Wafer-Level Vacuum and Hermetic Packaging for RF MEMS

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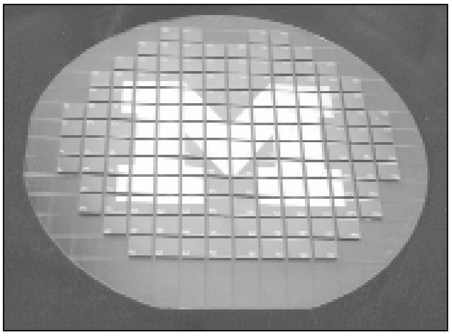
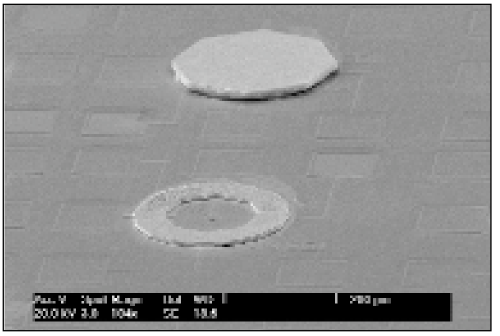


Wafer with lead-free solder bonded 1-level packages.



SEM image of 0-level transferred cap and a bond ring with the cap removed.

Recently, many advances have been made in the field of RF MEMS. Micromachined resonators, switches, and passive components are poised to change present transceiver design; however, several challenges still need to be addressed before they can become part of standard transceiver architecture. Vacuum/hermetic packaging and process integration pose several challenges that need to be met before RF MEMS can be successfully deployed in commercial applications. This project will develop low-temperature metal bonding processes that provide wafer-level hermetic and vacuum packaging for RF MEMS. In one approach, a metal cap is simultaneously transferred and bonded from a host wafer to a device wafer using a solder transfer layer and transient liquid phase bonding (see right figure above). The transferred thin-film metal packages provide a modular, low-profile encapsulation scheme that is a good candidate for 0-level MEMS packaging because it is easy to integrate into a complete process flow. It uses a robust bonding technique that can withstand much higher temperatures than its formation temperature, which will leave many options open for the subsequent packaging steps by maintaining a large process temperature window. This project is also investigating the use of solder seals for vacuum packaging. A lead-free solder is used to bond a silicon wafer to a glass wafer (see left figure above). Presently, we are working on characterizing the hermeticity and long-term reliability of these packaging techniques. This project is being partially supported by the Defense Advanced Research Projects Agency.