**Metal Layer Bonding**

- Pattern seal rings and bond pads photolithographically
- *Eutectic bonding*
  - Uses eutectic point in metal–Si phase diagrams to form silicides
  - Au and Si have eutectic point at 363°C
  - Low temperature process
  - Can bond slightly rough surfaces
  - *Issue:* Au contamination of CMOS
- *Solder bonding*
  - PbSn (183°C), AuSn (280°C)
  - Lower-T process
  - Can bond very rough surfaces
  - *Issue:* outgassing (not good for encapsulation)
- *Thermocompression*
  - Commonly done with electroplated Au or other soft metals
  - Room temperature to 300°C
  - Lowest-T process
  - Can bond rough surfaces with topography

**Hexsil MEMS**

- Achieves high aspect ratio structures using conformal thin films in mold trenches
- Parts are demolded (and transferred to another wafer)
- Mold can be reused
- Design with honeycomb structure for strength

**Hexsil MEMS Actuator**

- Below: Transfer of hexsil actuator onto CMOS wafer

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**Thermocompression Bonding**

- Below: Transfer of hexsil actuator onto CMOS wafer

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[Singh, et al, Transducers'97]
Silicon-on-Insulator (SOI) MEMS

- No bonding required
- Si mechanical structures anchored by oxide pedestals
- Rest of the silicon can be used for transistors (i.e., CMOS compatible)

SOI MEMS Examples

Micromirror

[Analog Devices]

SOI MEMS Examples

Micromirror

[Brosnihan]

The SCREAM Process

- SCREAM: Single Crystal Reactive Etching and Metallization process