Bonding, Packaging, and Sacrificial Processes

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Microsystems Principles
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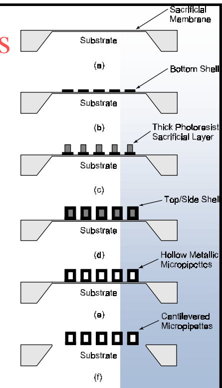
Sacrificial Processes

- Materials
  - Photoresist
  - Silicon dioxide
  - Entire wafers
  - Metals
  - Glasses
- Problems
  - Diffusion limits
    - Geometry
  - Sticking
    - Phase change can eliminate
    - Geometry



Sacrificial Processes

- Dissolved wafer processes
  - SOI wafers
  - Membranes
  - Moving structures
- Sacrificial processes
  - Channels, cavities
  - Release moving structures
- HEXSIL
- Membranes
- Cantilevers

Bonding

- Why?
  - Create channels or cavities
  - Create isolation layers (SOI wafers)
  - Reduce complexity on each chip
  - Packaging
- Methods
  - Anodic bonding
  - Silicon fusion bonding
  - Photopolymers
  - Eutectic bonding
  - Others
    - Press
    - Thermocompression metallic
    - Ultrasonic welding
    - Seam welding
    - Laser welding
    - Low-temp glass bonding

Anodic Bonding

- Also called electrostatic bonding
- Bonds glass to silicon
- Used to reduce temp to reasonable levels
- Performed at about 400 C with about 1.2 kV
- Positive ions in glass drift toward silicon causing high field at interface
- Pull silicon and glass close together
- Silicon positive, glass negative
- Use glass with similar thermal expansion coefficient
- Cleanliness critical to prevent voids
- Thin metal lines can pass through bond
- Using deposited glass (thin layers) reduce voltage significantly
- Works with e-beamed, sputtered, and spin-on glass

Anodic Bonding

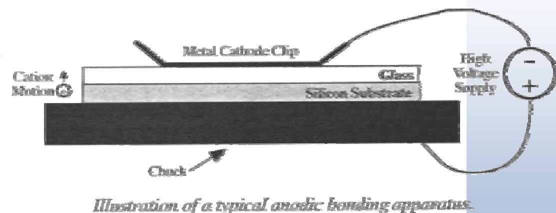
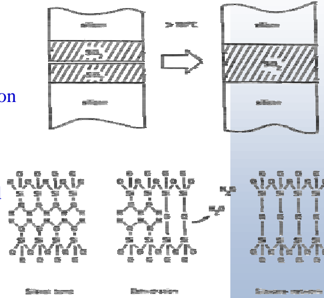


Illustration of a typical anodic bonding apparatus.

Silicon Fusion Bonding

- Silicon to silicon bond, oxides also work
- High physical strength
- Require hydroxyl groups on surface
- 300 to 800 C required for bond with higher anneals temps sometimes required
- Use of low-melting glass allows lower temp bond



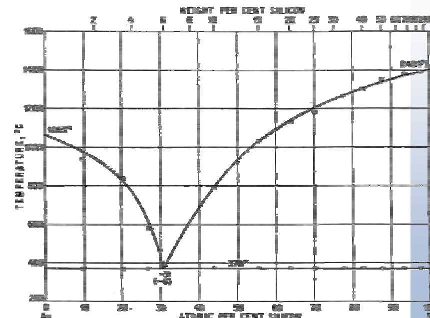
Epoxy or Polyimide Bonding

- Both conductive and non-conductive types
- Inexpensive and simple
- Lower bond strength
- Can form insulating layer
- Potential decomposition

Eutectic Bonding

- Uses silicon metal alloy (other alloys also) such as Si-Ag, Si-Au, Si-Al
- Silicon dissolves in gold at about 370°C and up
- Relatively low temperature
- Microstructure change allows high reliability, strong bond, good heat dissipation, and thermal stability
- Problems with bonding large areas

Eutectic Point for Si - Au



Other Bonding Methods

- Hardware store methods
- Glues, silicones, etc
- UV Curable materials
- Photoresists
- Waxes
- Chemical bonding
- Hydrophilic bonding
- The simpler the better!!!