Investigation of predictive modeling for process control in plasma activated wafer bonding for integrated sensors

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Multi Sensor Platform for Smart Building

- European multi-project wafer (MPW) service for flexible 3D-integration of components and sensors on CMOS electronic platform chips
- Key processes: Wafer-to-wafer (WtW) bonding and connection by Through-Silicon-Via (TSV) technology

Wafer bonding process flow and control concept

- Low-temperature plasma activation
- Single wafer cleaning
- Wafer-to-wafer alignment
- Prebonding
- Thermal annealing
- Postboding
- CSAM void measurement

Generic APC concept for the wafer bond process

- Pre-process
- Process
- Post-process
- Metrology

- Wafer-to-wafer bonding processes require tight process control to reduce voids
- Solution: Apply predictive, data based optimization in wafer bonding

Overview of data provided and data aggregation

- Wafer bonding process
  - Logistic and equipment/ process data for wafer cleaning, plasma activation, wafer alignment
  - Data are comprised of already condensed indicators (key values), time resolved trace data and separate indicators (activation)

- CSAM quality control
  - Location and size of bond defects on wafer together with wafer bonding information

Analysis of the wafer bonder and the CSAM data

- Correlation of the total void area to the wafer bonder parameters and the equipment states
- Visualization of the parameter excursion leading to higher number of voids per wafer

Prediction model for the class of voids per wafer

- Analysis of classification tree on data set
- Training and prediction during runtime, start with 20 training cases

Summary and outlook

- Analysis of wafer bonder data and CSAM data to analyze dependencies on wafer and partner wafer
- Identification of key parameters for void formation
- Identification of the wafer bonder parameters and equipment states; correlation to void formation
- Classification model to predict void class from wafer bonder data with an accuracy of 95%
- Outlook: Include information from processing steps prior to wafer bonding and increase data volume to further improve prediction of void formation

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