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C & E Recycling Portal

Newsletter from September 20th, 2007

1. Roll back the lead-free initiative: 12 ROHS myths!

- *Replacing tin-lead with pure tin is turning out to have been a huge mistake!*
- *Great, so the E.U. admits there is no reliable substitute. Yet, they require use of a substitute!*

Howard Johnston: I'm no expert in manufacturing technology, but I can smell trouble coming a mile away. I believe that our industry, having jumped onto the lead-free bandwagon, is headed towards a train wreck of immense proportions. Please tell your management.

I'm sure you've all heard about the recent EU legislation called ROHS (Restriction of Hazardous Substances). As of July of 2006, ROHS legislation precludes the use of lead in electronic products destined for sale in Europe with few exceptions. The primary motivations for this legislation were environmental concerns.

The ROHS legislation affects component lead plating as well as solder and solder paste. The legislation was developed, I believe, under the misconception that the switch from a tin-lead solder chemistry to pure tin would be painful, but technologically possible. The legislators incorrectly assumed that the only difference between tin-lead solder and pure tin solder was the melting point.

Prior to 2006, most electronic components were coated with lead-based solder, 63% Sn, 37% Pb, popularly called 63/37 solder. Manufacturers use that particular proportion because it has the lowest melting temperature of any Sn-Pb mixture (i.e., it is the Eutectic mixture). It makes a good, strong solder joint.

As a result of ROHS legislation, many component manufacturers have begun supplying parts with a lead-free plating made from ordinary tin. In many cases the old 63/37 solder coated products may no longer be available.

Replacing tin-lead with pure tin is turning out to have been a huge mistake. There are two significant differences between lead-free assembly and lead-based assembly.

(1) Lead-free assembly is not better for the environment, it is worse. The additional tin mining required to produce high-purity tin alloys, plus the mining of other precious metals required to alloy with tin in substitution for lead is a poor trade for the use of existing lead, much of which comes from recycled products. This information comes from a study conducted by the U.S. Environmental Protection Agency (EPA). The study undercuts the primary basis for ROHS.

(2) Lead-free assembly is less reliable than lead-based assembly. The E.U. environmental commission admits this point. That's why they grant exceptions for military and high-reliability applications that still use SnPb solder.

I'm all for environmental legislation when it actually helps. When it doesn't help, and it harms something else, I question the result.

What harm is being done? Let's start with tin whiskers. The electronics industry has discovered (re-discovered, actually, as this knowledge is quite old) that typical "bright" tin plating grows prodigious

numbers of tin whiskers in a short amount of time. A tin-lead Eutectic mixture does not grown whiskers. Something about the lead prevents their formation.

Tin whiskers are small, unbelievably thin metallic hair-like growths that naturally emerge from the surface of solid tin (Sn). On lead-free tin surfaces, tin whiskers may grow to a length sufficient to short one electronic circuit to another, creating product failure.

Material scientists attribute whisker growth in ordinary bright tin to various impurities within the tin. Purifying the tin-plating solution changes the character of the finished item. Instead of a bright tin finish you get a "matte" finish. This step helps reduce but does not eliminate the number of whiskers. Some people believe that matte plating fixes the problem. I don't think so.

Figure 1 (left) shows a young tin whisker growing straight out of a matte tin finish. This picture comes from Wan Zhangz and Felix Schwager, "Effects of Lead on Tin Whisker Elimination", J. Electrochem. Soc., 153 (5) C337-C343 (2006). This particular whisker was grown at ambient temperature under normal storage conditions. No electric currents are required to form whiskers. The growth is spontaneous. A matte tin finish certainly works better than a bright tin finish, but does not, in my opinion, fix the problem. Lead does.

You may be looking at Figure 1 thinking, "Hey, that whisker is only about 16 microns long (less than one thousandth of an inch), not long enough to do any damage." If whiskers grew no longer than one thousandth, I would agree. Unfortunately, they get longer.

Figure 2 (right) shows the dramatic growth that can happen under some circumstances. This picture is not for the faint of heart. Whiskers can easily exceed 1 mm—yes, that's 1,000 microns, and in some cases even as much as 10 mm.

I bring all this up because I recently toured a number of military electronics facilities. In discussions with engineers at those locations they all agreed that a matte tin finish is not sufficient to render their products suitably reliable. They have uniformly shunned the use of tin-plated hardware of any kind. Fortunately, military products get a special exemption from ROHS. They can use as much lead as they want. The exemption was granted on the basis that the E.U. commission understands quite clearly that no suitably reliable substitute for lead-based solders has yet been found.

Great, so the E.U. admits there is no reliable substitute. Yet, they require use of a substitute.

Is this some kind of plan to increase sales of electronic gadgets? Is this a way to make sure that products fail quickly, so consumers have to buy more?

We won't know for several years how severe the problem will ultimately become, but what we do know is that many tin-whisker failures have already happened, and more will happen in the future.

Already happened? Yes. 17 April, 2005—Millstone Nuclear Generating Station—A single tin whisker created a bridge (short circuit) between a diode and the output trace on a circuit card, causing a partial reactor shutdown. P. Daddona, "Reactor Shutdown: Dominion Learns Big Lesson from a Tiny Tin Whisker", The Day (New London, CT), July 4, 2005.

Environmentalists who favor restriction of lead in electronic circuits point out that the reactor didn't actually explode, and that we shouldn't have nuclear reactors, anyway. I don't find that response very satisfying.

Just in case you get into a debate about lead-free solder, here are some myths I've encountered during my research.

Myth #1. Tin Whiskers only grow in space. Not true. A lot of research in the period 2002-2006 was conducted by aerospace companies using a vacuum environment for their experiments. This created a perception that it is only a "space" problem. Actually, whiskers can and do happen everywhere. The whiskers in Figure 1 grew at ambient temperature and humidity.

Myth #2. Tin Whiskers only grow in temperature-cycling environments. Not true. They grow under ambient conditions. Accelerated life-cycle testing is carried out per JESD201 using temperature cycling, as that seems to exacerbate the growth, but at the time JESD201 was written no one knows the correlation between the accelerated tests and what will really happen over time.

Myth #3. Conformal coating stops whisker growth. Good idea, but it doesn't work. The tip of a whisker is sharp down to atomic dimensions. It pokes right through a conformal coating. No coating has yet been found that is immune, although there is some recent hope for a new low-modulus polyurethane material. "Evaluation of Conformal Coatings as a Tin Whisker Mitigation Strategy, Part 2", T. Woodrow, SMTAI, Sept. 2006.

Myth #4. Whiskers don't happen very often. Check out this list of hair-raising examples of tin-whisker failure in satellites, airplanes, medical, industrial and computer equipment. Engineers are now just beginning to recognize a lot of past failures as having been caused by tin whiskers.

Myth #5. A whisker is too small to short out anything important. That is true for some classes of high-voltage, high-power equipment. An individual whisker conveys only about 30 mA. In an AC power environment, the whisker would quickly burn out. In digital electronics, however, 30 mA is more than enough to cause serious havoc.

Myth #6. A better solder is just around the corner. I don't believe it. The industry has tried all sorts of additives from Antimony to Zinc and nothing works like Lead. The 63/37 mixture is very soft—that seems to be part of the magic. It doesn't accumulate stress, it merely deforms. Even if we had a better solder, unless it completely coats all exposed portions of every component lead, any exposed tin-plated leads remain subject to whiskering.

Myth #7. The solution is SAC solder. The "SAC" solder mixture is made from Tin, Silver, and Copper. The silver and copper additives suppress tin whisker growth, but it remains unclear whether they completely inhibit whisker growth over a long period of time. Military and other high-reliability products don't use SAC. They use only SnPb. In addition, SAC solder creates other problems.

For example, SAC solder requires a different soldering temperature profile than that used for Tin-Lead solder. If you mix SAC-based solder with non SAC-based coatings, the results can be very poor, so you must ensure that all your components use the SAC mixture. Yet, looking at two parts only a metallurgist can tell the difference between a lead-based lead coating and a SAC-based lead-free coating. Substantial possibility of error exists.
http://thor.inemi.org/webdownload/projects/ese/High-Reliability_RoHS/High_Rel_position_061206.pdf

Harvey Miller at http://fabfileonline.com/ has this to say about the use of SAC-based solder: "Without the softening effect of lead, the SAC alloys are more brittle and more likely to crack under pressure. They don't wet well, requiring more active fluxes. They don't have a sharp eutectic, staying plastic over a larger range, allowing intermetallics to form and leading to voids. Their higher melting temperatures stress laminates and components, limiting choices and narrowing process windows. There are unpredictable long-term degradation mechanisms such as: 1) the Kirkendall Effect, in which copper migrates into tin, leaving voids, 2) tin whisker formation, and 3) tin pest, in which the tin turns into powder. "

Finally, regarding SAC, here's a testimonial letter submitted by John Anderson to the Ron Lasky forum: "I have to repair industrial control equipment, and so far there has been a really poor track record with lead-

free solder. Mind you, the products I repair and design are almost always wet, cold, hot and vibrating and tin-lead solder is far superior to the lead-free assembly processes in every respect for extreme applications. Not only are tin whiskers a headache, but embrittlement problems cause thousands of hours of troubleshooting time searching for intermittent, hairline-cracked joints that we just don't see, or very rarely see with tin-lead solder. At this point, several industrial clients of mine are insisting on non-ROHS assembly (ROHS parts are OK, just not the assembly process) of all components used on assembly equipment and control systems…" http://www.indium.com/drlasky/entry.php?id=476

Myth #8. Eliminating lead from solder saves the environment. According to John Burke, http://www.rohsusa.com/, the US Environmental protection agency "Report on Solders in Electronics: A Life-Cycle Assessment" (472 pages) published August 2005 shows that the replacement for “leaded” solder generally referred to as “SAC alloy” has a greater impact on the environment than tin lead solder in a number of areas such as non-renewable resource use, energy use, global warming, ozone depletion, and water quality. Admittedly, leaded solder performs worse on issues of toxicity, mainly to workers who handle the material. Manufacturers can (and have already for the past 60 years) addressed the toxicity issue for workers by using exhaust hoods, wearing gloves, and washing hands. My conclusion? SAC solder is markedly worse for the environment than lead-based solder. We are not saving the environment by moving to SAC solder, we are damaging it. Here is a link to the full report: http://www.epa.gov/opptintr/dfe/pubs/solder/lca/index.htm

Myth #9. Lead leaches out of landfills into the groundwater. True for paint and gasoline, but not necessarily for pcb assemblies. Lead in a pcb assembly exists in a solid form that does not migrate like paint or gasoline.

Myth #10. Long-term reliability doesn't matter for consumer electronics. Try telling this to Swatch, the Swiss watch-maker. They were early adopters of the lead-free movement. After discovering hideous difficulties with tin whiskers, they ended up shutting down production for some months while they changed back to 63/37 solder. In the process, they helped push through a ROHS exemption for fine-pitch pcb circuitry.

Myth #11. Whiskers can't short between balls on a 1-mm component. This came from studies referenced by Swatch in their application for exemption. Swatch was seeking some kind of rule they could use to exempt themselves without raising the issue for everyone. They found some research support for the idea that whiskers don't grow beyond 800 microns. Based on that, they postulated that a 650 micron pitch was unsafe, and should be exempted, but 800 microns was fine and didn't need exemption. Now you go look at the picture in Fig. 2 and tell me that there is a hard upper limit on whisker length. I don't think so.

Myth #12. You are exempt from regulation. Not true. Some components will arrive at your factory door with 63/37 solder surfaces, some with SAC, and some with pure tin. You have to deal with the issue whether or not you sell products in Europe.

The ROHS committee has now granted exemptions for military equipment, some classes of high-reliability telecommunications equipment, and fine-pitch (less than 0.65 mm pitch) circuitry. These exemptions create an historic opportunity to roll back the ROHS legislation as it applies to all electronic printed wiring board assemblies. If you want to push back against the lead-free legislation, please go here, sign up for information, and write to Mr. Burke expressing your support: John Burke, "Push Back"

I am still collecting data on this topic. If you have any additional information or anecdotes you'd like to relate, please email me at howie03@sigcon.com.

Source: High-Speed Digital Design newsletter

2. Electronics coompanies green up their act!

- *Latest edition of our quarterly Guide to Greener Electronics!*
- *Every company ranked bottom of previous editions have made improvements to move up!*

The latest edition of our quarterly Guide to Greener Electronics shows that major electronics firms have made large, green strides since the guide was first launched in August 2006. Nokia still leads, closely followed by Sony Erricson, Dell and Lenovo.

The Greener Electronics Guide has been our answer to getting the electronics industry to face up to the problem of e-waste. We want manufacturers to take responsibility for the unprotected child labourers who scavenge the mountains of cast-off gadgets created by our gizmo-loving ways.

The guide ranks the 14 top manufacturers of personal computers and mobile phones according to their policies and practice on toxic chemicals and recycling. In the first edition of the Guide from August 2006, the average score was 4/10. Now every company scores above 5/10. Click on the version numbers to see how the rankings have changed:

Race to the top

Every company ranked bottom of previous editions have made improvements to move up. Lenovo was bottom of the first guide but rapidly improved its chemicals policy and launched a global takeback program. Apple was bottom of the next two editions but pledged in May to improve its chemical policy and increase its recycling rate. Sony was bottom of the June 07 edition but has since launched in the US the most advanced takeback and recycling programme of any company.

The biggest movers in the latest guide are Sony and LG Electronics. Both have had their penalty points lifted for leaving a US industry coalition that lobbies against producer responsibility for recycling discarded products.

Iza Kruszewska, Greenpeace International Toxics Campaigner, has been amazed at the progress the Guide has helped create: "There is still a long way to go for some, but the momentum is extremely encouraging. What is very exciting is that while the guide focuses on brand leaders, the improvements can be seen industry wide".

Even companies not featured in the ranking have improved policies in the race to be greener. PC maker Asus has improved it environmental policies and an Indian edition of the ranking has lead to improvements from the two biggest Indian computer companies, WIPRO and HCL.

Hewlett Packard (HP) is the only company who has fallen in each ranking - over taken by competitors, and weakening its support for a strong takeback policy. It also still needs to provide concrete timelines for the complete elimination of hazardous chemicals.

Panasonic now languishes at the bottom, despite launching some products free from the most hazardous chemicals; they fail to deal with old products responsibly. Apple, while not losing points, has dropped to 12th position. Its newly launched iPhone, and new iMac and iPod lines, still include the worst toxic chemicals - allowing its competitors to race ahead.

As well as driving improvements in company policy there are many improvements in company practice since the first ranking. More companies now have free take back programs making it easier to recycle your old electronics. More products are available without the worst toxic chemicals like PVC (vinyl) plastic and brominated flame retardants (BFRs). Motorola and LG have joined Nokia and Sony Ericsson in selling phones without these toxic chemicals. Sony has a wide range of products including models of the Walkman, camcorders and a digital camera that are partially BFR and PVC free. Panasonic lists examples of PVC free products that include DVD players, home cinemas, and video players.

Publicly comparing the performance of these companies has proven a highly effective way to bring about quick improvements in their environmental policies. However, we are still waiting for the companies to act on their promises to market a computer completely free of the worst toxic chemicals.

Source: greenpeace.org

3. Amendment to the German Packaging Ordinance: An environment-friendly decision!

- *Continuing focus on resource-efficiency!*
- *Affordable consumer service preserved!*
- *Improved chances for fair competition among dual systems!*

Cologne, 19 September 2007. DSD GmbH welcomes today's decision of the German federal cabinet on the amendment to the Packaging Ordinance as a crucial step forward in stabilising close-to-home collection of recyclables. ""It's an encouraging signal for both environmental protection and for the young competition among dual systems that the amendment can now proceed", commented Stefan Schreiter, DSD's CEO. "Sales packages that are sold to private consumers should take part in close-to-home collection of recyclables – anything else is unrealistic", This existing approach, he continued, which with savings of more than 200 million euros for DSD's customers since 2005 alone has meant substantial advantages for consumers, can thus be progressed.

As a crucial advance, Schreiter emphasised that it will in future no longer be possible to offet packaging quantities taken back in the shops from those originating from commercial enterprises. "The quantities that consumers take back to the shops are vanishingly small, they put most of their packaging in the Yellow Bag and the Yellow Bin". Self-complying disposal is thus essentially restricted to the commercial sector. "There it's a sensible option, and there it works properly as well". The amendment gives the providers of commercial disposal solutions an assured operational framework with interesting prospects. We, too, will be providing a service of this kind for our customers", emphasised Schreiter.

The amendment to the Packaging Ordinance, he went on, will enable the number of freeloaders in close-to-home collection of recyclables to be effectively limited, and thus put the dual systems back on sound financial foundations. “This gives us an opportunity to develop the resource-efficient closed-cycle economy for the benefit of our customers and the natural environment”, said Schreiter. “Sound financing creates scope for further competition.”

There is, he pointed out, no alternative in the medium term to separate collection of sales packages at the consumer. “Cost-efficient, high-quality recycling is conditional on people carefully separating their waste”, continued Schreiter. “Anything else would be uneconomical and would impair the quality of the recycled material involved”.

Source: gruener-punkt.de