ASSOCIATION CONNECTING ELECTRONICS INDUSTRIES®

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User Guide for the IPC-TM-650, Method 2.6.25, Conductive Anodic Filament (CAF) Resistance Test (Electrochemical Migration Testing)

Developed by the Electrochemical Migration Task Group (5-32e) of the Cleaning and Coating Committee (5-30) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

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1 SCOPE

This document is the product of the IPC Electrochemical Migration (ECM) Task Group. It was drafted to provide guidance regarding how the IPC-TM-650, Method 2.6.25, Conductive Anodic Filament (CAF) Resistance test can best be used for evaluating the effects of mechanical stress, laminate material fracturing, ionic contamination, moisture content prior to press lamination, and other material processing characteristics on conductive anodic filament (CAF) growth. This CAF test method provides a proven standard for determining the risk of THB failure within rather than on the surface of printed circuit boards (PCBs), typically filament formation along the boundary between the resin and laminate reinforcement.

2 INTRODUCTION

Conductive Anodic Filament (CAF) growth is a conductive copper-containing salt created electrochemically that grows from the anode toward the cathode subsurface along the epoxy/glass interface. The formation of atacamite as a conductive filament was first reported on a board surface in 1971 (Raffolvich). It was not reported as a type of electrochemical migration failure until 1979 [1]. More recently CAF reliability concerns in the industry have increased as board designs have advanced in terms of decreasing dimensions and/or higher voltages.

The mechanism for CAF is the transfer of copper (Cu) ions and the deposition of Cu salts in the presence of moisture and voltage bias influenced by concentration and pH gradients. The conductive path is the growth from the anode by a salt, as compared to dendrite formation on the surface of the board where metal ions deposit on the cathode [2]. CAF is associated primarily with mechanically drilled holes where the mechanical drilling disrupts the glass reinforcement fibers in glass bundles permitting the absorption of subsequent processing chemistry between the fibers and epoxy. The user of this document is encouraged to become familiar with IPC-9201, *Surface Insulation Resistance Handbook,* so as to distinguish CAF failures and possible confounding Surface Insulation Resistance failures.

3 PURPOSE

This user guide addresses test issues regarding determining internal feature CAF resistance based on knowledge of three product goals:

a) What are the long term reliability requirements?

b) What is the closest spacing required for a given voltage differential?

c) What is the maximum safe voltage differential between features with a given spacing?

4 BACKGROUND

Where large conductive filament growth is visible under a microscope, often there is some adjacent laminate material fracturing or defect that contributed to its formation. Examples of such visible filament growth follow. Only Figure 4-4 may show a true atacamite filament, however all examples shown in Figures 4-1, 4-2, 4-3 and 4-4 would fail the temperature, humidity, and bias conditions selected to determine multilayer board reliability between internal features.

The high magnification photo, Figure 4-1 below, shows a PCB with layer 1 (top layer) removed, revealing a near shorting condition between the plated-through hole and layer 2 ground plane. [Photo courtesy of Matsushita]

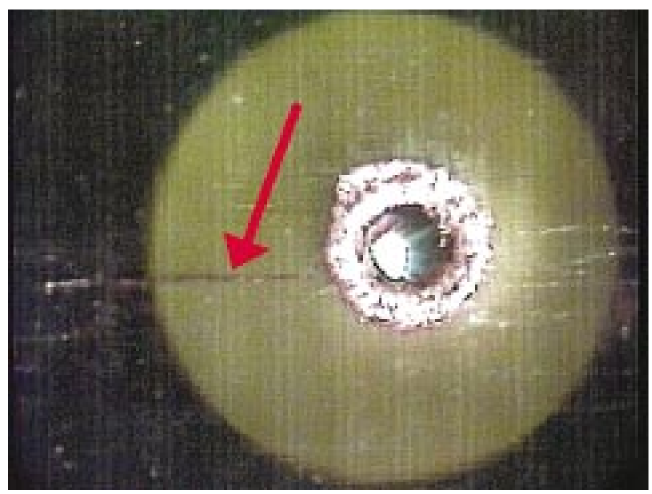

Figure 4-1 Conductive Filament Example

Poor press lamination and/or defective prepreg material may contribute to conductive filament formation if the resin/reinforcement bonding strength and resistance to mechanical stress is reduced.

Failure analysis, as seen in two perspectives in Figure 4-2, show a near-shorting condition from the hole barrel to the plane on layer 3.

During CAF testing, the use of a low bias voltage and at least 1.0 megohm current limiting resistor can facilitate,