

# Tin whiskers causes and prevention

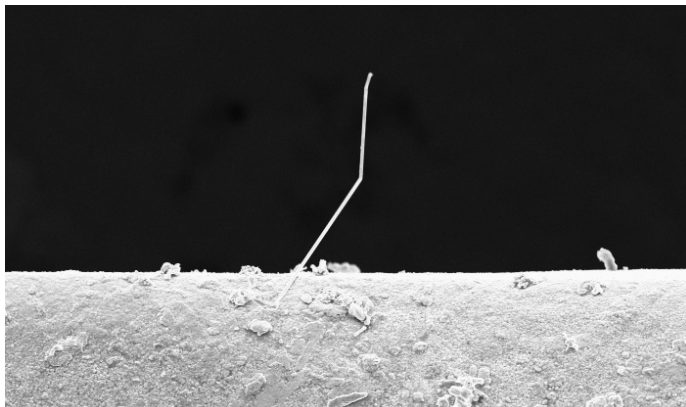
## Tin Whiskers

### What are they?

- Whiskers are thin fibres of tin that grow apparently spontaneously from electroplated tin surfaces
- Tin whiskers can cause short circuits and have caused several satellites, missiles, heart pacemakers and a nuclear power station to fail
- Electroplated tin coatings are used on most component terminations to aid soldering and to provide corrosion resistance
- Whiskers of several mm are possible although ~100µm is more common.
- Only long whiskers cause failures.

### Causes of Tin Whiskers

- Whiskers are caused by compressive stresses in tin coatings
- Stresses are induced by:
  - Irregular intermetallic crystals that grow at copper / tin interfaces
  - Due to stress induced by thermal expansion mis-match between layers of coatings
  - Due to formation of bulky oxides between tin grains in humid environments



SEM image of tin whiskers taken by ERA Technology Ltd

### Prevention of Tin Whiskers

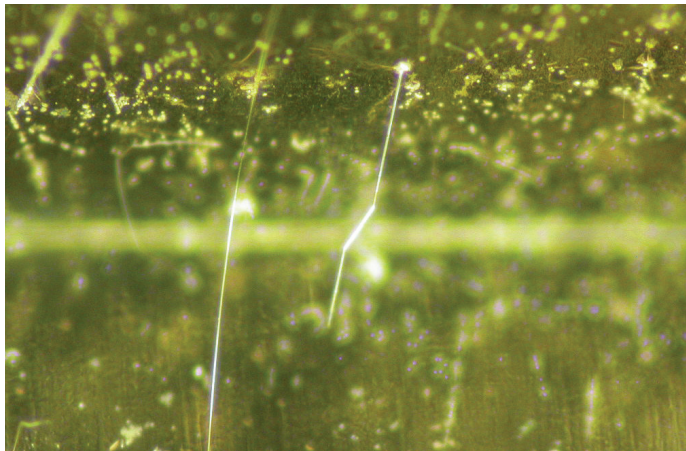
- A lot of research has been carried out into the causes and prevention
- iNEMI has published guidance
  - [http://thor.inemi.org/webdownload/projects/ese/tin\\_whiskers/Pb-Free\\_Finishes\\_v4.pdf](http://thor.inemi.org/webdownload/projects/ese/tin_whiskers/Pb-Free_Finishes_v4.pdf)
  - Risk should be small if this is followed but:
    - Equipment manufacturers buy pre-plated components from suppliers and have no influence over production process
  - Test methods are available but
    - These take at least 3 months – no use for QA
- Equipment manufacturers need a whisker mitigation strategy:
  - Approved supplier list for COTS components
  - Document coating specification for custom made parts
  - Design requirements
  - Conformal coatings

### Measures to avoid Tin Whiskers

- Whisker risk very low if the following are used:
  1. Use Ni/Pd/Au termination coatings (no risk but an uncommon coating)
  2. Use tin/lead terminations (extremely low risk but infrequently available)
  3. Thin matte tin on copper with a non-porous nickel barrier layer (very low risk)
  4. Bake matte tin on copper at 150°C for 1 hour within 24 hours of plating (no good later than this). Very low risk but only a few component manufacturers do this
  5. Melt electroplated tin – this usually prevents whiskers but the high temperature may cause heat damage. Hot dipped terminations are OK

## How to avoid Tin Whiskers

- Do not use SnCu plating but SnAg is OK
- Avoid alloy 42 lead-frame components or other low TCE materials if there is a choice
- Whisker resistant matte tin plating processes are new, not all electroplaters use them, check that they do and that operating procedures are followed
- Matte tin is usually less susceptible to whiskers although whisker resistant bright tin is available
- SnBi termination coatings are OK but ensure <6% Bi to avoid reliability problems with PbBiSb phases



Unusually long tin whiskers photographed by ERA Technology Ltd

## Design to avoid Tin Whiskers

- Follow iNEMI guidelines as far as possible
- Avoid components from sources you do not trust
- Avoid fine pitch terminations (if possible) – most whiskers are up to ~150µm in length
- Consider conformal coatings – even if whiskers form and break-through, they are unlikely to re-penetrate the coating on an adjacent termination
- Choose components that have been tested by the manufacturer
  - JEDEC test results should be freely available
- Remember that silver and zinc plating also produce whiskers
- If custom parts are to be plated with tin for corrosion resistance – use nickel barrier layer & matte tin

## Conclusions

- Tin whiskers are a real threat
- However their causes are understood
- Measures to avoid whisker failures have been developed

