Hesse Mechatronics
Wire Bonding Technology
University California - Irvine
Various types of wire bonding technology
Agenda

• What is a wire bond? Why use wire bonding?
• Quality Aspects of Wire Bonding
• What is the Future of Wire Bonding?
• Meeting today is to share with you who Hesse Mechatronics is, what wire bonding technology is all about and how we work with University California Irvine and industrial companies / research institutes / technical societies here in So Cal as well as the Americas.
Brief Introduction of Hesse & Wire Bonding

- **Hesse Mechatronics**
  - German-based, located in Paderborn, started as an automation company and then delved into wire bonding when the Berlin Wall collapsed

- **Wire Bonding Technology**
  - WWII patent, Bell Labs in NJ – late 1950’s
  - Started as thermocompression – then thermosonic (1960’s) – then ultrasonic (early 1970’s)
  - Still very popular technology today, and getting into more and more applications.
What is a wire bond?

• A wire bond is a mechanical link between 1 or more points (usually 2) that provides an electrical bridge to permit current flow.

• A “wire” normally has 2 “bonds”, 1\textsuperscript{st} and 2\textsuperscript{nd} bonds.
Why use wire bonding? (and not soldering or welding)

• Flexibility – bond onto different metals, different heights, various loop heights
• Low Temp Process – Au is bonded at 150°C and Al wedge bonding is done at room temperature
• It is a “clean” process – no post cleaning
• Relatively fast – 1 wire per second to 20 wires per second
Where is it used? – Everywhere!

- Automotive: VR, MAF, DIS, Li-ion batteries, Sensors
- Medical: Defibulators, pacemakers, hearing aides, ...
- Aerospace: power supplies, lighting, ...
- Military: radar, missiles, ...
- Consumer: games, laptops, ...
- HiRel: down-well oil exploration, detectors, ...
- Industrial: elevators, a/c heating systems, ...
- RF/Microwave: base stations, cell phones, ...
Various wire bonded applications
Slow Motion Video of a Heavy Wire Bond
We have two wire bonders installed in the Engineering Building

- BJ820 is for fine Al, Cu, Au wedge or ribbon.
- BJ959 is for heavy Al or Cu wedge or ribbon.
Bonders at University of CA Irvine
NC State: PREES and FREEDM Labs

- PREES and FREEDM are being funded by NSF and DOE.
- Hesse Bonder BJ935 is located in the PREES Lab
PowerAmerica at NC State – Wide Bandgap
Univ CA: Santa Barbara, Santa Cruz, LBL – BJ820

- CMS & Project – Particle Physics
Purdue Univ - Bonded battery for Formula 1 EV
Wire Bonding Definitions Part 1

• Atomic Bond
• Uses ultrasonic energy (and heat for Au / ball) to make the bond wire go “plastic”
• 120kHz for ball & fine wire
• 60kHz for heavy wire
• Other known frequencies: 40kHz, 110kHz, etc.
Testing Wire Bonds

• Pull Test
  – Lifts versus breaks

• Bond Shear Test
  – Shear Value
  – % Nugget

• Visual
  – “Neck”, “Heel”, tool-marks, cut marks
Pull Test

- Destruct Pull Testing
- Breaks versus Lifts
- Non-sticks during bonding
Bond Shear Test

• Destructive Bond Shear Testing
• Min Shear Value
• Min Nugget
• No existing standard for HW.
Visual Inspection of wire bonds is very important.

- Heel damage for wedge
- Neck damage for ball
- Crescent formation for ball bonding
- Loop height, missing wires, lifted wires, scratched wires, damaged wires, etc.
Quality Aspects of Wire Bonding

- **ASTM**
  - F1269 Shear Testing of Ball Bonds
  - F72 Gold Wire
  - F205 Measuring Diameter of Fine Wire
  - F458 NDPT of Wire Bonds
  - No heavy wire standards!

- **MIL-STD-883**
- NDPT versus Destructive Pull Testing
- NDPT on a wire bonder vs on a bond tester
Wire

- Wire Types: Au, Al, Cu, Ag, PtIr, Cu-Core, Pd-Cu
- Purity: 99.99%, 99.999%, 1%SiAl, .5%MgAl, Ni
- Tensile Strength: in grams
- Elongation: in %
- Spool: 2” DF, .5”, 4” (41B), 4” (41C)
- Shelf Life: 6 months to 1 year
- Machine Life: Cu – 1 to 4 days
- Storage
- Handling
What is the Future of Wire Bonding?

• Ribbon/Foil Bonding (General Motors)
• Cu Wire Bonding
• Ultrasonic Interconnection
• Laser-assisted wire bonding
Plan Moving Forward

- Hesse Mechatronics is really looking forward to working with the faculty and students at the University of California Irvine.
- We have already had 2 electric truck companies visit, 1 medical company and many more lined up.
- We are working with IMAPS to restart the local student chapter here on campus.
- Plan on having students get involved with learning wire bonding and work with us on projects to be presented at technical conferences.