

2214 Rock Hill Road, Suite 110 • Herndon, VA 20170-4214
Tel: +1 703-834-0330 • Fax: +1 703-834-2735
www.inemi.org • info@inemi.org

iNEMI Statement of Work (SOW) Board Assembly TIG iNEMI Creep Corrosion Project Phase 1: Industrial Survey

Version 2.0

Date: October 12, 2009

Project Leader: Xiaodong Jiang (Alcatel-Lucent)

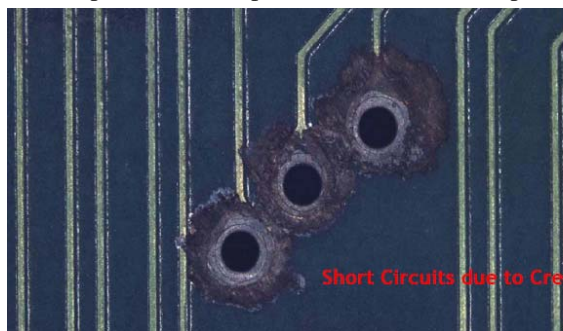
Co-Project Leader: Mason Hu (Cisco); Simon Lee (Dow Chemical)

iNEMI Coach: Haley Fu / Jim Arnold (iNEMI)

Basic Project Information

Background

Creep corrosion is a mass transport process in which solid corrosion products (typically sulfide and chloride) migrate over a surface without the influence of an electric field. Creep corrosion is highly surface specific and a given corrosion product can only migrate on a specific type surface. Recently, creep corrosion has been observed on printed circuit boards with lead-free surface finishes such as ImAg and OSP. In this case, the corrosion product (typically copper sulfide) creeps onto the solder mask surface and causes short circuits between the adjacent pads and traces. It has been demonstrated that the creep corrosion on printed circuit boards is promoted by the residue of certain types of fluxes.



Simulation in the laboratory has to take the highly surface sensitive nature of the creep corrosion into consideration. Mixed flowing gas (MFG) testing can simulate the environmental conditions in the global market place and has been successfully used to generate creep corrosion on electrical contacts (metallic surface) and IC components (dielectric surface). It has been demonstrated that creep corrosion can also be reproduced on printed circuit boards using MFG test. The MFG test provides a viable and realistic accelerated aging test for creep corrosion. However, it is also reported that the conditions of the current MFG corrosion resistance test method are unable to predict product life and reproduce the failure mechanisms observed in real world environments.

Related issued article:

[1]: APEX 2009: Creep Corrosion of PWB Final Finishes: Its Cause and Prevention

[2]: APEX 2008: Corrosion Resistance of PWB Final Finishes

Scope of Work

- A phased approach will be adopted on this project to reach the final goal.
- This SOW is focused on Phase 1 planning.
- Phase 1 will consist of a survey to collect the data on creep corrosion failures and related factors in the electronics industry. Subsequent analysis will be done on the information and feedback gathered from the survey.
- Phase 2 will use the output of Phase 1 to analyze and understand the root cause of creep corrosion.
- Phase 3 will be based on the results obtained in Phase 1 and Phase 2. This phase is envisioned to develop an industry acceptable test method to assess the development of creep corrosion in the field environment. Once an adequate test method has been developed and/or identified, this would provide the background for evaluating new materials and processes. Evaluating new material systems or assembly process to reduce the impact of creep corrosion is currently considered outside the scope for this project.

Purpose of Project

- Due to RoHS transition, the SnPb based PWB finish will move to Pb-free compatible finishes, not only on Pb-free products, but also on exempted products. Corrosion of electronics in many areas in Asia (China, India, Taiwan, and Middle East) is a significant issue. However, there is very little agreement on the test methods and conditions that should be used for simulating the environmental conditions in those areas. This project seeks to establish a standard test methodology to facilitate further investigation of this problem. The project will be broken into three phases.
- The purpose of **Phase 1** is to collect the environmental pollution related creep corrosion failures from the global electronics industry. The relevant information to be collected includes:
 - Components that caused the system failures, i.e., the weakest links of the PCBA.
 - The actual failure mechanism (corrosive shorts/opens, insulation resistance degradation/breakdown, etc.).
 - PWB surface finish type (e.g., OSP, ENIG, Immersion Ag, Immersion Sn ...).
 - The influence of the assembly process (e.g., exposure to reflow/wave processes, exposure to flux in the corroded area, flux material type, post-assembly cleaning process) on failure.
 - The end-use environment (e.g., geographical areas, temperature, humidity, sulfur content).
 - The estimated Defects per Million.
 - The Time to Failure for the recorded occurrences.
 - Identification of the Failure Analysis methods used in evaluation of failures.
- The purpose of **Phase 2** is to analyze the results of Phase 1 to understand the root causes of creep corrosion and the mechanisms of failure, taking into consideration the existing materials and the use environment.
- Phase 3 is envisioned to consist of developing test method(s) and the identification of test conditions that can be used to simulate environmental conditions that promote creep corrosion. If standardized, a common test method enables easy comparison of future investigations of this issue, leading to better materials, manufacturing processes, and end-use environment controls with the goal of eliminating creep corrosion.

What the Project Is / Is Not

Phase 1 - The Survey and Analysis	
The project IS:	The project IS NOT:
A survey of the occurrence of creep corrosion in the industry	
Inclusive of global applications	Specific to Asia
An investigation of environmental conditions related to creep corrosion (temperature, relative humidity, atmospheric concentration of sulfide)	Classification of the environmental condition
An investigation of the surface finishes related to creep corrosion	Evaluation or comparisons between finishes
An investigation of manufacturing factors related to the incidence of creep corrosion (e.g. flux, processing, operations)	

Phase 2 - The root causes and mechanism analysis	
The project IS:	The project IS NOT:
A data analysis based on the survey results and industry published work	A new series of experimental studies
An attempt to define the factors that induce creep corrosion	A physical and chemical analysis of the mechanism of creep corrosion
	An evaluation of the best process chemicals or final finishes

Phase 3 - The test method and conditions setting development	
The project IS:	The project IS NOT:
Intended to create a guideline such that test results can be easily compared	A requirement with strict pass/fail criteria
An effort to develop and define a test method, based on a well defined test vehicle, that will reproduce the corrosion observed in the field with the goal of establishing PCB and PCBA creep corrosion qualifications.	An effort to build a model that simulates corrosion conditions.

Previous Related Work

- IPC has a task group (3-11g) working on metal corrosion, environmental measurement methods, and MFG test. This group has investigated and reviewed environmental classification and measurement methods in the past. They plan to gather data on corrosion of metals used in electronic assemblies in order to establish a long-term predictive test method and model. They report that the conditions of the current 'mixed flowing gas' corrosion resistance test method are unable to predict product life and reproduce the failure

mechanisms observed in real world environments. The need for a new or modified test method is also prompted by the increase in occurrence and severity of electronic failures due to environment induced corrosion.

- ISA has an environmental classification standard based on Cu corrosion. However, the ISA standard does not take silver corrosion into account, which poses a serious dilemma to the operation and maintenance of critical processes and equipment. Currently, ISA is planning to revise the standard, and the silver data will be use quantitatively to designate environmental severity levels.
- The team knows there should be other creep corrosion related works performed by the individual firms in the different market segmentations. The detail list of the previous related works will be published as one of the survey outputs.

Prospective Participants

- Alcatel-Lucent
- Cisco Systems
- Celestica
- Huawei
- Intel Corporation
- Dow Chemical
- IBM
- HP
- PCB, solder paste and flux suppliers
- OEM and EMS who are concerned with creep corrosion

Project Plan

Schedule with Milestones

Phase 1 – The Industrial Survey and Analysis

For Phase 1, except for participant’s time, no material cost is foreseen.

Task	Phase 1	Months					
		1	2	3	4	5	6
	<u>Industrial Survey</u>						
1.0	Plan the Survey						
1.1	Define questionnaire (questions)						
1.2	Define survey data analysis method						
1.3	Prepare survey recipient list						
2.0	Prepare Logistics of Survey (Notify Prospective Recipients)						
3.0	Conduct Survey / Distribute Questionnaire						
4.0	Collect and analyze data						
5.0	Review/Share survey data with project members						
6.0	Prepare summary report of the survey results for iNEMI Membership						
7.0	Phase 2 Preparation, Develop Project Plans / SOW						

Phase 2 – Identify, analyze and verify the root cause(s) and failure mechanisms

The plan for Phase 2 will be developed during the final section of the Phase 1 tasks. Phase 2 may need budget for materials such as test coupons to analyze root cause.

Phase 3 – Develop test method and conditions setting development

The plan for Phase 3 will be developed during the final section of the Phase 2 tasks. Phase 3 may need budget for materials such as test coupons to develop test method.

Phase 1 – Detailed Information

1.0 Plan the Survey

1.1 Define the questionnaire (questions).

What are the questions that will be asked? They must be such that they enable the items in phase 2 to be clearly defined and scoped. Develop the key questions to be included in the survey based on the understanding of creep corrosion issues and provide some example answers. Decide on the format of the questions to enable easy and clean data analysis.

1.2 Define survey data analysis method.

What tools will be needed to analyze the data? Task 1.1 defines what data should be collected.

1.3 Prepare survey recipient list.

The team will list interested parties from industry to be included in the survey. Participation in the survey is not limited to iNEMI members; anyone from the industry may participate. The survey should have a broad coverage in order to define the scope and impact of creep corrosion in different market segments. The survey should include the portable/consumer, netcom (network, datacom and telecom), office/large business systems, automotive, medical, and instrument sectors.

- Resources
 - All team members are expected to
 - Contribute and review the list of questions
 - Contribute to the survey recipient list
 - One or more team members need to propose how the survey will be analyzed
- Materials and processes
 - Software/server to Host survey (iNEMI server, survey monkey etc)
 - Identify software, if needed, to perform data analysis

2.0 Prepare Logistics of Survey (Notify Recipients)

Use the planned server/software to distribute the survey sheet by email. May do a press release to alert the industry to the availability of the survey and invite them to join and submit the survey via web site. If necessary, the team can provide a guide to properly fill in survey.

- Resources
 - Team members to own posting the survey and send out to the recipient list

3.0 Conduct Survey

Collect the feedback via email or web site. The team plans to allow 4-6 weeks for the survey. We may follow up the survey with interviews, depending on the number of respondents. This would be necessary for in-depth investigation of the creep corrosion failures. A third party may be needed to help collect the feedback to ensure anonymity.

- Resources
 - Team members (from Task 2) to send reminders to recipients
 - Interviews set up to acquire more in-depth information on nature and statistics of failures

4.0 Collect and Analyze Data

Summarize previous related work the industry has done. Compile data and identify the key elements that affect creep corrosion. Find the common failure modes to focus on in subsequent project phases.

- Resources
 - Team members to collect all survey replies and compile data
 - Team produces a report based on the data

5.0 Share Survey Data with Project Members

- Resources
 - Team member to share data with team

6.0 Prepare Summary Report of the Survey Results for iNEMI Membership

Summarize the findings of the survey and decide what results will be shared to the iNEMI membership and the general public.

- Resources
 - Team members to share summary of survey results; give Webinar / report to general iNEMI membership)

7.0 Phase 2 Preparation - Develop Project Plans / SOW

Based on the results of Phase 1, define and detail the Phase 2 scope and goals. Finish the Phase 2 SOW.

- Resources
 - Team member to develop Phase 2 plan and recommendation for implementation.

Project Monitoring Plans

For Phase 1:

- Review all project requirements with prospective participants before the project begins.
- Planned teleconference schedule: weekly conference calls on Tuesday mornings.
- Meeting minutes provided through e-mail.
- Provide brief reports indicating progress such as a short series of PowerPoint slides showing the work in progress.
- A final survey and analysis summary document will be issued at the end of Phase 1.
- Make determination to continue or stop project at the end of Phase 1.
- Issue Phase 2 SOW as the planning document for Phase 3.

Outcome of the Project

- A summary of the creep corrosion failures in the electronics industry.
- A report of factors causing creep corrosion in polluted environments.
- Development of a test method and conditions that set guidelines for environment related creep corrosion long term reliability test method.

General and Administrative Guidelines

General and Administrative Guidelines for this project and all other iNEMI Projects are documented at http://thor.inemi.org/webdownload/join/gen_guidelines.pdf.