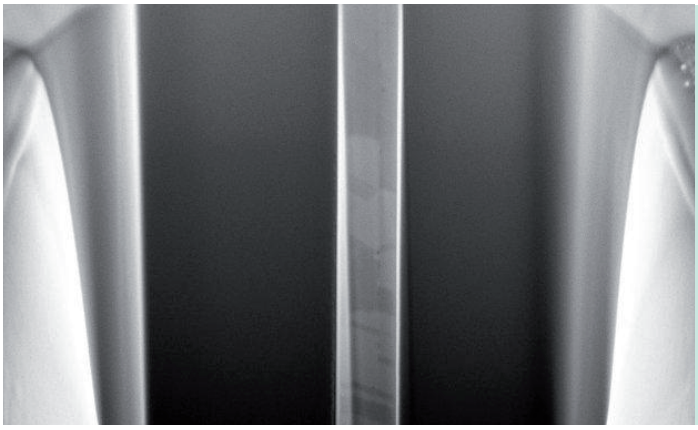
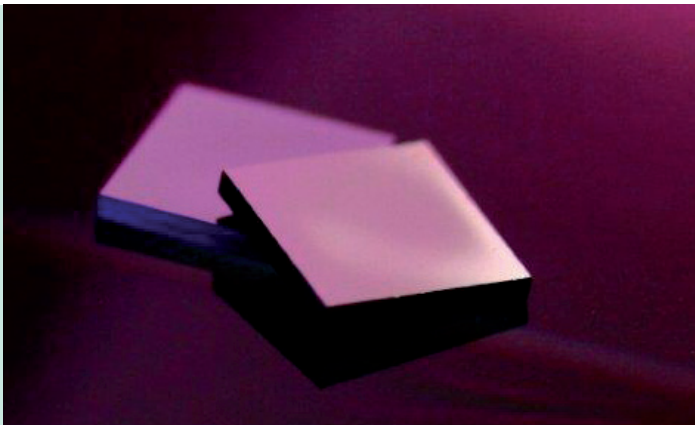
THERMOCOMPRESSION WAFER BONDING WITH THIN METAL LAYERS





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Figures:
SEM image showing a bond interface after CuCu thermocompression bonding (left); Photo of two hermetically sealed CuCu thermocompression bonded chips showing significant membrane deflection after dicing (right).

Photo acknowledgements: Fraunhofer ENAS

Description

The thermocompression bonding represents a solid phase direct bonding process without an intermediate layer. Materials like Cu, Au, Al, and Ti are mainly used to refine one bond partner or both of them. The bond formation is achieved through the atomic contact, temperature impact and pressure. Furthermore thermocompression bonding of metals is an interesting technology for achieving wafer level bonding at low temperature without the application of an electric field (anodic bonding) or complicated pre-bond cleaning procedure (plasma-assisted silicon direct bonding). Especially for 3D integration the use of metals like Al and Cu is focussed because of electronics aspects. In one bonding process the sealing as well as the electrical connection could be realized. Although gold and copper thermocompression bonding is already known since some time we also applying the Al based bonding. The Al thermocompression bonding is of high interest, because opposite to the Au and Cu based bonding it can be very easily integrated even in CMOS processes.

Bonding mechanism

The metal thermocompression bonding is a form of solid state bonding, more specifically diffusion bonding. Therefore it is necessary to apply simultaneously pressure and temperature in order to bring the mating surfaces into atomic proximity to form bonds. Several experiments have been done to understand the basic mechanism and to establish a standardized bonding process set up. Based on the results we suggest that the bonding consists of three stages: Interface formation, crystal misfit accommodation and grain growth.

Advantages of the process

- High fracture toughness
- Electrical conductive
- Hermetical sealing
- Small bonding frames
- Standardized deposition

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