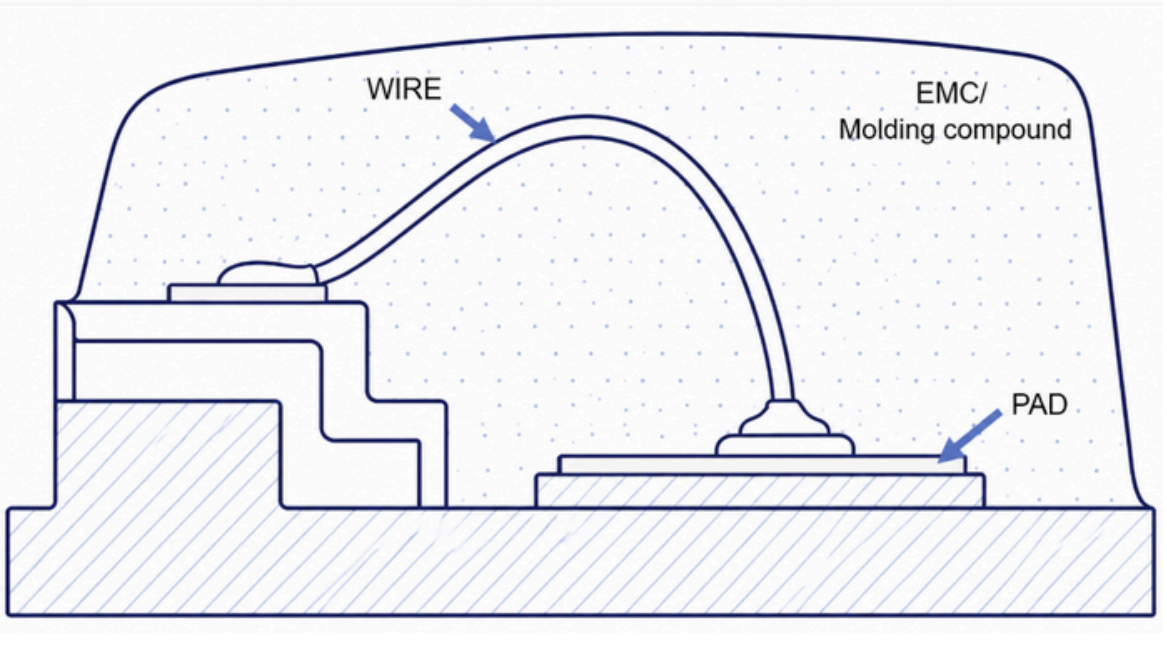
TA.TEC Engineering Insights #004

Where Wire Bond Contamination Really Matters

Wire, bond pad or molding compound?

A comparative study investigated how chlorine (Cl) and sulfur (S) contamination from three different sources affects Au-Al and Cu-Al wire bond reliability.



The contamination source matters - and Epoxy Molding Compound (EMC) showed the most critical impact in this study.

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What Did the Study Compare?

1

Three contamination sources



Wire • Bond Pad • EMC

2

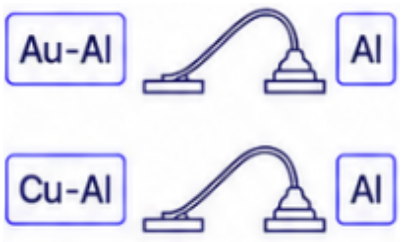
Two contaminants



Cl • S

3

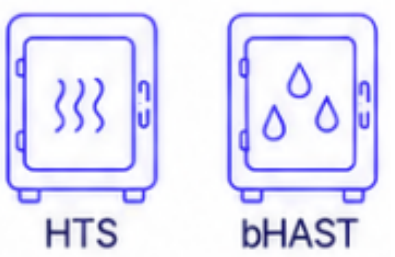
Two wire-pad combinations



Au-Al • Cu-Al

4

Two reliability tests



HTS • bHAST

Test Conditions



HTS
150 °C • up to 1000 h



bHAST
130 °C • 85% RH • 20 V • up to 192 h

Abbreviations

HTS - High Temperature Storage
bHAST - Biased Highly Accelerated Stress Test
RH - Relative Humidity
V - Voltage
h - hours

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Not All Contamination Sources Are Equal

EMC contamination showed the most critical impact on wire bond reliability compared with contamination from wire and bond pad.

Au-Al

Wire contamination
No reliability failure observed

Bond pad contamination
No reliability failure observed

EMC contamination
Failure observed with 500 ppm Cl

Cu-Al

More failures were observed than for Au-Al.

The majority of Cu-Al failures occurred with contamination from:

EMC **Bond Pad**

Cl and S did not affect the bond in the same way.

The contamination source changed the observed reliability response.

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Chlorine and Sulfur Act Differently

Findings from the paper: What the authors observed and how they interpreted it.

Chlorine - Cl

IMC = Intermetallic Compound at the ball-pad interface

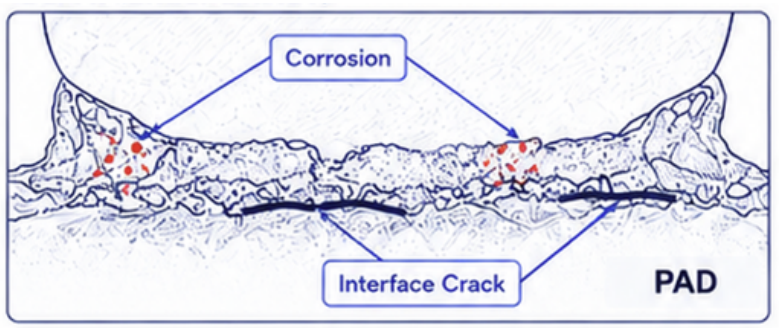
GENERAL MECHANISM

- Attacks the ball-pad IMC
- Causes corrosion

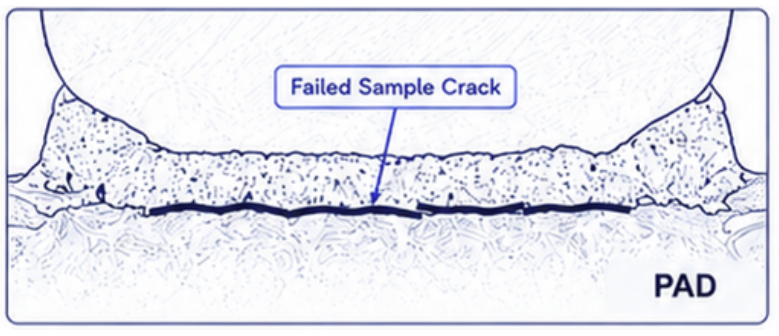
OBSERVED IN THIS STUDY

- **Cu-Al under bHAST**: interfacial cracks and corrosion products near the cracks were observed
- Several ppm of Cl could attack Cu-Al
- For **Au-Al**, failure was observed only with 500 ppm Cl from EMC

Cu-Al under bHAST



Au-Al

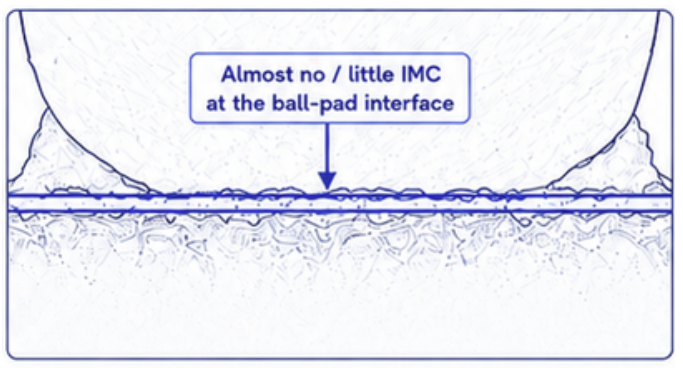


Sulfur - S

DIFFERENT MECHANISM FROM Cl

OBSERVED IN THIS STUDY

In one investigated Cu-Al sample, almost no / little IMC was observed at the ball-pad interface



AUTHORS' INTERPRETATION

- Associated with hindered ball-pad atom diffusion
- Associated with reduced IMC growth
- Associated with deteriorated ball-pad interfacial strength

Au-Al

- No reliability failure was observed up to 500 ppm S

Different contaminants showed different degradation behavior at the ball-pad interface.

Observations and interpretations are based on the tests and conditions investigated in this study.

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Engineering Insight

What this study teaches about wire bond reliability

The study showed different reliability responses across contamination source, contaminant species, wire-pad combination and reliability test.

Source matters

Among the investigated contamination sources, EMC showed the most critical impact.

- For Au-Al, failure was observed only with 500 ppm Cl from EMC.
- For Cu-Al, the majority of failures occurred with contamination from EMC and bond pad.

Wire-pad combination and reliability test matter

Reliability response depended on the combination of wire-pad system and test condition.

- Under bHAST, Cu-Al was more readily attacked by Cl than Au-Al.
- Several ppm of Cl could attack Cu-Al.
- Under HTS, Cl was not easy to attack Au-Al and Cu-Al.

Contaminant species matters

Cl and S showed different degradation behavior and mechanisms.

Cl Chlorine - Cl

- Attacks the ball-pad IMC
- Causes corrosion
- Associated with interfacial cracking

S Sulfur - S

- Associated with hindered atom diffusion
- Associated with reduced IMC growth
- Associated with deteriorated interfacial strength
- (authors' interpretation)

The observed reliability response depended on the combination of contamination source • contaminant species • wire-pad combination • reliability test.

Engineering synthesis based on the investigated test conditions.

TA.TEC Engineering Insights #004

Research Behind This Engineering Insight

Liao Jinzhi Lois • Wang Bisheng • Zheng Haipeng • Zhang Xi • Li Xiaomin • Hua Younan • Fu Chao • Tee Weikok • Yee Boonhwa • Mao Songlin

Comprehensive study of wire bond reliability impacts from wire, molding compound and bond pad contaminations



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