



The Product Realization Company

3D DIGITAL STITCHING AND ITS USE WITH DENDRITE GROWTH STUDIES

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IT'S A 3 DIMENSIONAL WORLD

Two dimensional images have been the norm for most of recorded history.

- From cave wall paintings to the photos of man on the moon – 2D images are what has recorded the visual history of the world.



Only recently has there been innovations into three dimensional methods of capturing an image that could be more realistic of what was actually being viewed.

Adventures into 3D Imagery:

Animation/Game Graphics

Pseudo Movement 3D

Holograms

2D and 3D stitching



PSEUDO 3D MOVEMENT



VIRTUAL REALITY GLASSES



Virtual Reality Movie of the Surface of Mars



Explore places that are impossible to go, ie. canyon's and surface of Mars.

Grand Canyon in AZ is 227 mi long x 18 mi wide
Valles Marineris on Mars is 2500 mi long x 125 mil wide

HOLOGRAMS

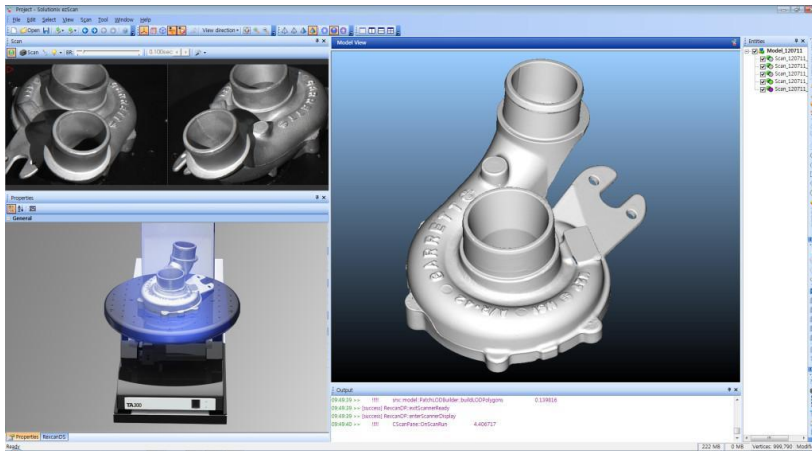


Cell phone Hologram

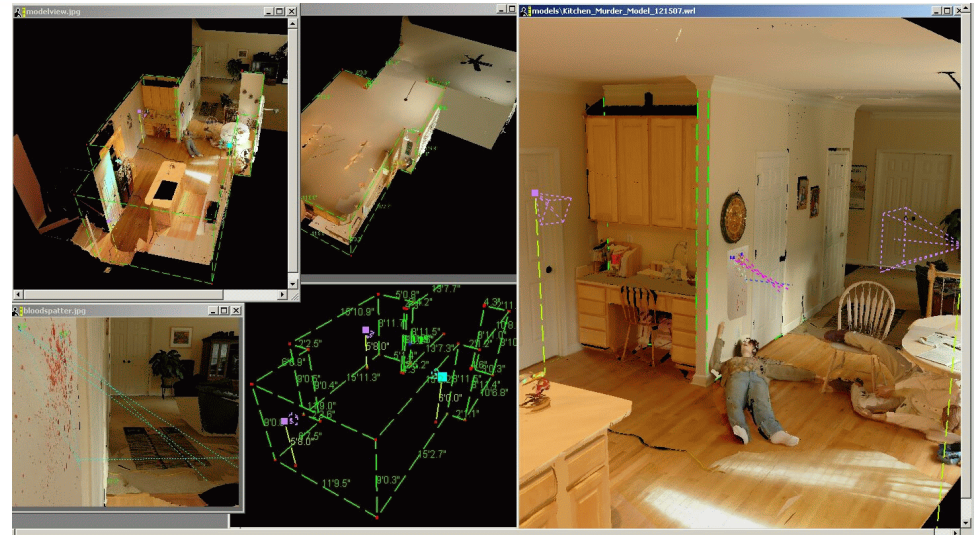


As shown in the Iron Man movie

3D DIGITAL SCANNING



Object & Part scanning



Crime scene recording in detail



Human body scanning



Handheld scanner



Ultrasound imaging

3D DIGITAL STITCHING MICROSCOPE MANUFACTURERS

There are several companies making 3D Stitching microscopes:



Leica DVM6 Digital Microscope

Most of the photos and data in this presentation were done with a **Keyence VHX-5000 System**

- Olympus
- Leica
- Bruker
- Keyence
- Others



VHX-5000 CONTROL CONSOLE

Virtually the whole imaging process can be controlled from this console.



CONTINUAL SHRINKING PACKAGING



Magnification: X13.1

**A 008004 size Package on
a US penny**

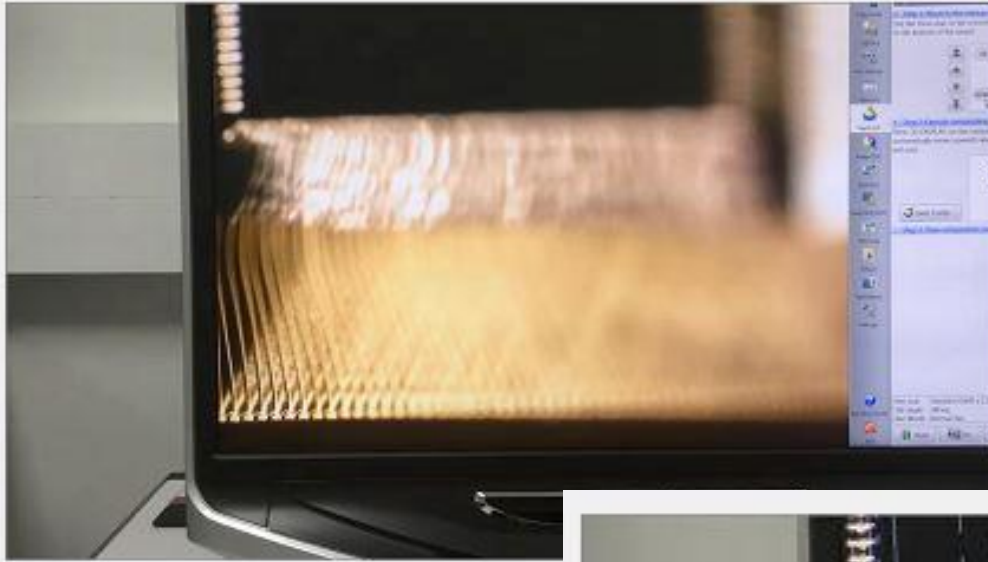


Magnification: X200.0

PLEXUS

The Product Realization Company

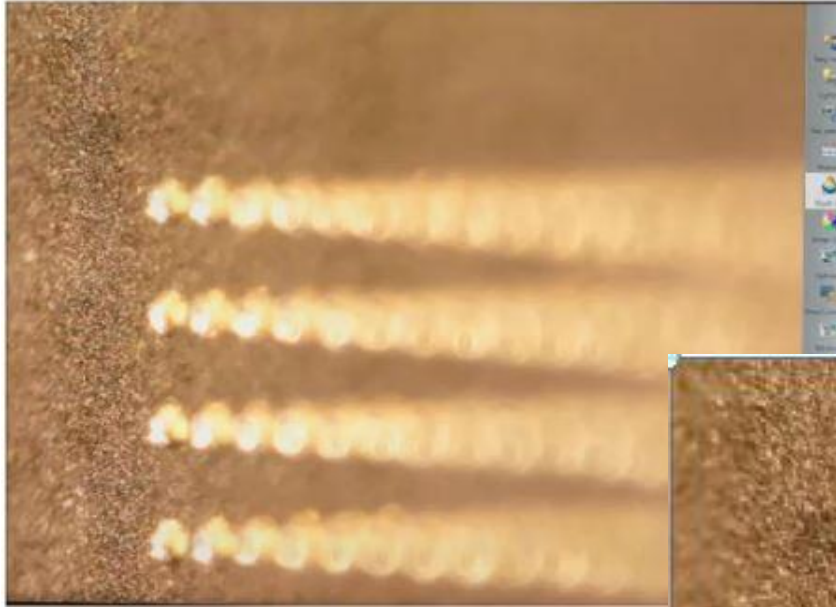
EXAMPLES OF 3D STITCHING



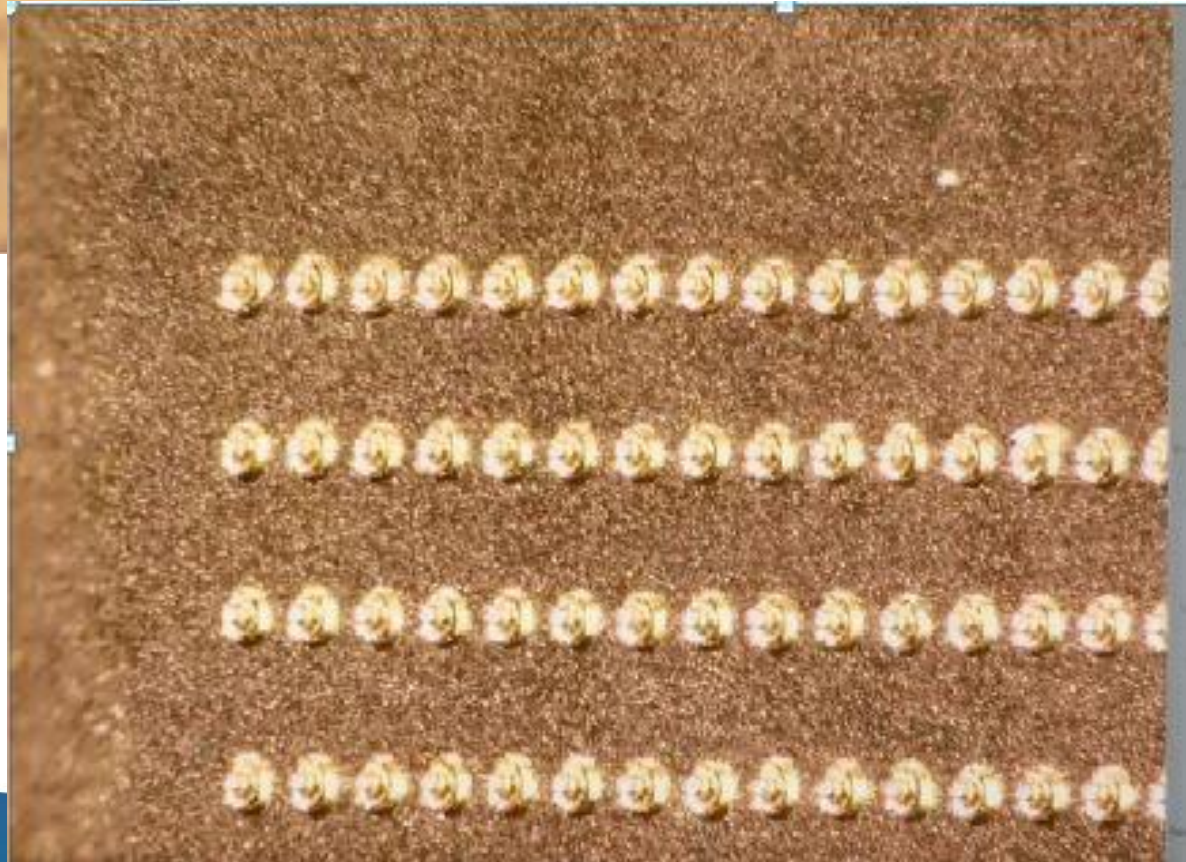
Video of 3D stitching in action
Wire bonds
Before and After 3D Stitching



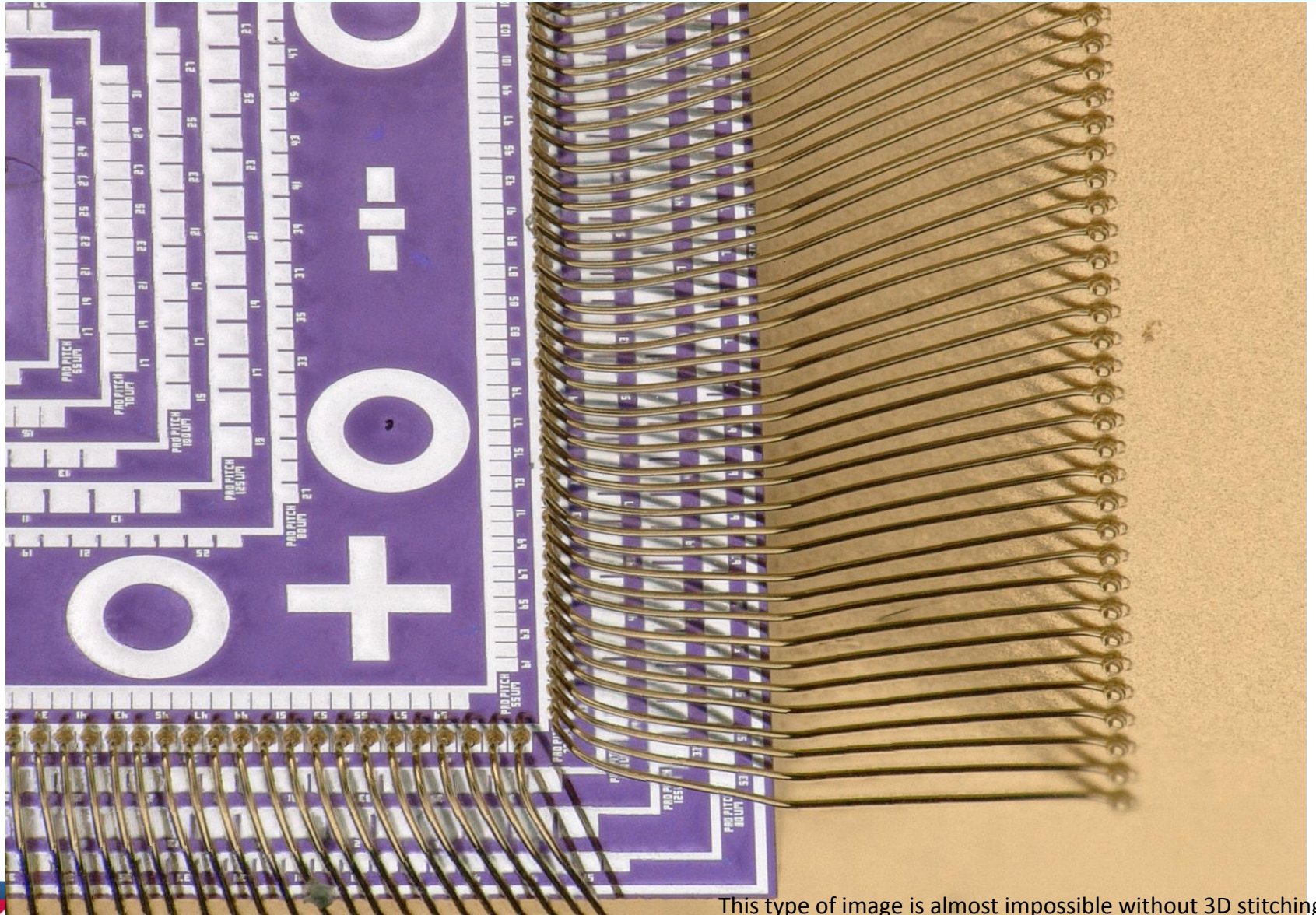
3D STITCHING - ARRAY OF GOLD BUMPS



Video of 3D stitching in action
Stud Bumps
Before and After with 3D stitching

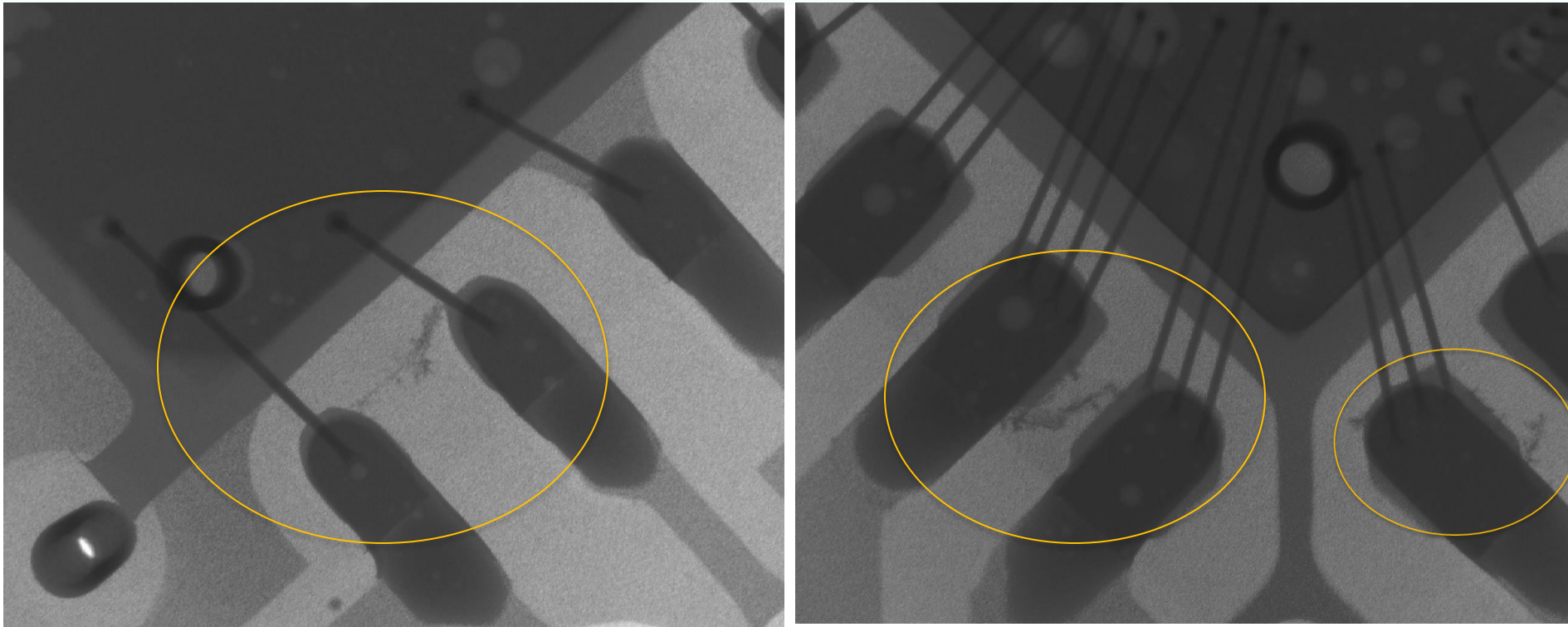


3D DIGITAL STITCHING GETS EVERYTHING IN FOCUS



This type of image is almost impossible without 3D stitching.

DENDRITE FAILURES DURING HUMIDITY TESTING



Dendrites found with X-Ray inspection with high-end X-ray inspection system

Dendrites caused failures of qualification products during 85% RH/85°C and biased THB testing at a couple of our factories.

Task: Find a way to predict on incoming boards and components if we are going to have problems with dendrites during rel testing?

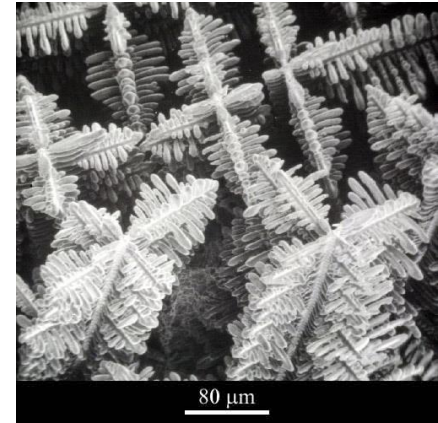
DENDRITE GROWTH STUDIES

The term "dendrite" comes from the Greek word 'dendron', which means "tree"

Dendrites usually appear as fern-shaped or stringers that grow across the surface or between gaps of a product.

Dendrite growth requires:

1. Moisture/humidity
2. Low DC voltage, ~ 5 -10V with low current
3. Exposed metal conductors or conductive material.
4. Surface or gap to grow within



Moisture dissolves some of the material into a solution of metal ions which are then directed by the presence of an electromagnetic field towards the opposite charge.

Dendrites will grow until it makes a connection with the opposite charged surface.

As the structure sizes of electronic circuits decreases and products get smaller, the significance of the dendrite growth effect increases significantly.

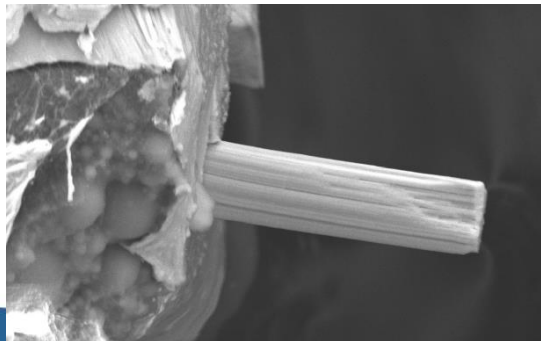
That's why we're concentrating our work on dendrites!

TIN WHISKERS

THE 1ST WHISKER PAPER by H.L. COBB – 1946 “CADMIUM WHISKERS”

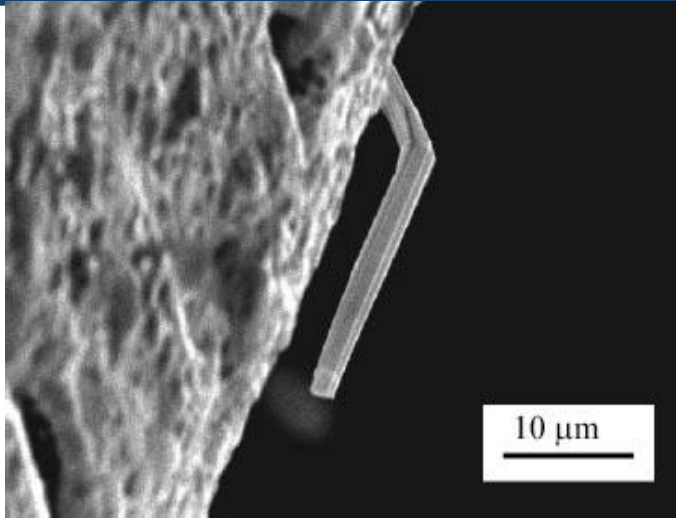
Tin/Metal whiskers differ from metallic dendrites in several respects:

- Metal whiskers form in the presence of compressive stress.
- Whiskers are hair-like and grow perpendicularly to the surface.
- They take several weeks or months to grow.
- The presence of “Lead” in the plated material greatly diminishes their growth potential.
- Whiskers will grow on many metals: Tin, Zinc, Cadmium, and even Lead.
- It is known that whisker formation does not require dissolution of the metal or the presence of an electromagnetic field.
- Industry is trying to control whiskers by use of conformal coatings.

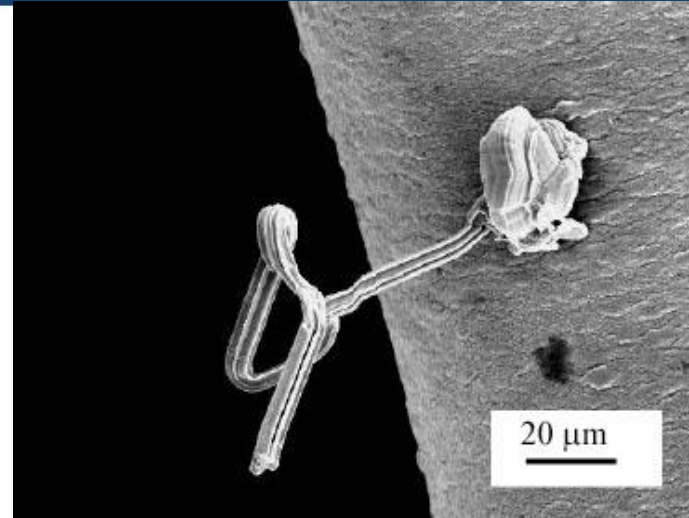


TIN WHISKERS (WITH BRIGHT TIN PLATING)

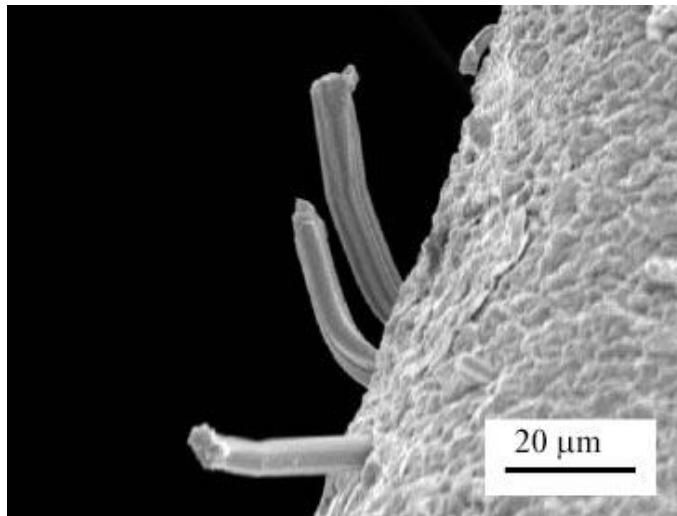
Growth rates seem to increase in a vacuum



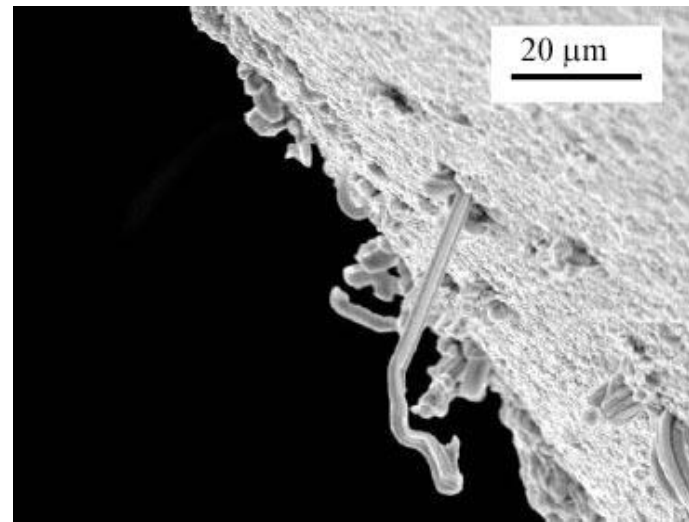
6 months of exposure to 50°C/90% RH



16 months exposure to 50° C



4 months exposure to 50° C/90% RH



6 months exposure to 50° C/90% RH

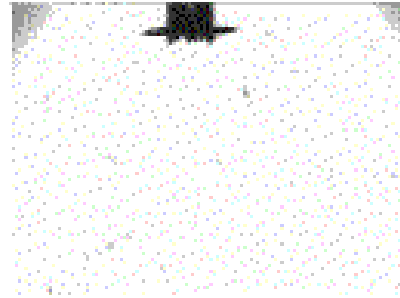
ACCELERATED DENDRITE GROWTH STUDIES

USING THE VIDEO CAPABILITIES OF THE STITCHING MICROSCOPE

Need a method of understanding the details about dendrite growth:

Can a test method be used to evaluate incoming boards and components?

Can we detect the susceptibility to dendritic growth in moisture life testing?



Dendrite Growth Study Method:

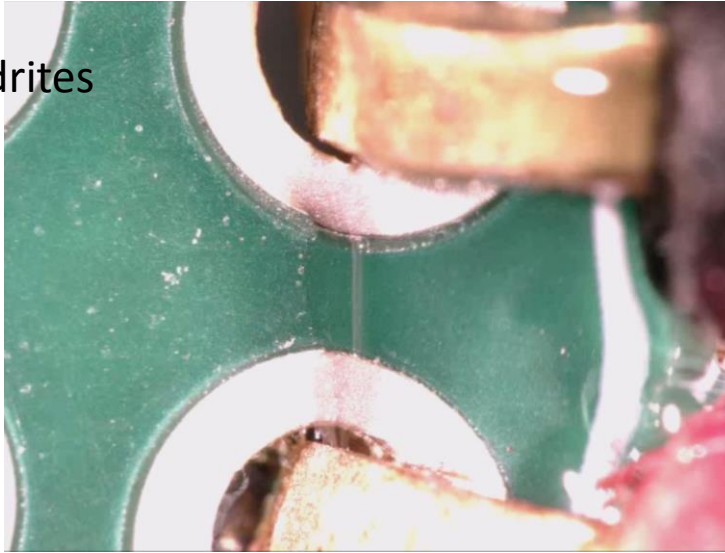
- Standardize on a 9 volt power supply with small clips to grasp package leads or contacts on a board. (Even a 9 volt battery will work – virtually zero current).
- Using an eyedropper, place DI water onto the test area to bridge the gap.
- Watch under microscope for bubbling on the surface (hydrolysis).
- Watch for small dendrites to start growing from the negative terminal side.
- When the dendrites grow to touch the other side, growth stops on that dendrite (It reduces the voltage differential between the two surfaces).
- Other dendrites will grow until the voltage differential is fully normalized.
- Dendrites grow slowly at first then speed up at the end because of the “field intensity” changing.

See IPC-TM-650-TM 2.6.13 for further details

DENDRITE GROWTH STUDIES

Dendrites grow from the negative (cathode) towards the positive (anode) terminal

Video of dendrites
growing

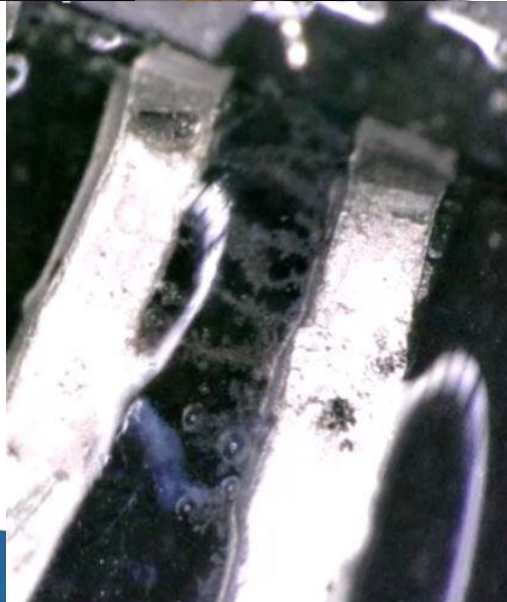


DENDRITES BETWEEN LEADS OF A QFP PKG

- As shown, dendrites don't just grow on the body of the package, they also grow between the leads.



Video of dendrites growing



DENDRITES ON PQFP PACKAGE LEADS

Delicate Fern Dendrite grown between leads of PQFP package

Video of dendrite growing



DENDRITES CAN BE CLASSIFIED BY TIME TO GROW

Time for dendrites to grow can be grouped into 3 categories.

Time to Grow Dendrite	Concern about Board or Component
Under 1 ½ minutes:	Ionic contamination, plating is porous (ie: high phosphorus content, plating baths out of tolerance, etc), high chlorine, sodium, or bromine exposure on leads, etc.
Around 3-6 minutes:	Represents standard plating process – little contamination, or is not affecting plating surfaces significantly. Should be OK through normal life testing
At 6-12+ minutes:	Very dense plating – little to no contaminates on or in plating materials, expected to pass long life reliability testing. Should pass all high rel testing.

FUTURE WORK ON DENDRITES

- We're working on evaluations where we will be correlating the Ion Chrome extraction data to the failure results of the 85/85 testing for worst case (highly contaminated) conditions.
- We're starting to use dendrite growth data to comprehend differences between vendors cleanliness and plating processes - asking for coupons on boards from vendors.
- When we get full data collected and finalized, we will be working with vendors to show them how to test their products with this method to determine board performance.
- If found helpful, we can work with standards groups to put this methodology out for the industry to use as seems fitting to their application.



THANK YOU

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