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Conformal Coating Material and Application "State of the Industry" Assessment Report

Developed by the J-STD-001 Conformal Coating Material & Application Industry Assessment (5-22arr) of the Assembly & Joining Committee (5-20) of IPC

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Abstract

Conformal coatings are thin layers of polymers applied to the surfaces of electronic assemblies, primarily to protect the electronics from the operational environment. In most manufacturing specifications, conformal coating thickness is defined as the thickness of the final polymer film on a flat, unencumbered surface of the assembly. However, the conformal coating thickness on other assembly and component surfaces are usually uncharacterized. This report outlines an IPC study of major conformal coating types, coating application techniques, and coating cure technologies, characterizing the final film thickness on common component surfaces. The study included volunteers from numerous manufacturing companies who applied coating using vetted manufacturing processes for the production of high reliability electronics.

Overview

Conformal coating, for the purpose of this document, is defined as a thin, often transparent, polymeric coating that is applied to the surfaces of printed circuit assemblies (PCAs) to provide protection from the operational use environment. Typical coating thickness ranges from 12.5 µm [0.49 mil] to 200 µm [7.9 mil].

Processing characteristics and curing mechanisms vary with the coating chemistries used. The desired performance characteristics of a conformal coating depend on the application and should be considered when selecting a coating material and process. Conformal coatings are used for the following:

- Inhibit current lea.k.a.ge and short circuit due to humidity and contamination from service environment
- Inhibit corrosion
- Improve fatigue life of solder joints to leadless packages
- Inhibit arcing, corona and St. Elmo's Fire in high voltage circuits
- Reduce damage from mechanical shock and vibration by providing mechanical support to small parts that cannot be secured by mechanical means.
- Provide some protection and mitigation against tin-whiskers and other conductive foreign objects or debris (FOD).

The beneficial effects of the coating depend on its properties, thickness and coverage. These characteristics in turn depend on the coating chemistry, application process and curing process.

The measurement of conformal coating thickness, in situ, has always been a tremendous challenge for the industry. Consequently, it has been an industry best manufacturing practice (BMP) is to measure conformal coating on a flat, unencumbered portion of the circuit assembly, or on a flat witness coupon processed at the same time as the circuit assembly. The J-STD-001 specification specifies thicknesses for conformal coating but those thickness ranges are for flat, unencumbered portions of the circuit assembly. It is a common misconception that the J-STD-001 specified thickness ranges apply to ALL surfaces of a circuit assembly.

The unanswered question is, when conformal coating is applied to flat, unencumbered surfaces of a printed circuit assembly such that it meets the thickness criteria of J-STD-001, what degree of conformal coating coverage can be expected on other critical surfaces, such as component leads, undersides of components, etc.?

In 2013, the J-STD-001 committee tasked a group of subject matter experts (SMEs) to answer this question by investigating conformal coating coverage in greater depth to determine the degree of conformal coating coverage that can be achieved by industry-standard conformal coating application/cure processes. Collins Aerospace led this massive effort, which involved a large number of volunteer sites.