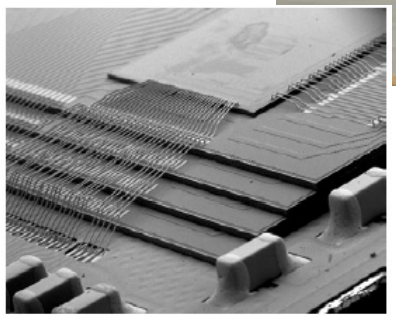
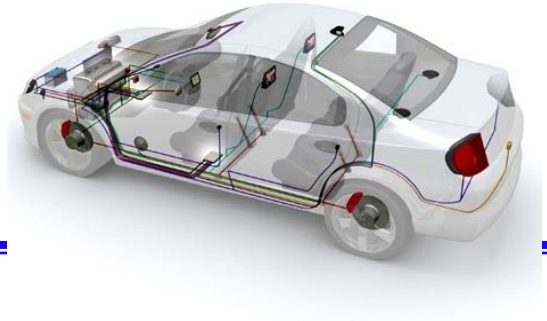
Reliability in harsh environment:
Application in transportation and industrial environment





Eckard WOLFGANG (Germany) Hélène FREMONT(IMS-Bordeaux - France)

Harsh environment: Transportation and industrial

- Embedded electronics
  - ➢ in transportation sectors
    - ❖Automotive: electric and hybrid vehicles
    - ❖Aeronautics and space
    - ❖Ground transportation: trains
  - ➢ in industrial environments
    - ❖Nuclear plants
    - ❖Explosive atmospheres (ATEX)
    - ❖Oil drilling
    - ❖Alternative Energy Technologies

- T
- ΔT
- Vibrations
- Moisture
- *Radiations*
- *EMC*

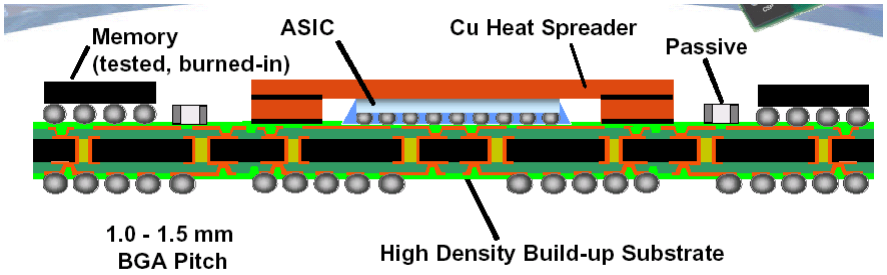
+

- Chemical
- Dusts
- Pressure

- *NEW TECHNICAL FOCUS FOR IRPS 2010 is introducing a new technical topic on "Reliability of Alternative Energy Technologies" – Unique IC-based reliability phenomena and failure mechanisms in alternative energy technologies including solar, wind, transportation, nuclear, power transfer (smart grid) and power storage.*

Technology evolution: worsening the stresses

- At Chip level
  - Dimension increase
  - Diversification of functions (SoC)
  - Higher power density
  - Higher frequencies
  - ….



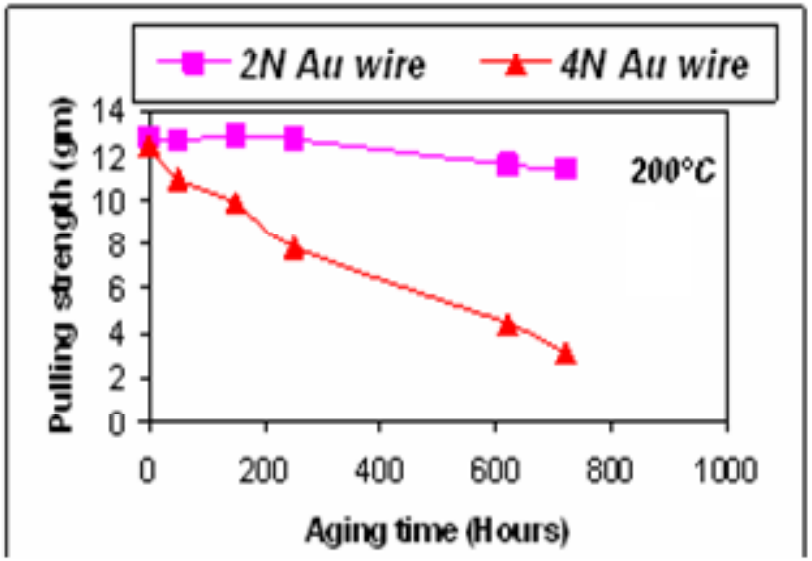
- At package and assembly levels
  - Densification of internal interconnections (SiP)
  - Juxtaposition of RF, analog, digital and power blocks,
  - New material (lead free solders)
  - More aggressive processes (PoP)
  - New dimensions of stresses (3D)
  - ….

Technology evolutions + Harsh environment : Increasing the risks

- Thermal Effects
  - Thermal Gradients within the chip (SoC)
  - Thermal Gradients within the package (SiP)
  - Close to « Power electronics » problems
- Specific components
  - Passive (capacitive, inductive structures…)
  - Specific Quality/Reliability requirements
- Mechanical stresses
  - Third dimension
  - Multiple and miscellaneous interfaces
- EMC

Worsening the stresses: reliability challenges

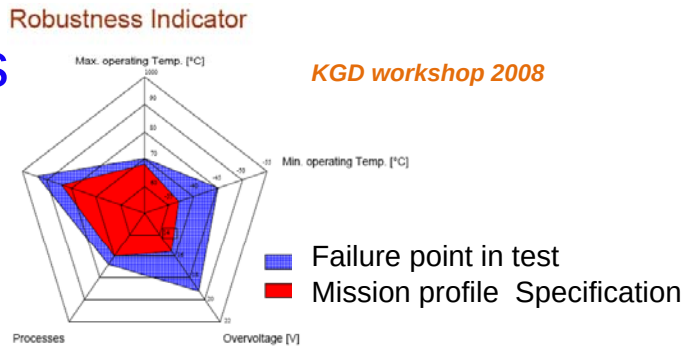
- Materials are used at their strength limits
  - ➢ Is it possible to accelerate the aging ?
    - → Increased role of simulation
    - → Necessity of parameter knowledge
  - ➢ Are in-situ measurements possible ?
- New mechanisms are activated
  - ➢ New models must be defined
- Interaction between loads
  - ➢ Multi-physics simulations
- Technological choices are critical



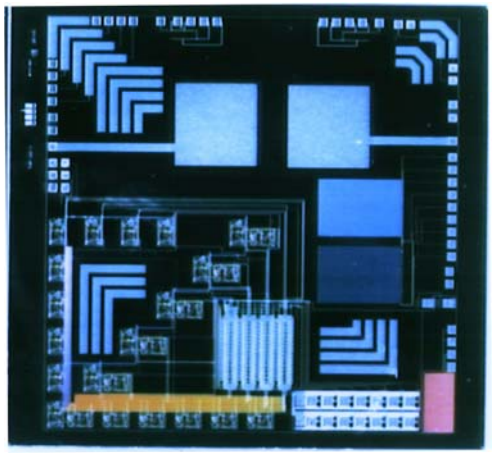
Consequences on Qualification tests

- Qualification standards become obsolete
- Qualification must be adapted on a case to case basis
  - Adaptation to mission profile
  - Adaptation to suspected failure mechanisms
  - Use of combined stress (interaction between phenomena)
    - Vibration + temperature
    - Moisture + ΔT
    - ...
  - Test sequences is not indifferent
    - Moisture followed by Thermal Shocks
    - Vibration after Thermal Storage
    - ....

Some tracks for reliability control of electronic systems in harsh environments



- Selection of relevant technologies
- Design for reliability (IC, Board systems)
- In situ structures for stress detection and measurements
- Development of accurate failure mechanisms models
  - ➢ Role of FE simulation: multiphysics
  - ➢ Mixed models
- Reliability active monitoring (for systems)



Selected topics for discussion

• Mission profiles	M. Ciappa
• Intelligent testing	E. Wolfgang
• Industry-oil drilling	H. Frémont
• Heat and reliability	U. Scheuermann