"Fusion Cuisine"

Hybrid Technologies to address MEMS sensors, Magnetics and High Voltage Probing

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Overview

• Probing Sensors
• Pressure Sensors
• Pressurized Probe Cards
• "Vertical Cantilever Probes"
• Vertical "LuPo" Probe Head
• Magnetic Sensors
• Rotary Magnet Probe Card
• Summary
Probing Sensors

• Besides electrical contact to the sensor device (probes...), the sensor element has to be stimulated:
  – pressure
  – magnetic field
  – light, radiation, humidity....
MEMS Pressure Sensors – the D.U.T.

- Technology: surface micro machined sensor cell

- Array of cells to increase sensitivity

- Ant's head
- Bond pad
- Sensor cell area

- CMOS circuitry
Probing MEMS Pressure Sensors...

- signal capture through electrical probes
- stimulation of sensor cells by applying air pressure

"Fusion" of a chip-scale pressure chamber + "Vertical Cantilever" probe card.....

"LuPo" – Luftpolster Probe Card
"LuPo-ABS" Probe Card

- "LuPo-ABS": Luftpolster – Air Bearing Seal

principle setup of "NoTouch" – gap seal pressure chamber probe card
"Vertical-Cantilever" Hybrid

- "Long" probe tips needed to comply with constraints imposed by pressure chamber geometry
- Scrub behavior depends on friction on probe tips on pad surface, sometimes not well predictable
  - "skating", e.g. on Pt pad surface, pad edge damage
- Solution: "Hybrid" of Cantilever probes with guide plate known from Vertical probe card technologies

-> "Vertical-Cantilever Probe Card"

- Epoxy ring
- cantilever probes
- (vertical) guide plate
Vertical-Cantilever Probes

- Probe geometry for "stubbing" contact geometry
  - optimized through FEM simulation
- Integration into "LuPo" pressure chamber
"Vertical-Cantilever" - Example

- Automotive-grade pressure sensor
- Paliney probes chosen for contacting of Platinum pads
- 8x multi-site
Vertical "LuPo" Probe Card

- Vertical probes
- "LuPo" seal to wafer surface (floating)
- Vertical probe head housing
- Guide plate for probes (ceramics)
- Compressed air supply channels
Vertical "LuPo" Probe Card

• Challenge:
  – apply advantages of Vertical buckling beam technology to pressure sensors probing

-> "Hybrid" of Vertical probe head (buckling beam configuration) with "LuPo" pressure chamber!

• integration of functionalities:
  – Vertical probe head housing serves as guide plates mount + part of pressure chamber + compressed air guide
  – MLO interposer serves as electrical connector + compressed air guide

• New concept for mounting and replacing vertical beams developed
Vertical "LuPo" - Example

- automotive-grade pressure sensor (same as for Vertical-Cantilever)
- 8x multi-site (capable of 32x – limitation here: tester ressources)
"LuPo-ABS" - Lab Characterization

Homogeneity of pressure inside chamber ("hat top") better than 0.05 %
High precision wafer level sensor calibration feasible!

2-D pressure scan of LuPo chamber (diameter 8 mm), undertaken with micro static pressure probe mounted to prober chuck
Magnetic Sensors

- various effects from Physics used to measure magnetic field strength: Hall, GMR...
- single- and multi-axis sensors
- requirements for variation of the magnetic field in strength and/or direction

2-D rotary magnetic sensor IC

picture courtesy: austriamicrosystems
Magnetic Sensor Probe Card

- customer request: wafer probe card for production test of an angular magnetic sensor
- 0.5° precision rotational positioning of magnetic field vector in the wafer plane required
- -> "Fusion" of high precision angular positioner with high strength Neodymium magnet integrated into probe card
- challenges: non-magnetic design of probe card (except magnet itself of course)
  - stiffener
  - screws....
- Design of angular positioner to fit within probe card space constraints
- Communication of angular motion control unit with tester
Magnetic Sensor Probe Card

- Angular positioner with stepper motor drive and high resolution encoder
- Wafer Probe Card (Teradyne Flex platform)
- Customized cantilever needle spider design to allow placement of permanent magnet close to probe tips
- Neodymium permanent magnet
Magnetic Sensor Probe Card

- 0.1° angular precision and repeatability
- 50 mT field strength in the wafer plane
Summary

• Wafer probing of sensor devices poses the additional challenge of "stimulating" a sensor element
• "Fusion" of various technologies allow the design and manufacture of robust production probe cards:
  – micro contacting technology
  – custom PCB and mechanical design design
  – motion control
  – pressure application
  – magnetics design
  – FEM simulation
  – ...

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