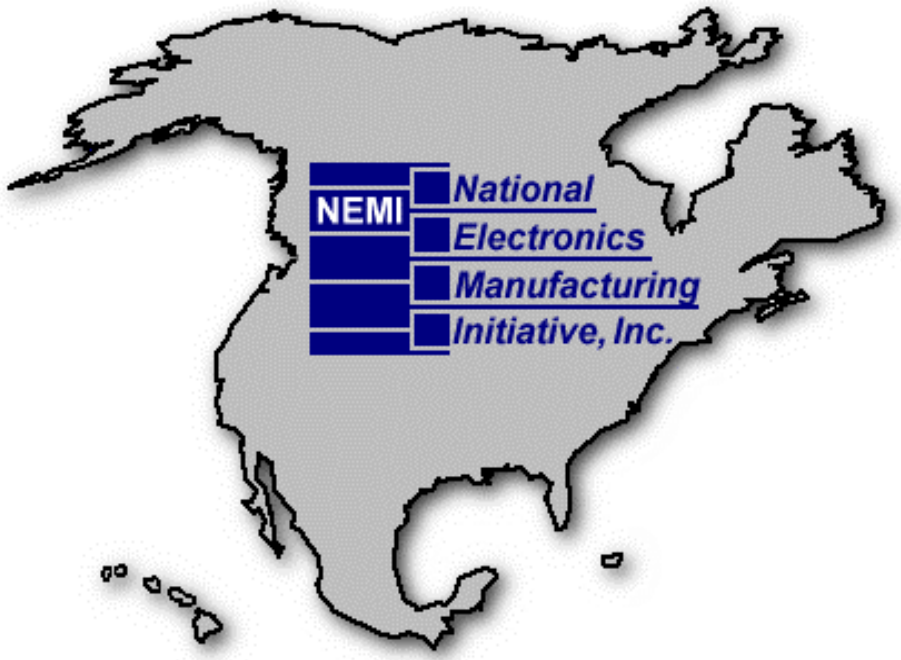


# Sn Whiskers Standards Committee
# An Overview

*Swaminath Prasad*
*ChipPAC*
*Chair: Sn Whisker Standards Committee*
*11/07/2002*
*IPC 2002 – New Orleans*

# Agenda

| | |
|---|---|
| • *Introduction and Overview – Swami Prasad* | *8.00-8.20* |
| • *Phase 2 DOE Results - ICs* | |
| – *Nick Vo (legs 1-3) – Motorola* | *8.20-8.35* |
| – *Irina Boguslavsky (Legs 4-16) – SUNY Buffalo* | *8.35-9.20* |
| • *Break* | *9.20-9.30* |
| • *Phase 2 DOE Results (Keith Spalding & Rudy) - Passives* | *9.30-9.50* |
| • *Board level whisker experiments* | |
| – *Valeska Schroeder – HP* | *9.50-10.20* |
| • *Independent whisker experiment results* | |
| – *Nick Vo - Motorola* | *10.20-10.40* |
| – *Jay Brusse – NASA Goddard* | *10.40-11.00* |
| • *Tin Whisker Modeling Group* | |
| – *Update – Irina and Maureen* | *11.15-12.00* |
| • *Lunch* | *12.00-12.45* |
| • *Next Step and Roadmap* | *12.45- 6.00* |


# Committee Structure

- ***Tin Whisker Test Standards Committee (Test Group)***
  - *41 companies including two governmental organizations*
  - *Swaminath Prasad (Chair) - ChipPAC*
  - *Jack McCullen (Co-Chair) - Intel*
  - *Mark Kwoka (Co-Chair) - Intersil*

- ***Tin Whisker Modeling Group (Modeling Group)***
  - *13 companies including one government organization.*
  - *George Gaylon (Chair) - IBM*
  - *Maureen Williams (Co-Chair) – NIST*
  - *Irina Boguslavsky –NEMI Consultant*

# Objective/Scope of work – Test Committee

- ***Objective:***
  - To identify an accelerated test method for whiskering by evaluating various known test methods.
- ***Scope of Work:***
  - *Collect all existing test methods for whiskers*
  - *Evaluate theory behind whisker formation*
  - *Devise a test or tests to detect whisker formation*
  - *Evaluate the test method with known good and"bad" processes to prove suitability*
  - *Develop a test specification and provide it to IPC/JEDEC for release as an industry standard.*

# Team Members – Test Committee

- Agilent
- Alcatel USA
- Allegro Microsystems
- AMD
- Analog Devices
- ChipPAC (Chair)
- Cooper Bussmann
- Delphi Delco
- Engelhard Clal
- Enthone
- FCI Framatome
- Flextronics
- HP
- IBM
- Indium
- Infineon AG
- Intel (Co-Chair)
- Intersil (Co-Chair)
- IPC
- ITRI Soldertec
- Kemet
- Lockheed Martin
- Microchip
- Micro Semi
- Molex
- Motorola
- On Semi
- Phillips

# Team Members – Test Committee

- Raytheon
- Soldering Tech.
- NASA Goddard
- NIST (Co-Chair)
- NEMI
- Shipley (Co-Chair)
- Solectron
- ST Micro
- SUNY Binghamton
- SUNY Buffalo
- Technic.
- Texas Instruments
- US Army

# Overview of the Committee Effort in 2002

- **Direct:**
- **Completed two comprehensive matrices phases one and two, both for IC's and Passives.**
- **Progress made in arriving at a definition for whiskers.**
- **Proposal for a common inspection protocol being worked on.**

- **Indirect:**
- **Generated considerable momentum to understand whiskers and tin plating globally.**
- **Membership has grown from 27 to 41 members this year.**

# Summary of JEITA Work

- Input provided by Ichi Sakamoto :OMRON, Japan (dated July 2002)
- Whisker growth is difference with property of plating deposit
- Plating deposit that has nickel substrate has tendencyto control growth of whisker
- Whisker will grow most at room temperature on deposit that has Cu substrate
  - However we do not think that room temperature is the optimum conditions for the test method.
  - We keep studying the mechanism of whisker growth at room temperature,and review a first hypothesis, and research the conditions to optimize the growth of whiskers.
- All the samples had 2 microns of Cu under plate over base metal.

# Summary of ITRI Work

- **Input provided by Dominic Lodge : ITRI, UK (dated Nov2002)**

# Tin Whiskers (ITRI)

- **Soldertec at ITRI Ltd is currently undertaking a project to establish a standard test for propensity to whisker**
- **Overall, it will assess:**
  - **accelerated ageing storage conditions**
  - **effect of coating**
  - **effect of substrate**
  - **effect of stress**

# Tin Whiskers (ITRI)

- **In the first stage, accelerated storage conditions were assessed:**
  - **85 °C / 85% Relative Humidity (4 weeks)**
  - **50 °C / 85% Relative Humidity (4 weeks)**
  - **50°C Ambient (4 weeks)**
  - **Thermal Cycling over –40 to +85 °C (500 cycles)**
  - **Room temperature, Ambient conditions (2 years)**

# Tin Whiskers (ITRI)

- To encourage whiskers to grow, Soldertec used:
  - Old tin plate chemistries (Matt and Bright)
  - Brass substrates
  - A Phosphor Bronze substrate was also used as a control

# Tin Whiskers (ITRI)

- All conditions used produced whiskers
- Thermal Cycling seemed to give the most consistent results across all the sample sets

# Tin Whiskers (ITRI)

- **Work is continuing with Thermal cycling (90 minute cycle), testing coatings:**
  - **'New' chemistries of matt & bright tin**
  - **Matt and bright SnCu**
  - **Eutectic and 90/10 SnPb**
  - **Repeat of 'old' bright tin for comparison**

**Substrates are mainly Phosphor Bronze (similar to Olin 194), with some Brass**

# Tin Whiskers (ITRI)

- **Results due by the end of 2002**
- **Further info: Dominic.Lodge@tintechnology.com**

# E3 -Update

**STMicroelectronics, Infineon and Philips (called E3) cooperate and together they:**

- decided to use matte Sn as preferred plating
- have an extensive dbase of whisker growth on different lead-frames, storage conditions and with different suppliers in a timeframe of > 2 years
- have a common criterion for whiskers: <50 µm length after 2 years storage at ambient temperature
- concluded that whiskers are caused by compressive stress from the irregular growth of intermetallics at the substrate/layer interface
- found that room temperature grows the longest whiskers at the same time on Cu-based lead-frames
- investigate accelerated test method for whisker growth in a European Union founded project called PROTIN
- identified countermeasures for whisker growth

# Summary & Initial Findings (PHASE 1 - NEMI)

| Legs | Pattern | Preconditioning | Temperature | Humidity | Whisker Results (Samples) | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | A | B | C | D |
| 1 | 111 | 500 TC (1wk) | 50 | amb | no | no | yes | no |
| 2 | 112 | 1 wk Amb | 50 | amb | no | no | yes | no |
| 3 | 121 | 500 TC (1wk) | 50 | 85 | yes | no | yes | no |
| 4 | 122 | 1 wk Amb | 50 | 85 | yes | OSE | yes | no |
| 5 | 211 | 500 TC (1wk) | 85 | amb | no | no | yes | no |
| 6 | 212 | 1 wk Amb | 85 | amb | no | no | yes | no |
| 7 | 221 | 500 TC (1wk) | 85 | 85 | yes | OSE | yes | no |
| 8 | 222 | 1 wk Amb | 85 | 85 | yes | no | yes | no |
| 9 | 0 | 1 wk Amb | amb | amb | no | HKE | OSE | no |
| 10 | 1 | 500 TC (1wk) | amb | amb | no | HKE | OSE | no |

HKE: Hershey ™ Kiss Eruptions, OSE: Odd Shaped Eruptions.

Inferences:

1) For the thin tin plated samples (A) on Cu, it appears that the higher humidity factor is significant keeping others constant.

2) The accelerated combinations generate whiskers on the brass coupons C.

3) No whiskers to be seen on the standard Sn/Pb plated samples.

# Summary & Initial Findings (PHASE 1 - NEMI)

- Experimental matrix formulated after review of available whisker data in the industry.
- Defined parameters for bright and matte finishes.
- Study includes selected ICs and Passive components.
- In general, whisker growth has been observed on the samples that were likely to whisker though the density was lower than expected. No whiskering was seen on Sn/Pb plated samples.
  - Indications are that whisker growth occurs along the edges of the lead. Thin tin seems more susceptible to whiskering.
  - Accelerated testing appears to promote whisker growth.
  - Some changes to the surface morphology observed on the thick tin plating after accelerated testing. These have been defined as Hershey™ Kiss Eruptions.

# Summary & Initial Findings (PHASE 1 - NEMI)

- It appears that brass coupons with tin plating when subjected to accelerated test conditions have significant whisker growth especially along scratches on the coupon surface.
- Passive components (Sn on Ni) show incidence of whiskering when subjected to temperature cycle condition. The probable test condition is (tests still on-going):
  - Temp Cycling (-40 to 90C) for 500 cycles
- The type and density of whiskers on fuses were significantly different than standard Cu stamped leadframes.
- Developed a plan to evaluate whisker growth after board mount.

# Future Course of Action (Test & Fundamental Group) APEX 2002 -NEMI

- Additional Data from Motorola, NASA, Shipley & Others.
- Brainstorm on the next steps in experimentation to arrive at a recommended test method.
- Propose an experimental matrix to determine the fundamental causes for whiskers.
- Review the test matrix for whisker test after board level assembly.
- Additional evaluations to determine the acceleration factor(s) and the failure critieria.
- Establish a timeline for implementation of the test method as a standard.