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The Need For Gold Removal On Solderable Surfaces

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The Criteria J-STD-001 Rev F

4.5.1 Gold Removal

- Gold removal is performed to reduce the risk of failure associated with embrittled solder. Gold embrittlement is not a visually inspectable anomaly. In cases where analysis has determined there is a gold embrittlement condition, the gold embrittlement **shall [N1D2D3]** be considered a defect, see IPC-HDBK-001 or IPC-AJ-820 handbook for guidance.

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The Criteria J-STD-001 Rev F

4.5.1 Gold Removal

- Except as noted above, Gold Shall [N1D2D3] be removed:
  a. From at least 95% of the surfaces to be soldered of the through-hole component leads with 2.54 µm [100 µin] or more of gold thickness
  b. From 95% of all surfaces to be soldered of surface mount components regardless of gold thickness.
  c. From the surfaces to be soldered of solder terminals plated with 2.54 µm [100 µin] or more of gold thickness.
- A double tinning process or dynamic solder wave may be used for gold removal prior to mounting the component on the assembly.

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J-STD-001Changes Between Revisions of Docs

Note:

- Gold embrittled solder connections can occur regardless of gold thickness when solder volume is low or the soldering process dwell time is not sufficient to allow the gold to dissolve throughout the entire solder joint.

001 Rev E & F, Para 4.5.2, Other Metallic Surface Finishes Removal

- Other metallic surface finishes **shall [N1P2D3]** be removed from 95% of the surfaces to be soldered on components if it is determined that the solder joint integrity will be compromised.

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J-STD-001Changes Between Revisions of Docs

Rev D 2005, A double tinning process or dynamic solder wave may be used for gold removal.

Rev E, 2010 A double tinning process or dynamic solder wave may be used for gold removal prior to mounting the component on the assembly.

Rev F, 2014 A double tinning process or dynamic solder wave may be used for gold removal prior to mounting the component on the assembly.

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The Criteria J-STD-001 ES SPACE

4.5.1 Gold Removal

- Gold **Shall Be** Removed: D3
  - Gold **shall be** removed from at least 95% of the surface to-be-soldered of all component leads, component terminations, and solder terminals.
  - A double tinning process or dynamic solder wave may be used for gold removal prior to mounting the component on the assembly

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The Criteria – IPC/ WHMA-A-620

4.1.2 Material, Components and Equipment – Gold Removal

Gold **shall**[4] be removed from the surface to be soldered when the thickness of gold exceeds 2.5 µm [0.0001 in].

A double tinning process or dynamic solder wave may be used for gold removal.

These requirements may be eliminated if there is documented objective evidence available for review that there are no gold related solder embrittlement problems associated with the soldering process being used.

(4) Class 1-Not Est
Class 2-Proc Ind
Class 3-Defect

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The Criteria J-STD-001 Rev E

4.5 Removal of Component Surface Finishes Certain surface finishes on component terminations or PCB lands may impact the quality of the solder connection. Follow the requirements of 4.5.1 and 4.5.2.

The following requirements may be eliminated:

a. If there is documented objective evidence, available for review, that there are no gold related solder embrittlement issues, or other metallic surface finish solder joint integrity problems (e.g., with Sn or SnBi) associated with the soldering process being used (see IPC-HDBK-001 or IPC-AJ-820 handbook for guidance).

b. For electroless nickel immersion gold (ENIG), nickel-palladium-gold (NiPdAu), or electroless nickel electroless palladium immersion gold (ENEPIG) finishes.

- The (a) information in 620 is based upon Rev E

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The Criteria – NASA – 8739.3

- 7.2.5 c - Gold plating on all surfaces that become part of finished solder connections shall be removed by two or more successive tinning operations (solder pot or iron), or by other processes demonstrated to have equivalent effectiveness
- 7.3.1 Termination areas shall have been "tinned" with hot-coated tin-lead solder or hot reflowed electrodeposited tin-lead solder prior to mounting the parts (Requirement). Final solder terminations shall not be made to any PWB or solder cup that has not had the gold removed from the termination area (Requirement).

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Why Gold Plating

Pro

- Gold:
  - Does not tarnish
  - Does not oxidized
  - Is solderable
  - Has a long shelf life

Con

- Gold:
  - Porous
  - Can be too thick
  - Dissolves in Eutectic Tin/Lead
  - Creates embrittlement of solder joints

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What is the Problem?

- Gold embrittlement and voiding in SMT solder joints.
- Gold plated components falling off the board
- Evaluations exhibited Au-Sn intermetallic platelets distribute over the fracture surface and in the surface of the voids.

Gold Embrittlement of Solder Joints
By Ed Hare, Ph.D.
Updated – February 2010

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Gold Embrittlement

- Additional phases form when gold is dissolved into the eutectic tin-lead alloy. The most important phases are AuSn4 and AuSn2 intermetallic compound phases.
- The embrittlement is the result of a large volume fraction of hard Au-Sn IMC platelets in the ductile Sn-Pb matrix.

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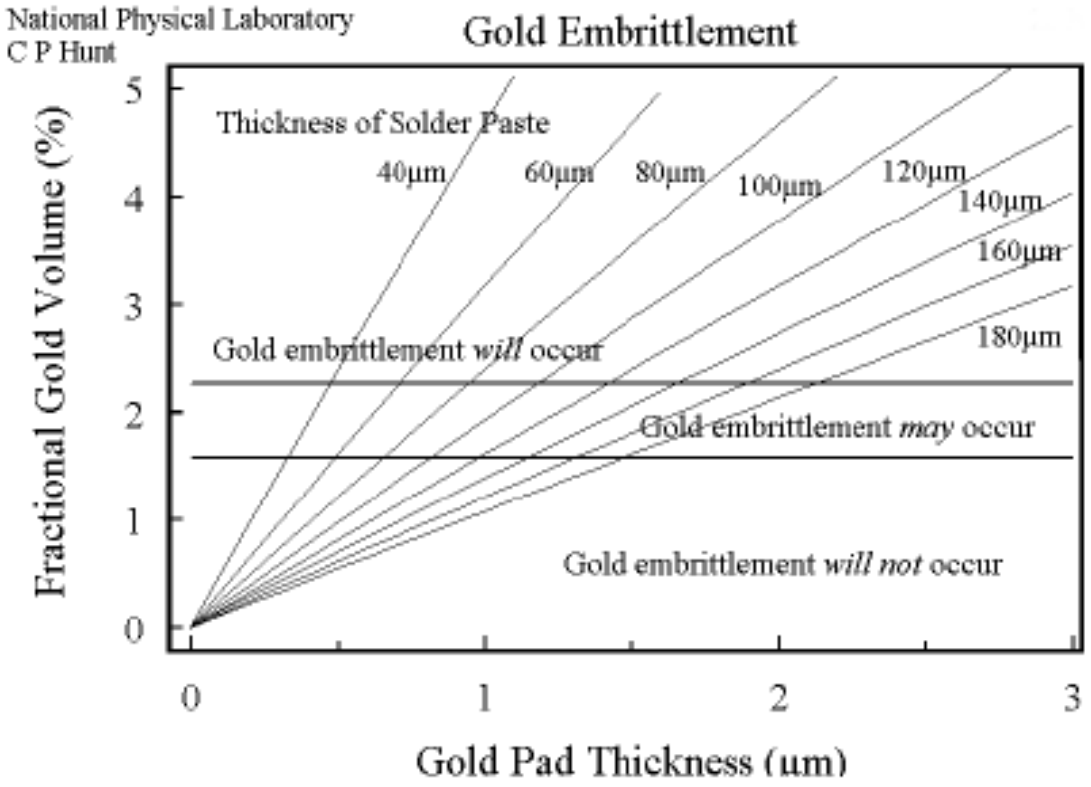
Gold Embrittlement



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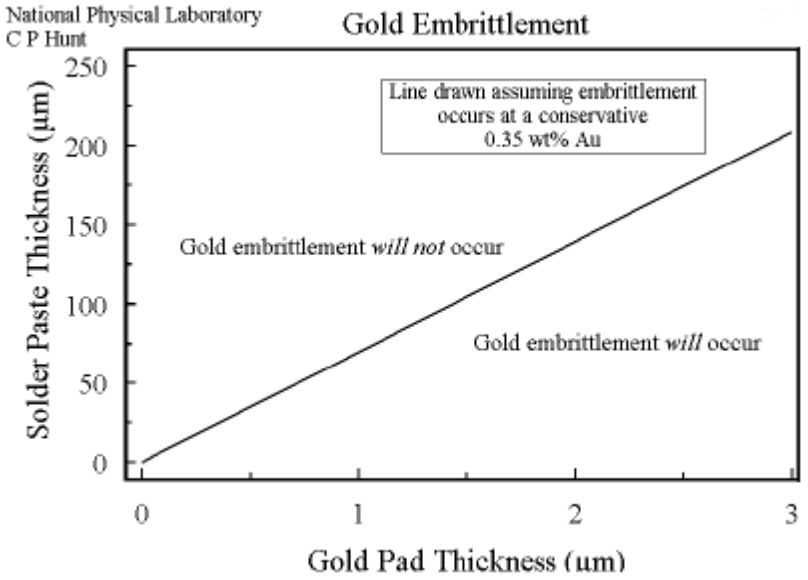
Gold Embrittlement



The data presented in these figures are from a theoretical calculation and have not been tested in practice but should be useful as a guide to avoiding problems of embrittlement.

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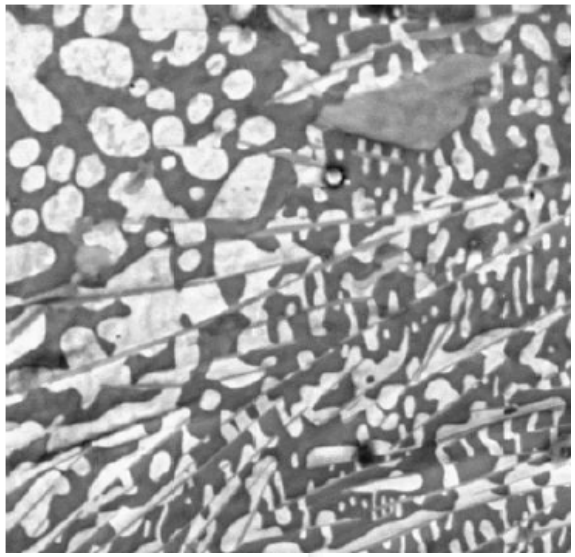
Gold Embrittlement



Gold Embrittlement of Solder Joints
By Ed Hare, Ph.D.
Updated – February 2010

•Eutectic tin-lead microstructure with gold embrittlement [BSE SEM image at 3400X]. Bright areas are Pb-phase, darker areas are Sn-phase, and intermediate contrast areas are Au-Sn IMC (primarily AuSn4 and AuSn2).

• Image processing was used to estimate the area fraction of IMC in this image, which was calculated at 20.5% corresponding to a severely embrittled solder joint.

•At a fixed concentration of gold, thinner plates would have a larger total interface area with the surrounding matrix and therefore a stronger contribution to the overall mechanical behavior of the solder joint. This makes it somewhat precarious to rely on general rules such as the 3 wt% gold threshold for embrittlement.

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Gold Embrittlement

- Figure 3: [Ref. IFN 897A_1, BSE SEM image, 94X] This is a BSE SEM image of the fracture surfaces of failed connector solder joints. There is severe voiding and flux entrapment (dark material) associated with the fracture surface.

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Updated – February 2010

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Gold Embrittlement

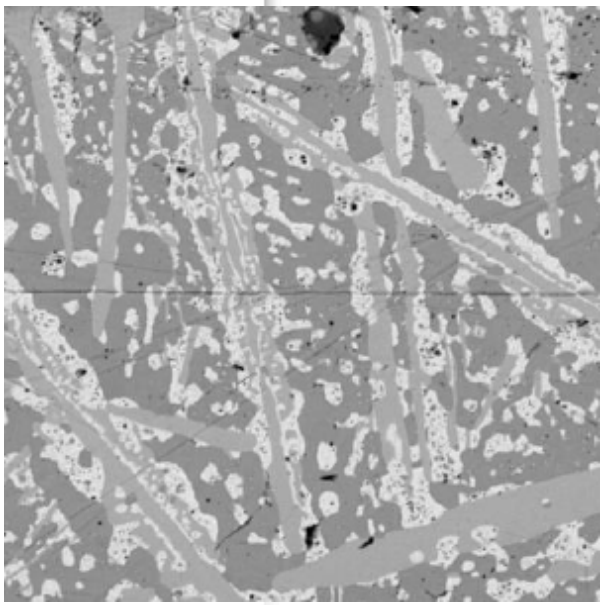

Figure 5: [Ref. IFN 370_5, BSE SEM image, 1513X]. This is the microstructure of the solder joint showing the distribution of Sn-phase (dark gray), Pb-phase (light gray) and Au-Sn IMC (intermediate gray). Image analysis suggests the Au-Sn IMC is ~28% area fraction. EDS results gave ~ 10 wt% Au, which is ~3X the 3 wt% threshold.

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Gold Embrittlement

Typical Gold Plated Items

- Lead Frames
- Special ASIC component
- Connector Pins
- Terminals
  - Cups
- Board Contact
- Board conductor traces

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Class 3 requirement

- Double tinning of the gold plated item to remove all the gold.
- Train all people to build and solder to class three

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Thank You

Any Questions?

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Further Information

For questions regarding this webinar, please contact Leo Lambert at leo@eptac.com

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