Wafer Bonding Technologies

Personnel

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Wafer level bonding is emerging as key technology for developing three dimensional structures for microsystems and for creating electrical interconnects for the first level packaging of MEMS and microelectronic devices. The ability to create a uniform, good quality bond across the whole area of the wafer is dependent on the surface chemistry of adhesion, and the mechanics of the bonding process itself. Work is being performed in parallel to model the processes for silicon direct fusion bonding, anodic silicon-glass bonding and gold thermo-compression bonding. Test techniques are being developed and evaluated to determine bond strength and toughness.

Silicon direct fusion bonding is a key technology for several of the high power density MEMS devices under development at MIT. Key factors in determining the quality of fusion bonds, include the wafer thickness, density of etched features, curvature, roughness and surface adhesion. A model is being developed using solid mechanics principles, in conjunction with a surface adhesion law.

Gold thermocompression bonding has great potential for creating hermetic seals and three dimensional interconnects. The process is being explored through experiments, with particular attention devoted to the role of the creep/plasticity of the gold layer on the resulting bond toughness. Process variables under investigation include bonding pressure, temperature, gold thickness, and the use of diffusion barriers.

Anodic bonding is a well developed bonding technology for silicon to borosilicate glasses. However, the desire exists to extend the technique to other materials, and to allow for the bonding of etched wafers. An experimental program is underway to investigate the possibilities of achieving this goal. In the course of achieving this, it is hoped that a more comprehensive understanding of the bonding technique will be developed.