

Reliability in harsh environment: Application in transportation and industrial environment



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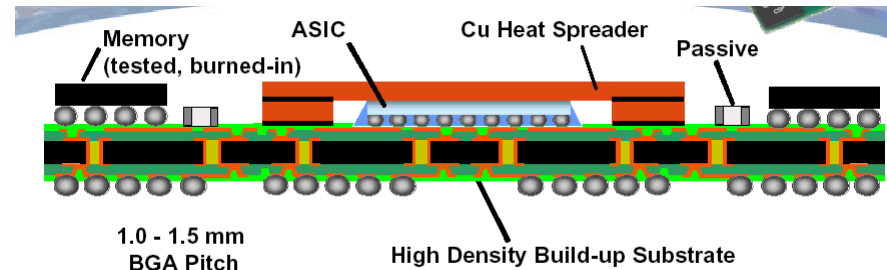
Harsh environment: Transportation and industrial

- 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
 - *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.*
- T
 - ΔT
 - Vibrations
 - Moisture
 - *Radiations*
 - *EMC*
 - +
 - Chemical
 - Dusts
 - Pressure

Technology evolution: worsening the stresses

- At Chip level

- Dimension increase
- Diversification of functions (SoC)
- Higher power density
- Higher frequencies
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- 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)
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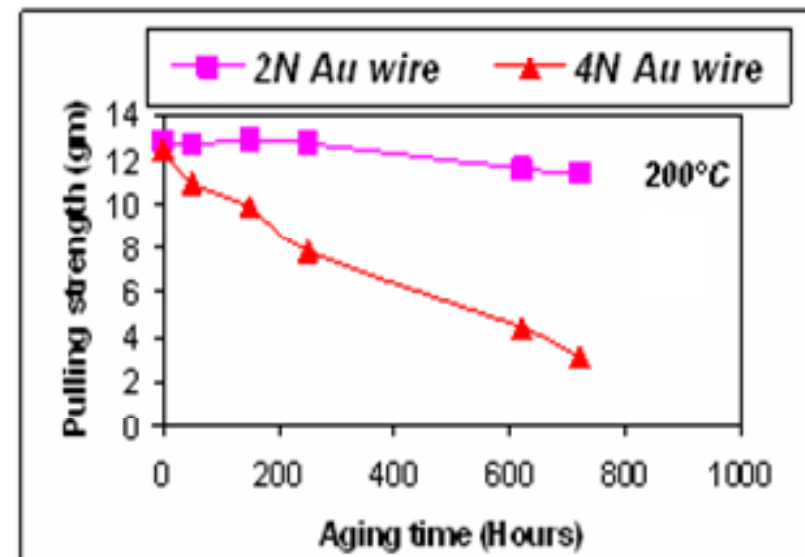
Technology evolutions + Harsh environment : Increasing the risks

- 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



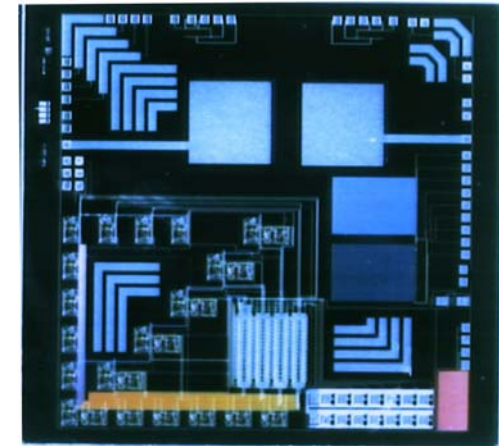
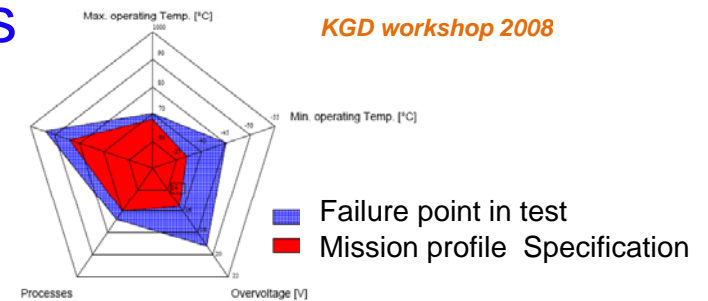
Consequences on Qualification tests

- 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**)

Robustness Indicator



Selected topics for discussion

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

