Zinc Whisker Contamination

A Paper on the Effect and Abatement of Zinc Whiskers in Data Processing Centers

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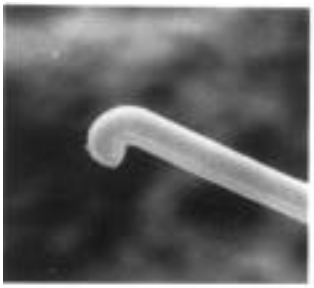
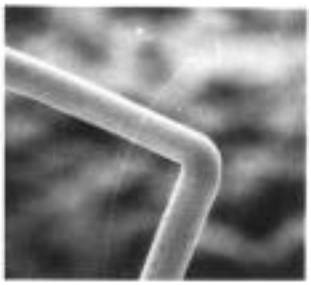
Abstract

This paper describes the phenomenon known as Zinc Whiskers, their potential and historic impact in modern computer data centers and the appropriate methods for reducing exposure to this fault vector. Experiential data is described (but not presented) and Compaq's position with respect to incidents involving Zinc Whiskers is stated.





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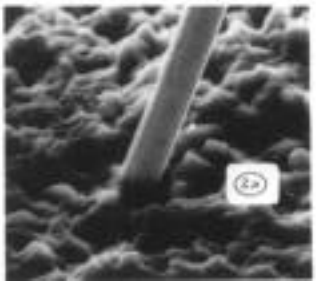

Phenomenon

Zinc Whiskers were first discovered in1948 by Bell Labs in which a whisker on a zinc-plated bracket caused increased losses in quartz filters used in a telephone transmission system (1). The whiskers constitute a very serious anomaly that is causing problems ranging from inconvenience to complete havoc in today's computer rooms. Zinc Whiskers originate from zinc electroplated products commonly used in computer rooms. Zinc (Zn) is an element used to prevent rusting or oxidation of steel. Steel pieces are coated (passivated) with zinc. This coating can either be zinc Hot Dipped Galvanized (HDG) or electroplated. The HDG coating is not associated with the Zinc Whisker contaminate and can be easily recognized by the irregular triangular (spangled) pattern on the metal surface. Electroplating provides a uniform gray surface but in some cases brighteners may have been added to the zinc plating process, creating a bright shiny appearance.

Zinc whiskers grow from the electroplated surface without any external stimuli. Whiskers have been observed to grow in vacuum (2). This is known as "spontaneous" growth that differs from whisker growth known as "compression" whiskers that are formed by applying an external compressive stress to the electroplated film (3). Spontaneous whiskers have been observed on electroplating of tin, zinc and cadmium and all appear similar (4). Electroplated zinc, when viewed under an electron microscope, resembles fibers in a basket weave or lattice pattern. This pattern is created by the configuration of zinc atoms that are in lines or rows across the film surface. The zinc atom structure begins to separate from the steel and pushes the zinc coating away from the steel surface. The whisker growth occurs from the base and not the tip. The result of this separation is tiny zinc columns that are pushed or grow away from the surface. The growth of the whisker does not leave a depression or thinning of the zinc film, which indicates the atom transport, occurs over a long distance (4). This breakdown process is known as "atom migration".

The whiskers grow at a rate of about 250 microns per year and have a uniform diameter of about 2 microns. The whiskers can reach lengths of up to 1 cm (0.4 inches). The whiskers can become a potential problem to electronics when they reach a length of 500 microns (0.5 mm or approx. 1/64 inch).
For the past several years, the electronics industry as well as the metal and plating industry has been aware of the phenomena known as Zinc Whiskers. IBM's *AS/400 Physical Planning Reference V4R1* (SA41-5109-00) states: "Raised floor tiles that have a zinc-electroplated passivation coating have the potential to grow zinc whiskers. IBM believes that zinc whiskers cause intermittent AS/400 operational problems. The AS/400 may either post an error or power down" (5).

Where Zinc Whiskers Are Found

Any zinc-electroplated surface may experience this anomaly but the products of most concern are certain types of floor tiles used in a computer room raised floor application. The floor tiles that can be suspect are wood or wood composite cores with a flat sheet steel bottom or underside. The steel surface, if passivated using electroplated zinc can be a major source of contamination. To our knowledge, no zinc electroplated floor tiles have been manufactured for several years.

Implications

The main concern is that zinc is a conductive material. A whisker can be considered as a low capacity fuse with DC resistance of 10 to 40 ohms depending on the whisker geometry with a DC fusing current of 10 to 30 mA (6).

Although the whiskers are small in size, they are large enough to cause problems in today's microcircuits. These problems are shorts circuits, voltage variances and other signal disturbances. When sensitive electronic equipment becomes contaminated with zinc whiskers, equipment failures and system resets can occur. In most cases, the same short circuit that was caused by the whisker will either vaporize the contaminating whisker by the current flow or the whisker will become dislodged when the board or card is removed, leaving definite fault analysis impossible. Data suggests that a large percentage of NTF (no trouble found) statistics may be due to intermittent failures caused by zinc whisker contamination.

The effects of this contaminate could turn out to be the single most failure-causing anomaly of electronic and computer equipment in our data centers. These data centers located deep inside our banks, stock exchanges, government facilities and hundreds of other businesses are all susceptible to this unique and possibly catastrophic contaminant.

Zinc Whisker Abatement

There are companies who specialize in identification, containment and cleanup of this kind of contamination. This process, although not inexpensive, is effective and can safely remove this and other contaminates. These organizations understand the sensitive nature of business-critical systems and can complete the cleanup with little or no disruption to data processing schedules. There are several computer site-engineering companies that offer zinc whisker "abatement" programs for computer rooms (7-9). Data Clean offer zinc whiskerabatement as a professional service for customers. Data Clean is one of the most well knowservice providers of zinc whisker removal. The president of Data Clean, Rich Hill says, "We thought zinc whiskers had peaked a couple of years ago but customers are reporting problems even more frequently today". "We are seeing a resurgence in contamination related failures.

References

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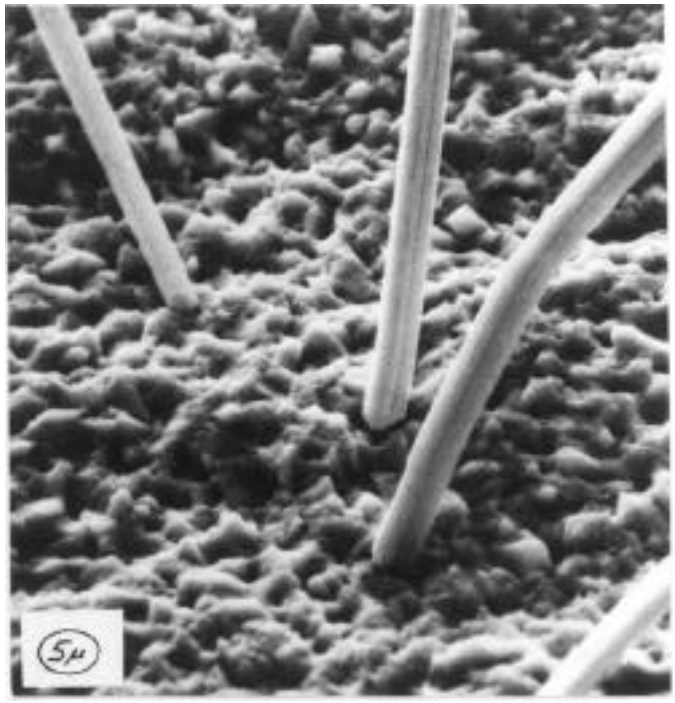
8. ComputerSite Engineering, Inc.; 1347 Tano Ridge Rd; Santa Fe, NM 87501; (505) 982-8300.
9. Worldwide Environmental Services (WES) www.wes.net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