the results of our latest work in this area. Direct attach of cMUTs to associated electronics is promising for point of care low cost probes. However large area arrays based on this approach rely on the availability of high voltage TSVs which are not yet available in volume production. Fabrication of cMUTs directly on top of device electronics has been explored by other groups and some recent results will be briefly reviewed.

Conclusions: Significant challenges remain in close integration of cMUTs with associated interface electronics for complex transducer array assemblies. Three currently proposed solutions to close integration have been reviewed. It is likely that each of these will find a niche in specific applications.