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Lead Free Solder: A Risky Alternative

Lead free solder poses not only environmental issues in today's world of electronics, but also reliability issues. It is true that lead is a very hazardous waste to have in our environment. However, lead free solder can negatively affect our daily use of electronics as well; for example, everyday electronics that citizens might depend on for communications or time could malfunction, or even something more serious such as medical or military equipment, which people's lives depend on. Environmentalists believe that lead was poisoning the environment by seeping out of landfills, and say that circuit boards were the source (Black Para. 5). However, others say that what we gain in helping the environment in lead solder restrictions, we lose in trying to obtain other resources for a lead free solder. While many environmentalists have advocated the restrictions on lead solder in electronics, I have come to believe that these restrictions should be removed because lead-free solder has many reliability issues, creates just as much of an environmental impact as toxic lead waste, and because lead solder from circuit boards is not as excessive of a waste in landfills as they make it seem.

Solder is a metal alloy that is electrically conductive and typically has a low melting point. It is used to attach electronic components to circuit boards. For years, people have used leaded solder in printed circuit boards (PCB's) as it has been seen as the most reliable option for electronics. However, due to tests of lead amounts in circuit boards, since August of 2004, the

Restriction of Hazardous Substances Directive (RoHS) has restricted the use of lead in solder altogether in the European Union. It is still in effect today. While it was only restricted in the EU, it has had a snowballing effect. People follow the business, so those who want to sell in the EU will comply with the restrictions of RoHS, including many corporations in America. With many people moving to lead-free solder, they had to find a good option to replace the lead. PACE, Inc., "A recognized world leader in the development of solutions for the assembly and repair of highly advanced electronics," says, "the most commonly used lead-free alloy [is] Sn96.5 Ag3.0 Cu0.5, commonly referred to as SAC 305" (Lead Free vs. Leaded Solder). This solder is a tin, silver, and copper alloy, where the tin was the main replacement of lead. It is still widely used.

Those against the use of lead in circuit boards might begin by arguing that there is a lot of lead waste harming the environment coming straight from circuit boards. This argument is backed up by the statistics found by many members of the Ministry of Education in the Southwest University of Science and Technology in China. These statistics come from the Total Threshold Limit Concentration (TTLC) procedure. With this procedure, they test for metals by crushing PCB waste down to one millimeter particles and examining each metal. The detection limit was measured in milligrams of lead per one kilogram of the total PCB material. For lead, this limit was 1000 mg/kg of printed circuit board material. From the years 1996 to 2004, the detection of lead was well over the limit, with numbers like 30,100 mg/kg in 1999 and 23,400 mg/kg in 2003. After the implementation of RoHs in 2004, which restricted the use of lead in PCB's, numbers dropped well below the detection limit. These numbers included 483 mg/kg in 2005 and 185 mg/kg in 2007 (Chen, et al.). These statistics clearly show that the limit of lead in

PCB's was surpassed by an astounding amount. They also show that restricting lead in circuit boards did have quite an evident impact on these numbers. This is the basis for the argument that lead waste is coming directly from circuit boards. Environmentalists have used these statistics to determine that we need to restrict the use of lead solder, but do these numbers really give enough evidence to make this decision?

While the fact that lead waste in the environment is unhealthy is inevitable, I do not necessarily agree that these statistics show that lead waste in the environment is as excessive as it may seem. Of course the ratio of milligrams of lead to kilogram of PCB would be reduced if they are no longer using lead solder. Proponents of this study are right to argue that the limit of lead was surpassed with the use of lead solder in PCB's. But they exaggerate when they claim that these statistics show where excessive lead waste is coming from. In no way do I mean to undermine the findings of this study. However, it is important to point out that these statistics do not show a reduced amount of lead in the environment. Electronics are ultimately a very small portion of where our lead waste comes from, and even a very small portion of our landfill waste in general. Journalist Valerie J. Brown provides a quote from Jan Whitworth, a policy analyst with the Oregon Department of Environmental Quality, who explains how "[e]lectronics in general are one percent of the waste that goes into a landfill" (qtd. Brown Para. 5). This means that they are blaming a mere one percent of our waste for all the lead waste that they think is there. It's such a small number. She also includes a quote from Fern Abrams, director of environmental policy at IPC–Association Connecting Electronics Industries, who says that "It has never actually been shown that lead is actually leaching out of landfills" (qtd. Para. 5). While the TTLC procedure provides information on how much lead is used per kilogram of PCB, it

fails to show this. Furthermore, because lead has a very high melting point of about 621°F, it is not possible for this metal to melt in a landfill or even evaporate in an open fire. The solid particles merely stick to the soil and get buried into the ground, which was where the lead came from to begin with. Such a low percentage of the total landfill waste surely cannot be the only cause of lead waste in the environment.

If electronics are such a small amount of the waste that go into our landfills, then where could all of this lead waste they have supposedly found even be coming from? Andrew D. Kostic, senior project engineer at the Aerospace Corporation, provides some very interesting points. He explains how electronics use less than one percent of the world's consumed lead, while lead-acid batteries use as much as eighty percent but are exempt to RoHS (Kostic 15). While I do realize this evidence does not necessarily show why lead waste is not as excessive as the tests make it look, I think it is an important point to note because this supposed lead waste could be a result of these batteries. However, they have put their time towards restricting a smaller consumption of it. Why are these exempt? Why are there more concerns towards a product that uses such a low amount of the world's consumed lead compared to that of lead-acid batteries? These are just a few curiosity questions that have arised from many who disagree with the restrictions of lead as well. This is not the only debate on switching to a different solder, though.

Environmentalists will argue that lead free solder is better for the environment than lead solder. This is because using this lead free solder has reduced the amount of lead waste in the environment. However, they have only looked at what they are gaining with this lead free solder, not at what they are losing on their own side. Electrical Engineer Howard Johnson explains how

while lead is worse for the environment in terms of toxicity, lead free solder, specifically the SAC alloy, is not necessarily better in other areas of environmental damage. Johnson then goes on to explain why exactly why this is:

> 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. (Para. 7)

In other words, while we are limiting lead waste in the environment, we are still contributing to environmental destruction in other areas. This includes mining, which uses up more fuel and limited resources to obtain and use even more limited resources for a new lead free solder. When we use lead for the circuit boards, many times the lead is being used from products that have been recycled to obtain the materials. Also, because such a small amount of lead is found in landfills, and we've never shown it to be seeping out of them, how do we really know that this restriction is helping? Forcing corporations to switch to a lead free solder seems to have shown even more environmental issues than lead ever has.

Another issue that is often debated between supporters and critics of lead free solder is the reliability. There are those who claim they hadn't seen any reliability issues at all with the the SAC305 solder. IPC online editor Terry Costlow argues that there are many benefits to take away from lead free solder. In 2011, he provided a quote from Ronald C. Lasky, an instructional professor at Thayer School of Engineering at Dartmouth, on the reliability of lead free solder. In

an article published by Costlow, Lasky says, “We’re now 5 years into the implementation of RoHS and we’ve made $3 trillion in electronics. We haven’t really noticed any big change in reliability” (qtd. Costlow Para. 3). To him, there hasn’t been a reliability problem. Costlow then goes on to explain how lead free solder has actually helped us in size efficiency of new devices and also how it has become easier to mass produce with this solder.

It seems to be a stroke of luck that Lasky had not seen any reliability issues even by 2011. The problem with lead free solders like SAC 305 is irregular formations known as tin whiskers. These are hairlike structures that form and protrude out from the solder. At first thought, this may not seem like a problem. However, as these formations become more plentiful and longer on a circuit board, they can cause arcing, where the electricity flowing jumps from one whisker to the next. This arcing can short out the circuit board altogether, forcing you to buy something new. Maybe having to merely buy a new product doesn’t seem like that big of an issue, but what happens when that product you’re using is what you’re depending on to survive? There have been many documented failures of military and medical equipment ever since the switch to lead free solders. John Keller, editor in chief of Military and Aerospace Electronics, writes about failures of air and surface launched missiles at the US Naval Air Warfare Center in California. He explains, “Problems also have been reported with the F15 jet fighter radar, the Patriot missile, and the Airborne Warning and Control System (AWACS) aircraft” (Keller Para. 20). These have all been due to tin whisker failures. With the failure of the radar in the F15 jet fighter, how is the pilot suppose to not only navigate, but also recognized enemy fighters in his airspace? He cannot. This alone should be enough to recognized the issue of reliability with lead free solder. There is a clear and present danger with the use of this solder, and it may cost

somebody their life. The people of our military depend on this equipment to work, and even further, the people of our country. If these things fail at the wrong time, our military is unable to properly defend this country, and that will result in a large loss of life. Keller says, “It’s probably going to take a lot more failures-some likely involving more than a few human deaths-before this issue gets the attention it deserves” (Para. 22). In other words, many people won’t pay any attention to this issue unless something tragic happens to bring it up widely with the public. Other solutions need to be found to reduce lead waste in the environment because the reliability issues outweigh the problem of environmental pollution.

In the end, we are still stuck with the unreliability of lead free solder, and we are no better off in terms of environmental issues. Instead of continuing to search for a more reliable lead free solder, I think that it would be beneficial to put more effort towards a better recycling program for electronics; with this, we can maintain reliability and still reduce toxic waste in the environment. However, if this continues, as I am sure it will, we will continue to see equipment failures. Environmental pollution will show no improvement from this switch, and while I’m sure there will be a reliable option for lead free solder eventually, we don’t know how long it could be until then. What we do know: the electronics industry isn’t waiting.

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