MEMS Technology for Acoustic Wave Devices

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MEMS and acoustic wave (SAW and BAW) devices are based on similar technology and physical background, but they have been developing in different communities for a long time. In this short course, the lecturers, who have been deeply involved in developing both MEMS and acoustic wave device technologies, present and discuss the following MEMS-related design and implement techniques for the ultrasonics community:

1. Wafer bonding and layer/device transfer techniques
2. Wafer-level packaging and integration techniques
3. MEMS fabrication techniques for RF devices enabled by wafer-bonding and layer transfer
4. Design techniques for RF devices enabled by wafer-bonding and layer transfer

In the first half of this short course, topics 1 and 2 are lectured by Prof. Tanaka. Wafer bonding is important for the wafer-level packaging of MEMS and acoustic wave devices. The lecture overviews different kinds of wafer bonding techniques and guides for the best choice of method for a specific purpose. Recently, hetero acoustic layer (HAL) types of SAW device, where a very thin piezoelectric single crystal layer is bonded with a support substrate of another material, are collecting increasing attention. Wafer bonding is also a key fabrication technique for such devices. In parallel, various kinds of wafer-level packaging method are systematically explained. The lecture focuses two keys, hermetic sealing and electrical feedthrough from a sealed cavity. The goal of the first half part is to widen attendees' options of fabrication and packaging methods for various acoustic wave devices.

In the second half of this short course, topics 3 and 4 will be discussed by Prof. Gong, introducing several device-level design techniques to best harness the performance out of transferred single-crystal piezoelectric layers. Both resonant (e.g. resonators and filters) and non-resonant devices (delay lines and correlators) will be showcased, and their design spaces will be explained. It will be shown that the device platforms based on transferred single crystal piezoelectric layers hold strong potential for a wide range of RF applications from 5G to IoT.