Testing and control of tin-based platings on lead-free components For external use

Rev 1 Jan 31, 2003 First release
Rev 2 June 30, 2003 Changed test description and failure criteria in test requirement 4 and 5

Tin whiskers can cause electrical short circuits and represent an unresolved reliability risk for lead-free tin (Sn) and tin-alloy lead platings. If a Pb-free plating is implemented, HP prefers the use of Ni/Pd/Au plating, matte Sn-based platings (100%Sn, Sn-(1-3%)Bi, or Sn-Ag) over a Ni underlayer of at least 50 µinches, or solder dipped platings. However, certain businesses may make exceptions and accept Pb-free Sn-based platings only if the following requirements are met. These requirements should reduce the risk of product failures due to tin whiskers. Please refer to "HP's position statement on tin-based plating for lead-free components" in Appendix A for more details.

General expectations of suppliers of plated components[1]
The Supplier is responsible for implementing the HP defined test process requirements. HP has provided a detailed test specification/test plan below. The Supplier is expected to provide control methods to execute the test specification as appropriate. The Supplier will manage (with HP support) the development, setup and qualification of the test process. The Supplier will work with HP to provide all testing. At this time, a third party is not available to conduct testing.

The Supplier shall carry out all final inspection and testing in accordance with its internal quality plan/processes and the HP-specified quality expectations. The quality plan, subject to HP review and approval, should require that all specified inspections and tests have been satisfactorily completed and the associated data and documentation are available in accordance with the Supplier's quality procedures.

Requirements for all tin-based lead-free platings
The following five requirements will be met before components with a Pb-free, Sn-based plating will be considered by HP.

1. Supplier will define acceptable values and tolerances for plating process parameters. These parameters will include current density, voltage, acidity, bath chemistry (sulfate vs. MSA), bath contamination with Cu, Zn, Pb, Ni, Fe, and added carbon-based compounds. HP will not mandate plating process parameter values or tolerances, but requires that platings made with supplier-defined acceptable values and tolerances pass HP's required long term (requirement #4) and short term

[1] This includes HP suppliers that manufacture plated components or are responsible for the purchase of plated components (i.e. outsource design manufacturers and contract manufacturers) must insure that plated components they purchase on behalf of HP meet these criteria.

(requirement #5) whisker testing. Supplier will provide documentation of defined values and tolerances for process parameters.

2. Supplier will establish a system to measure and to control (within established tolerances) plating process parameters known or suspected to influence whisker growth (defined by supplier in requirement #1). Supplier will provide initial documentation that process parameters are in control, and subsequent documentation upon request.
3. Supplier will establish a system to measure and to control (within established tolerances) characteristics of the tin plating known or suspected to influence whisker growth. These characteristics will include plating thickness, plating grain size, plating carbon content, plating crystallographic texture, and plating alloy percentage (if appropriate). HP prefers tin plating thicknesses greater than 10 µm. HP requires carbon content below 0.05%, grain size greater than 5 µm, and copper content in the plating bath of less than 50 ppm, except with specific approval. Supplier will provide initial documentation that plating parameters are in control, and subsequent documentation upon request.
4. Supplier will demonstrate the ability to produce whisker resistant plating over the extremes of established plating process parameter tolerances. This means long term whisker testing must be performed for initial qualification and on a yearly basis after qualification. These tests include two tests suggested by NEMI and JEITA, performed on 5 separate parts per test and at least three leads per part or two terminals per passive. All whisker analyses will be made with a scanning electron microscope (SEM) at 300x to look for whiskers and 3000x for photos of the maximum length whisker (magnifications near these two values may be acceptable). SEM analysis will be performed at the beginning and end of the six month tests. **Required tests:** (1) Low constant temperature (ambient) testing at 25°C+/-5°C and 30-80% relative humidity for six months, (2) High constant temperature testing at 55°C+/-5°C and 80-95% relative humidity for six months **Acceptability criteria for both tests:** Plated parts must satisfy one of the following failure criteria: (a) No whisker[2] longer than 10 µm for high reliability and price-performance products and no longer than 25 µm for consumer products is acceptable (See Table 10), except with specific approval from a particular HP business. *OR* (b) whisker density and maximum whisker length do NOT exceed the whisker density and maximum whisker length observed on a Sn-(3-10%)Pb plated control sample that has been plated in production on the exact same base material and component design as the Pb-free component being qualified.

[2] Pictures of whiskers are available on request if that will assist in analysis.

Table 10. Pass/fail criteria for 6 month, constant-temperature whisker testing, described in requirement #4, as a function of HP product category. Whiskers observed following these 6 month tests must be less than the maximum whisker length given in this table for the appropriate product category.

HP product category	Maximum whisker length
Consumer	25 µm
Price-performance	10 µm
High reliability	10 µm

5. Supplier will demonstrate the ability to maintain a consistent and high quality plating that is resistant to whisker formation and growth by performing short-term whisker testing on at least a monthly basis. These tests include three tests suggested by NEMI and JEITA, performed on 3 separate parts per test and at least three leads per part or two terminals per passive. All whisker analyses will be made with a scanning electron microscope (SEM) at 300x to look for whiskers and 3000x for photos of the maximum length whisker (magnifications near these two values may be acceptable). SEM analyses will be performed at the beginning and the end of each test. **Required tests[3]:** (1) Low constant temperature (ambient) testing at 25°C+/-5°C and 30-80% relative humidity for one month, (2) High constant temperature testing at 55°C+/-5°C and 80-95% relative humidity for one month, and (3) thermal cycling, 20 min. cycles (air to air chamber) from +85°C+/-5°C to –40°C+5/-15°C for 500 cycles. **Acceptability criteria for all three tests[4]:** Plated parts must satisfy one of the following failure criteria: (a) No whisker longer than 10 µm or with an aspect ratio greater than 2/1 (length/width) is acceptable, except with specific approval from a particular HP business. *OR* (b) whisker density and maximum whisker length do NOT exceed the whisker density and maximum whisker length observed on a Sn-(3-10%)Pb plated control sample that has been plated in production on the exact same base material and component design as the Pb-free component being qualified.

[3] If preferred by the supplier, it would be acceptable to perform all three tests on one set of components. SEM analyses should be performed initially and after all tests are complete. The same failure criteria given in requirement #5 are applicable.

[4] The acceptability criterion for the thermal cycling test is under investigation and may change in the near future.