

Are Zinc Whiskers Growing in Your Computer Room?

Rich Hill

Agenda

- What Are Zinc Whiskers?
- History of Whiskers
- How Do I Know IF I have Zinc Whiskers?
- How Can Zinc Whiskers Affect Me?
- How Common are Zinc Whiskers?
- The 12 Steps to Zinc Whisker Remediation

What are Zinc Whiskers

- Hairlike Crystalline Structures That MAY Grow From Mostly Pure Zinc Surfaces
- Length: Up to 15mm, Typically < 1mm
- Diameter: 0.006 – 10.0 μ m, Typical ~ 1.0 μ m



What Causes Zinc Whiskers to Grow?

- Growth Process: UNKNOWN
- Molecular Stress or other Diffusion Processes Within the Metal Causes Grains to Organize and Grow Outward From the Surface
- Whisker Growth DOES NOT Require Dissolution of the Metal NOR an Electromagnetic Field
- There is NO Clear Evidence that Environmental Factors will Exacerbate Whisker Growth

Background

- Metal Whiskers First Discovered in 1940s
- Zinc Is One of Several Metals Known to Produce Whiskers. Others Include:
 - Antimony
 - Cadmium
 - Gold
 - Indium
 - Tin

Where Do Zinc Whiskers Come From?

- Typically Woodcore Access Floor Panels
- Some Concrete Access Floor Panels, AND



Where Do Zinc Whiskers Come From?

● Building Components

- Steel Studs
- Suspended Ceiling Hangers & Grid Systems
- Electrical Conduit



Where Do Zinc Whiskers Come From?

- Equipment Cabinet Frames
- Server Frames (The Actual Computers)

How Common Are Zinc Whiskers?

- There's More Than You Think!
- Remember the Various Sources
- Data Clean Alone Fields One Call per Week

Can I See Zinc Whiskers?



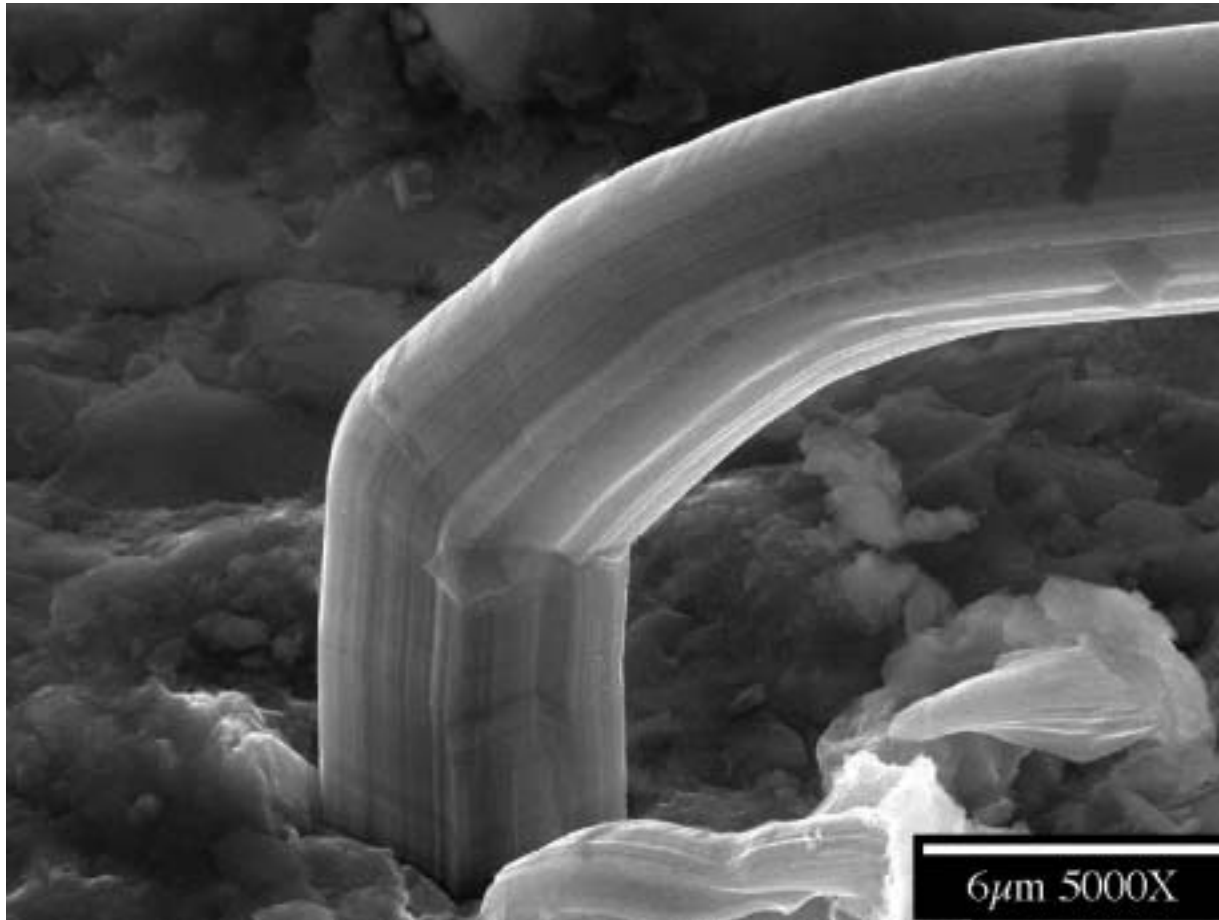
How About Close Up?



Zinc Whiskers Using SEM - I

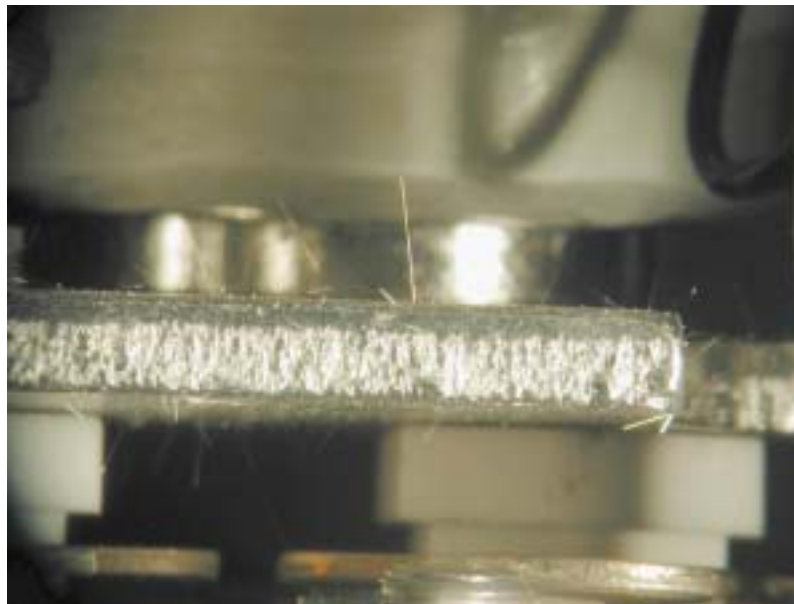


Zinc Whiskers Using SEM - II



Zinc Whisker Failure Mechanism

- Impact is a Function of Age & Size
- Zinc is a conductor
- Whiskers bridge circuit leads either singly or similar to a snow drift



Symptoms of Zinc Whiskers

- Unexplained H/W Failures
- Unexplained S/W Failures
- Unexplained System Failures
- High Bit-Rate Errors



Whisker Combustion

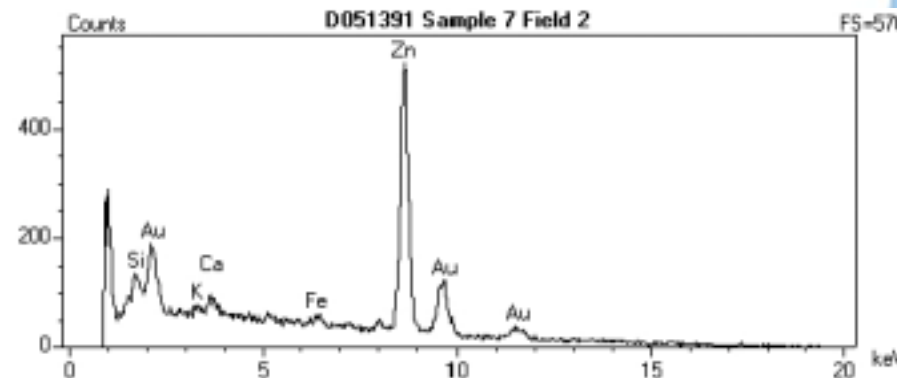
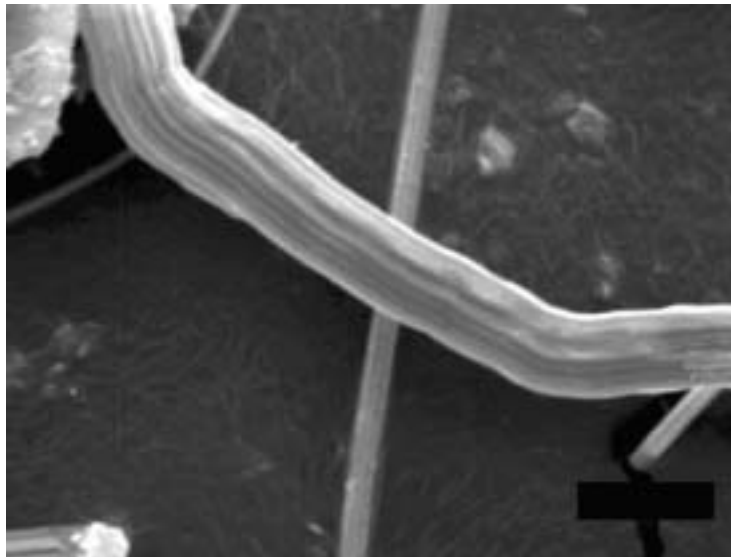
- Short Circuit causes Arc
- Arc consumes whisker & produces plasma
- Plasma fuels continued combustion
- Combustion continues to consume surrounding metals until available fuel is exhausted

Impact of Zinc Whisker Contamination

- Reduced Throughput & Bandwidth
- Hardware Failures
 - PSU Failures are Common
 - Tape & Tape Head Wear
- Cancelled Manufacturer Warranty Coverage
- DOWNTIME
- DOWNTIME

How Do I Really Know?

- Test!
- Lab Test Must Look For:
 - Geometry – Scanning Electron Microscopy
 - Molecular Confirmation – Energy Dispersive X-Ray Spectroscopy



Health Effects of Zinc Whiskers

- No Reported Issues
- No Significant Published Research
- Zinc Is a Natural Nutrient – Consumed Concentrations are reasonably low
- Potential Pathological Impact From Fibers Based on Geometry

Zinc Whisker Remediation

- The 12 Steps to ZW Recovery
- The Good News: There Is Life After ZW
- The Bad News: The Path Is Often Painful
 - Most Follow the Same Path
 - Everyone Joins the Path at a Different Point

Step 1 - Bewilderment

- Why Is My Equipment Failing?
- New H/W Is Supposed to Be Better Than Old
- We Just Upgraded Our A/C and Everything Is Failing
- We Just Remodeled and Everything Is Failing
- We Just Did (Your Project Here) and Everything Is Failing

Step 2 - Suspicion

- You Know You Shouldn't Have So Many Failures
- You Remember an Article
- A Colleague Mentions ZW
- Your Industrial Hygienist Mentions ZW
- A Technician Mentions ZW
- Resist Temptation to Blame Everything Else

Step 3 - Education

- Get Smart!
 - www.google.com
 - <http://nepp.nasa.gov/whisker>
- Ask Around
- Be Smart!
 - Don't Tell Your Customers
 - Don't Tell Your Vendors – Yet!

Step 4 - Denial

- This Can't Be Happening to Me!
- What Did I Do to Deserve This?
- This Assignment Was Supposed to Be a 'Walk in the Park'!

Step 5 - Enlightenment

- Get Some Testing
- You Got Smart
- Realization That ZW Is More Common Than You Thought
- Realization That There Is Light at the End of the Tunnel

Step 6 - Acceptance

- Believe the Test Results and the Empirical Conditions
- Start Building Your Case to Educate and Convince Others
 - Track Failures
 - Autopsy Failures
 - Consider the Consequences

Step 7 - Planning

- Begin Planning for Remediation Like Any Other Project
- Determine the Desired Outcome
- Consider the Needs of the Business
- Work With Your Vendor

Step 8 - Preparing

- No Project Can Succeed Without Preparation
- The More You Prepare, the Better the Outcome
- The Best Remediation Projects Occur When the Customer is Actively Involved

Step 8 – Still Preparing

- Schedule Downtime If Possible
- Remove ALL Unnecessary Equipment and Materials
- Alert Vendors – Be Prepared and Have Spares Close by
- Plan for Any Reconfiguration
- Plan for Any Cable Mining
- Plan for Material Staging and Disposal
- Plan for Cutting and Drilling
- Seize the Opportunity to Improve

Workplan Overview

- Remove/replace the Root Source of the Contamination
 - Thoroughly Clean the Environment
 - Underfloor Plenum
 - Tops of Floor
 - Inside Racks
 - Inside Equipment *
 - Ceiling Plenum
 - HVAC Ducts *
- * May be Impossible or Unreasonable

Step 9 - The Floor - Replacement

- Replace the Floor
- Old Panels Are Removed and Bagged
- Underfloor Is HEPA Vacuumed & Wiped
- New Panels Are Installed
- Captive Panels Are HEPA Vacuumed & Wiped
- New Cutouts Are Cut, Trimmed, and Installed
- New Perimeter Panels Are Cut & Installed

Step 9 – The Floor – Cleaning Only

- Clean the Floor Panels Only
- Existing Panels Are HEPA Vacuumed and Wiped Clean
- Floor Is Re-cleaned Every 6 Months to Limit Impact of Re-growth

Step 10 – The Envelope

- Ceiling Is Tacky Rolled
- Walls Are Tacky Rolled
- Features and Components Are HEPA Vacuumed and Wiped
- Ceiling Plenum May Be Cleaned If Return Air Path



Step 11 – The Equipment - Outside

- Racks Are Cleaned
- Accessible Surfaces of Equipment Are Cleaned

Step 12 – The Equipment - Inside

- Shut Down
- Tag Cables
- Remove From Racks
- Disassemble & Clean
- Reassemble
- Reinstall in Racks
- Re-cable
- Power up & Test

Managing the Process

- Shut Down What You Can
- Capable Personnel Onsite
- Decision Makers Available
 - Stuff Happens
 - Plans Change
 - Who Will Decide?
- Be the Solution, Not Part of the Problem!
 - Facilitate the process
 - Protect the vendor from interruptions

Summary

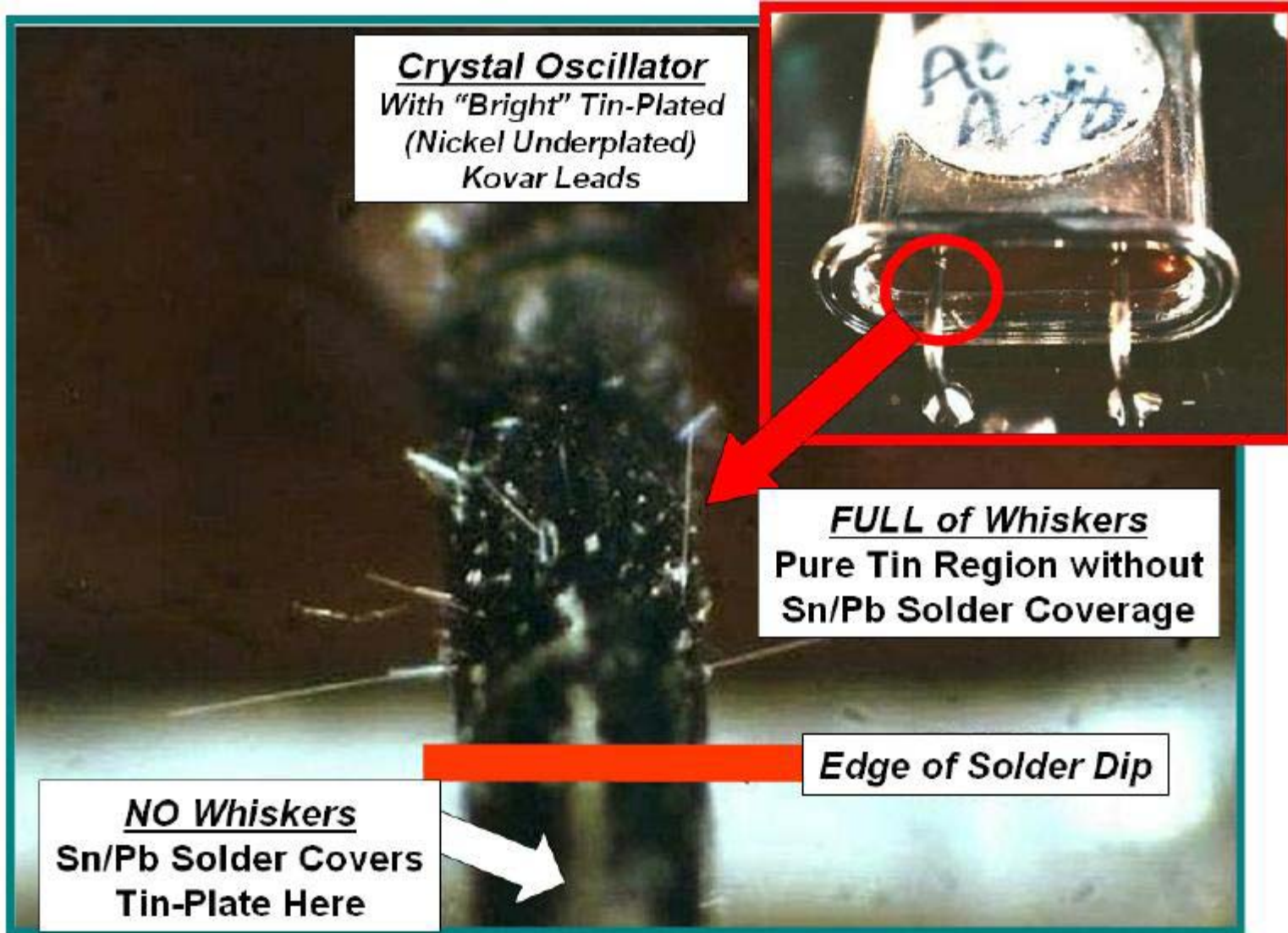
- How Do You Protect Yourself From ZW?
 - You Can't Prevent Growth
 - But You Can Be Knowledgeable
- Don't Ignore ZW
- Don't Be Over-Reactive
- Be Proactive – Seek Help

Tin Whiskers

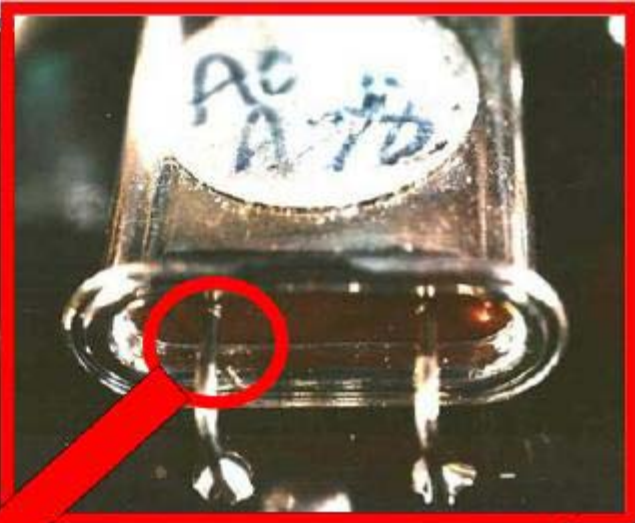
- The Next Y2K?
- More Prevalent than Zinc Whiskers
- New Mfg. Standards will Exacerbate the Problem

Get the Lead Out!

- Historically, Electronic leads were plated with Sn/Pb to improve solderability
- Byproduct was prevention of whisker growth
- Initiative to remove Pb from consumer electronics led by EU
- Manufacturers want to be part of the Pb-free initiative
- Byproduct is whisker growth!



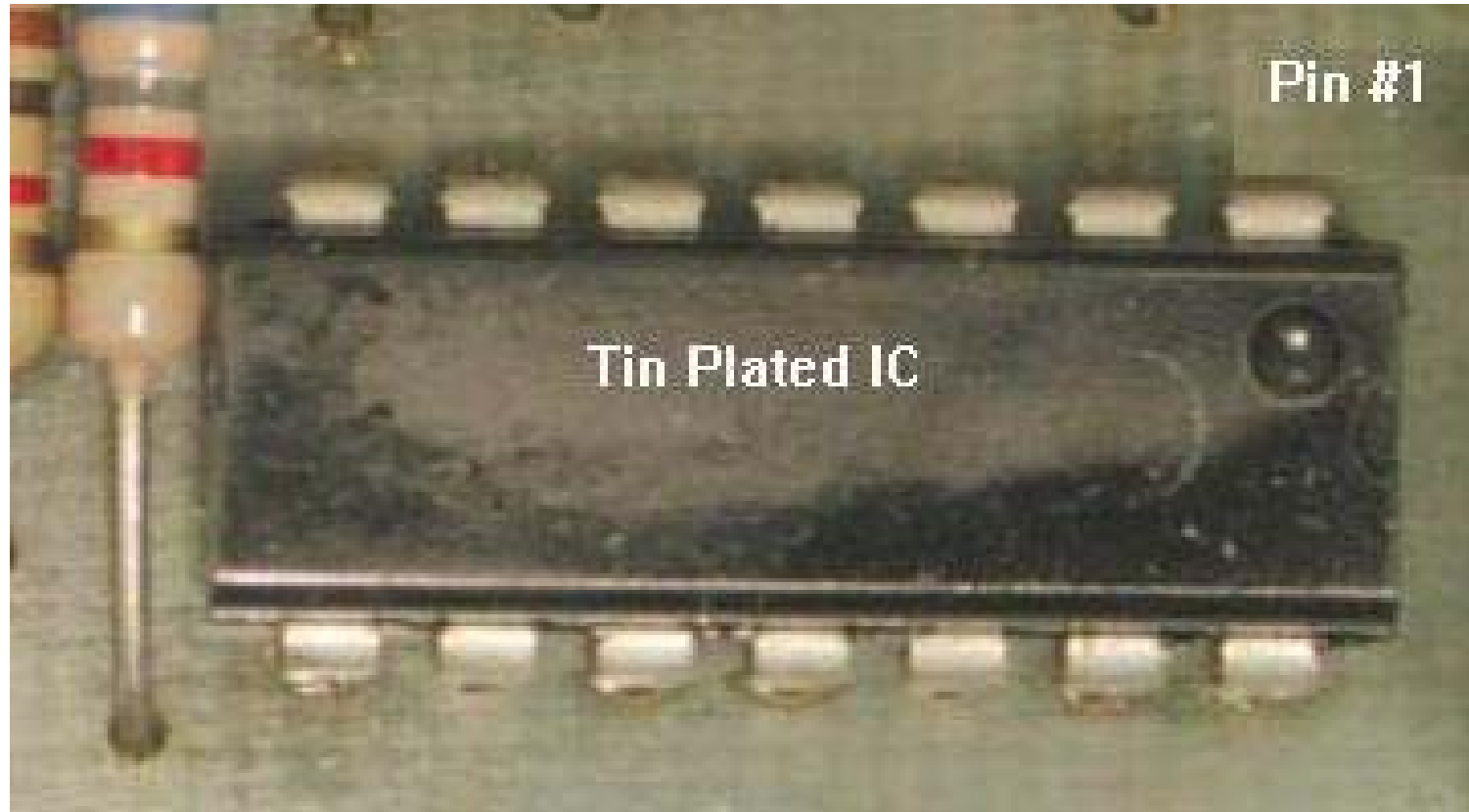
Crystal Oscillator
With "Bright" Tin-Plated
(Nickel Underplated)
Kovar Leads

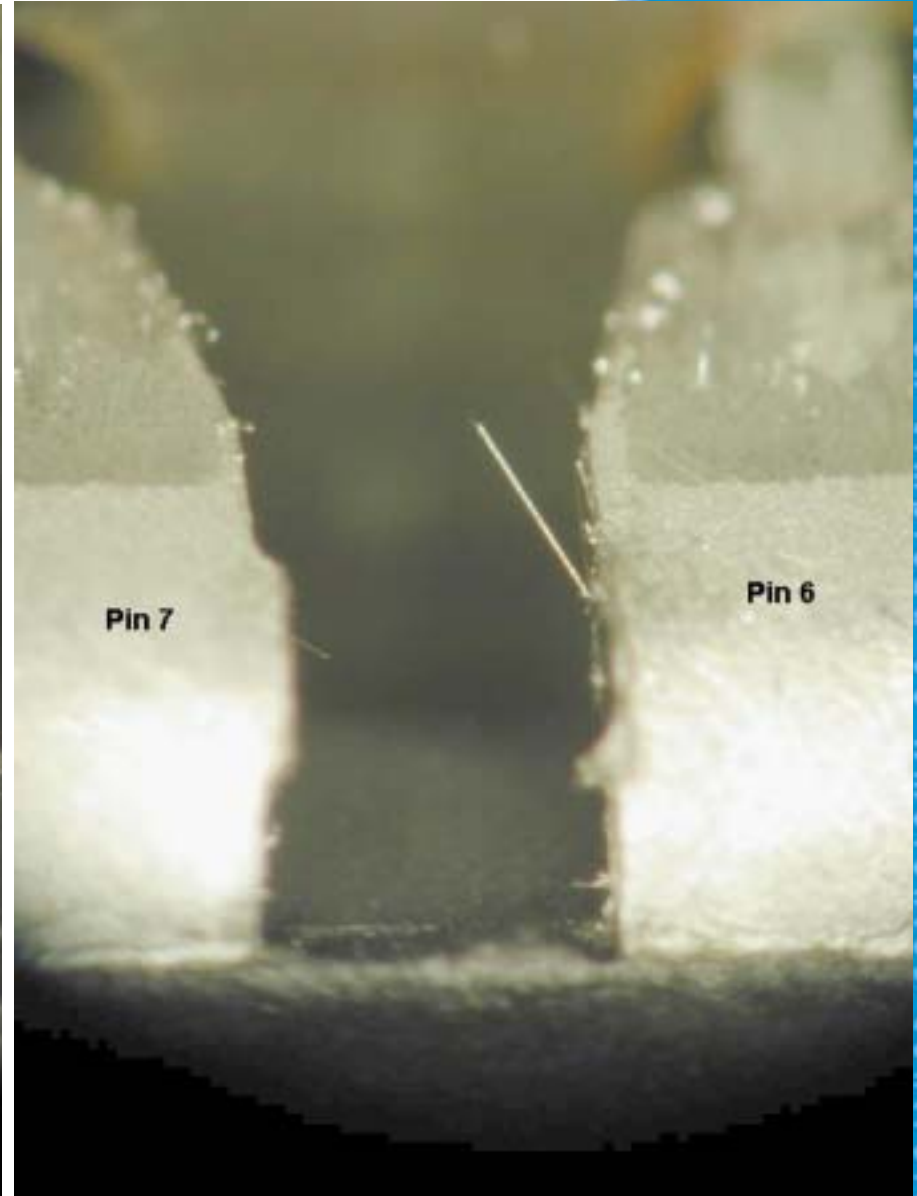
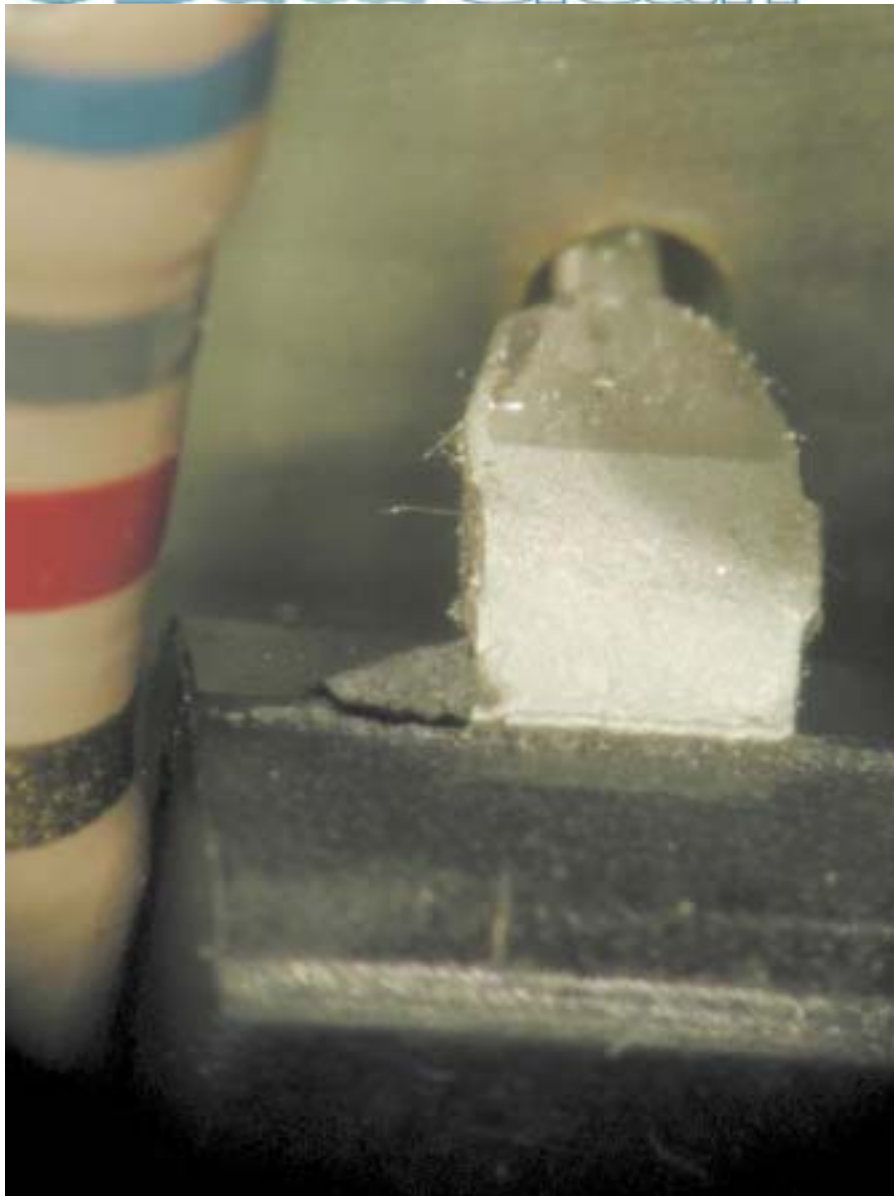


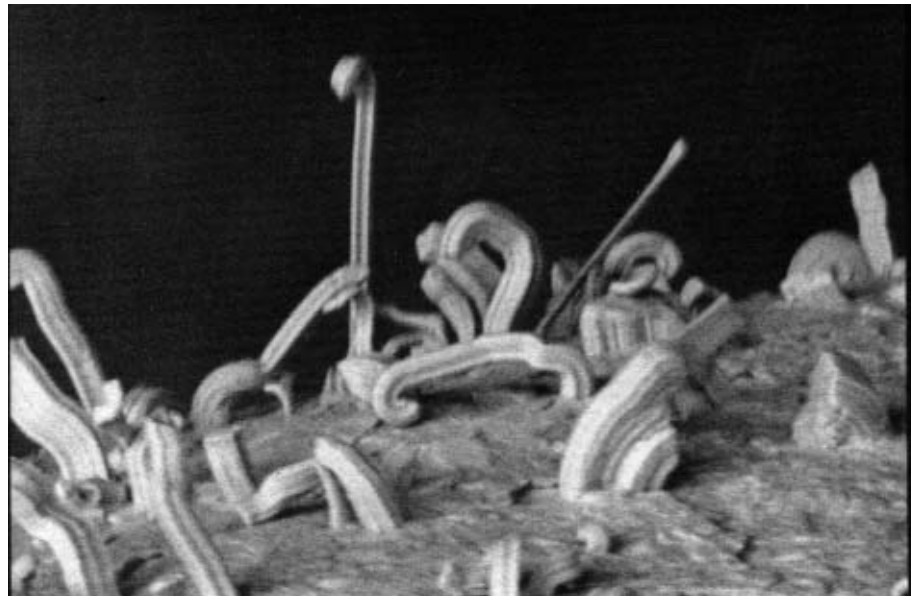
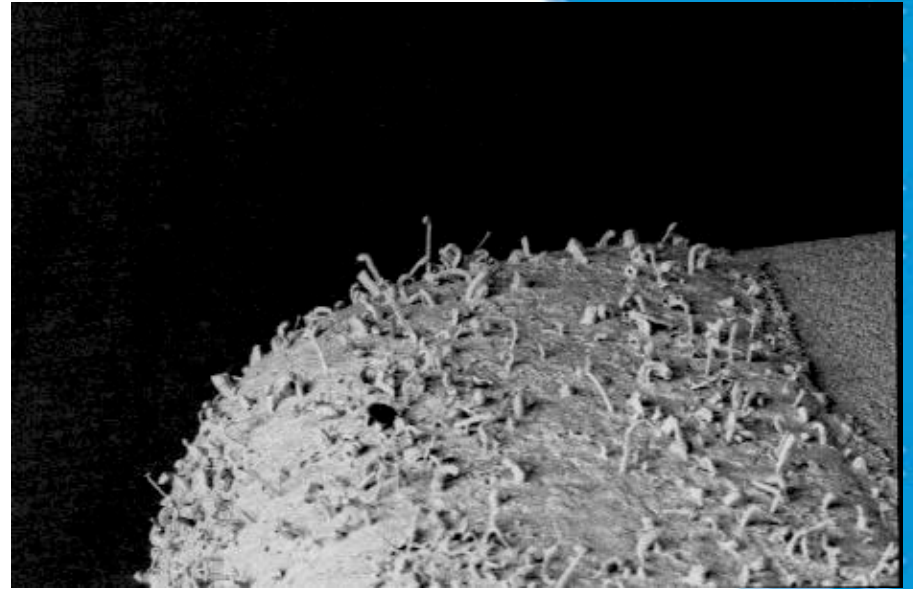
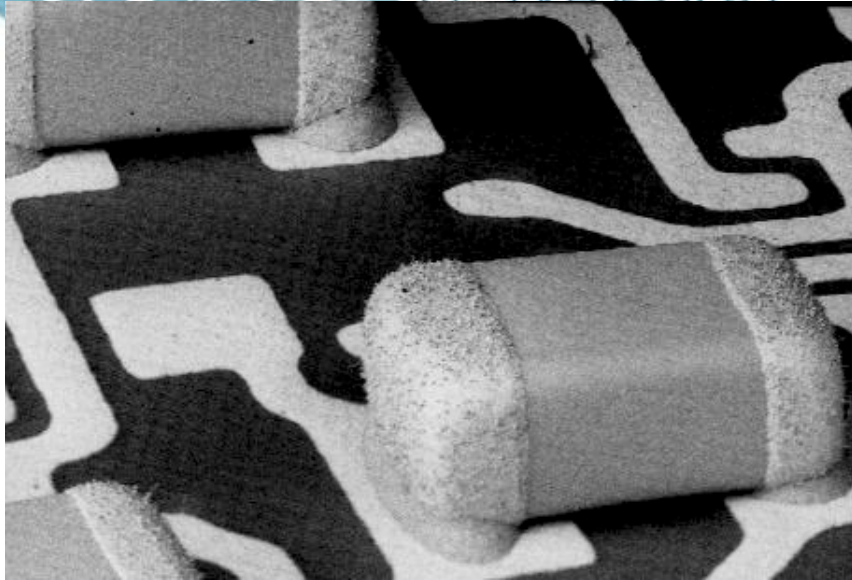
FULL of Whiskers
Pure Tin Region without
Sn/Pb Solder Coverage

Edge of Solder Dip

NO Whiskers
Sn/Pb Solder Covers
Tin-Plate Here







Acknowledgments

- Photos Courtesy of NASA
- Photos Courtesy of Hewlett-Packard Company
- Photos Courtesy of Falconmet Engineering & Laboratories, Inc.

- Questions?
- Thank You

Are Zinc Whiskers Growing in Your Computer Room?

Rich Hill

rhill@dataclean.com

www.dataclean.com

800-352-7282 x22

Gilberto Ferreira Ramos

gframos@dataclean.com.mx

www.dataclean.com.mx

800 823-4404 (México)