MS2® SOLDER DROSS ELIMINATOR

Economic and Technical Advantages of Chemical Dross Elimination and Prevention

Daniel (Baer) Feinberg
Fein-Line Associates

+44 (0)1292 834 000
info@dross-elidrossminator.com
dross-elidrossminator.com

Abstract

Dross generation has always been a costly issue for the electronics assembly industry. At least half, and in many cases, more than half of the metal (solder) purchased for electronic manufacture is wasted as it becomes tied up in dross. With the advent of lead free solders as well as the spike in tin prices during 2008 the moderate economic pain of dross generation has become acute. In addition to metal cost, lead free solders have become known to exacerbate quality issues such as copper dissolution. A process introduced two years ago cures virtually all problems caused by dross and has now been shown in production to mitigate some of the other issues associated with lead free solders.

This paper will show the true cost of dross in 2008/2009 terms, including metal replacement, loss of efficiency, and safety aswell as environmental and quality issues which clearly demonstrate a need for a solution to this problem. In addition to dross elimination the process has been shown in the lab to reduce temperatures for wave and selective soldering and to improvewetting. Updated full production data at major EMS assemblers as well as lab test data will be presented.

In addition to answering the technical questions, why and how the "economics of dross" will be examined and a specific and significant cost savings scenario will be presented based on the first two years of full production.

Additional Information

This is a new paper which builds on one I gave two years a go at IPC Expo/Apex. This paper has new information with the economic and quality examples based on full production data at major companies.

Economic and Technical advantages of Chemical Dross Elimination and Prevention Solder dross has been a problem for the electronic assembly industry since wave soldering overtook manual placement and soldering decades ago. Dross is a costly byproduct of molten solder, oxygen and turbulence. Once solder is converted into dross it becomes hazardous waste with an emphasis on waste. When solder cost was under $2.50/Lb sending out 50% to 70% of your solder and getting a fraction of its value was not a real big deal. With all metal prices hitting new all time highs earlier this year and with the mandated use of very expensive lead free solders the cost of dross has now gotten the attention of upper management at most leading companies. Consider this; an average wave solder machine generates 2.7 Lbs of dross per hour. Dross causes solder related defects, higher lead free alloy melting points cause even more dross, Dross creates defects such as bridging, shorts and skips and you also have to consider the cost to remove the dross, clean the unit and then add solder and perhaps even recalibrate the wave. Over all dross is a VERY expensive and disruptive process.

There have been a number of solder dross reduction processes for quite some time, they include oxygen barriers such as powders and oils. These are partially effective for a short period of time but they only modestly reduce the amount of solder dross and they do not stop dross from forming. There are even mechanical devices to squeeze some good metal from the hot dross. These devices do not convert dross back into useable metal instead they try to separate good metal from unusable dross. The metal that is recovered is of low quality and the process is not really effective. What has been needed is a process that virtually eliminates dross while at the same time keeping new dross from forming. The Molten Solder Surfactant from P. KAY Metal (MS2) does precisely that. For the remainder of this paper this material will be referred to as "the material" or MS2 if needed for clarity.

The material eliminates dross and therefore reduces solder purchases by up to 75% and it does it without mixing with the metal.

A triple blind test was performed by three independent testing facilities comparing solder alloy before the material was added to the process and solder alloy after use in a MS2 treated wave. The three facilities could not determine any difference in the metal samples. This material simply eliminated the issue of dross from the manufacturing process.

Figure 1. Shows a typical wave solder unit in production. You can see that dross is forming. Soon the process will have to be stoped and the dross removed and then fresh solder will have to be added to replace the dross that has formed and was removed.

(Figure 1)

Figure 2 shows the same wave after the material has been added. Note that there is no dross and therefore no wasted solder. The solder alloy is clean and pristine with virtually no reduced chance of providing dross related defects to the soldered assemblies.

(Figure 2)

When using this material there are no other process changes necessary. This material does not mix with the metal and therefore it is compatible with any alloy of type of solder. It is not necessary to change flux type or brand or to make other adjustments. In fact, because the solder unit remains dross free it is running in a steady state mode and therefore frequent adjustments are not necessary.

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The Economics of Dross

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One of the first things to be considered is savings to be realized. In order to generate a typical representation of what savings could be expected a company was chosen as a partner. Their process was bench marked and costs/usage measurements were taken before and then while using this material in their process. The facility which did the testing has four wave solder units.

First here are some averages. A typical wave solder machine generates 2.7 Lbs of dross per hour. If expensive nitrogen is used then the dross generation can be somewhat less and if the unit has multiple waves or is turbulent then dross generation can be higher but the average is 2.7 Lbs/Hr. In some facilities up to 70% of the solder added to the unit can be to replace dross that had to be removed. In this facility, as they are a controlled higher production facility a little over 50% of the solder that is added was due to dross.

This facility uses SAC 305 and at the time of the test they were paying $20/Lb for their solder. This facility purchases on average 2000 Lbs of solder per month which at $20/Lb equals $40,000 for their four units.

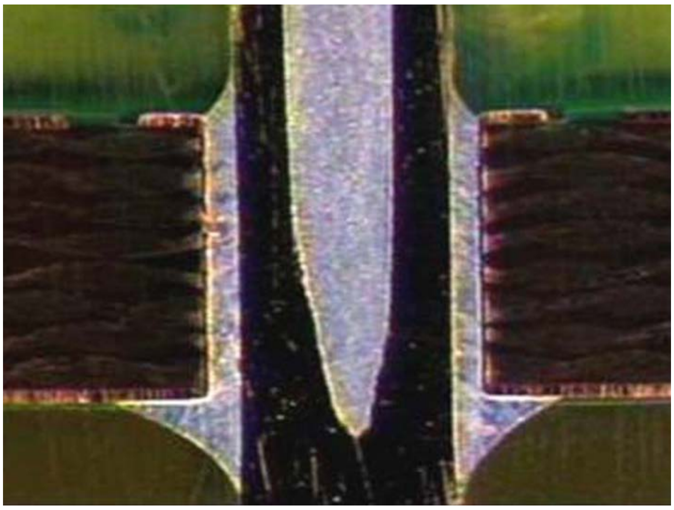
Using the 50% dross/waste number, which is a little conservative, they had to add 1000 Lbs of solder/Mo to replace metal that was tied up in dross. They do sell the dross to a scrap broker and usually do not get credit for the full (on average) 1000 lbs but they do get $7/Lb for the dross. Their net cost for solder per month therefore averaged $40,000 minus the $7,000 they
received from the scrap broker for a net cost of $33,000.

Whey using the dross eliminating material, since there is no dross they only have to purchase 1000 Lbs of solder (the original 2,000 Lbs minus the 1,000 Lbs that was wasted as dross) Their cost for solder is therefore reduced by half or $20,00/Mo. You still have to add in the cost of this material which is $2,600/Mo which, when deducted from the savings provides a total savings of $17,400 per month or a yearly savings of $208,000 or a 47% savings. Obviously the savings will vary from facility depending on the amount of dross generated, the alloy used and therefore the price they are paying for solder.

There are others savings that must be considered. Issues such as. Downtime to clean dross from the unit, Time to recalibrate the wave as dross builds up, safety issues having to do with removing hot dross from the unit, cost of storage and shipment of dross to a scrap broker as well as “shrinkage of dross” in the supply/recycling chain will all vary from facility to facility but are meaningful. There is also the big one, the savings associated with a reduced DPMO having to do with a dross free process
can be significant. Some companies using this material have also reported being able to increase the conveyer speed and to also reduce the solder temperature. These calculations have not been quantified in a controlled experiment as yet however.

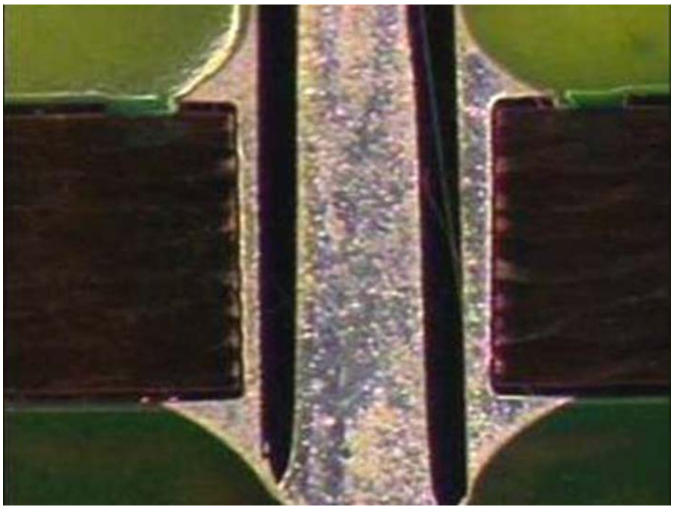
Improved Quality

There is case after case where the using company reports improved solder joint quality when using this material. Following are but a few graphics depicting the type of improvement seen. These graphics were supplied by a company while using this material. In figure 3 below they show their typical solder joint without using this material. As you can see the fill on the bottom of the hole is excellent but the fill on the top. While acceptable could not be considered ideal.



(Figure 3)

In Figures 4 and 5 below you can see that while using the dross elimination material, the solder pot is clean and dross free and therefore wets and flows better.

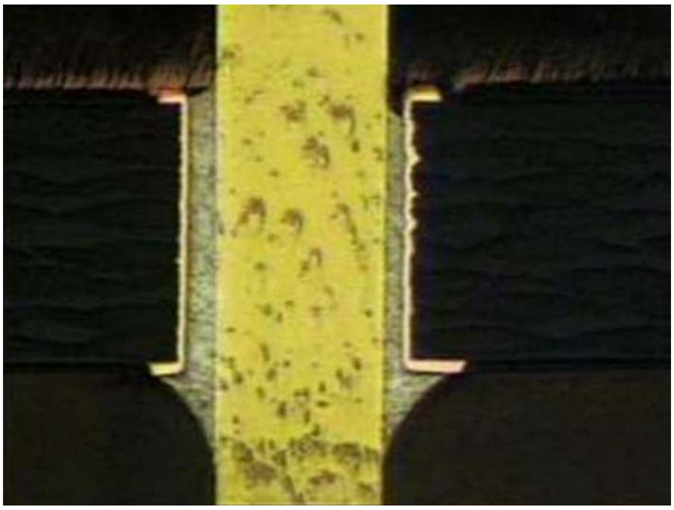


(Figure 4)

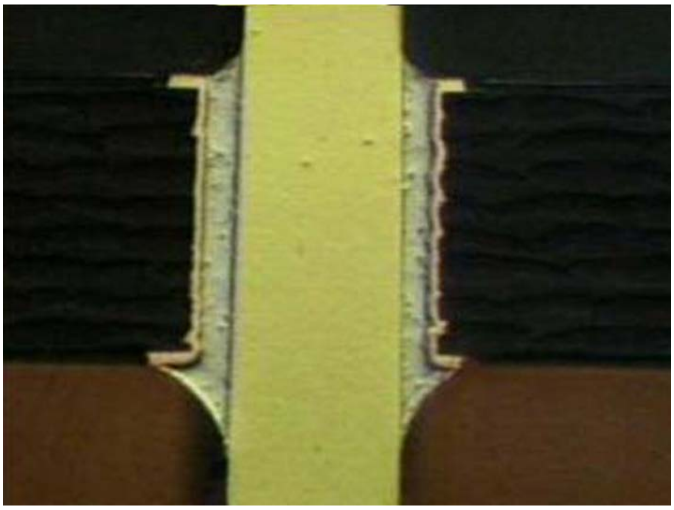
(Figure 5, magnified top left of figure 4)

Following are additional examples (Figures 6 and 7) of "Before" and "After" provided from yet a different using facility.

In addition to fill both testing as well as observations regarding wetting show a measurable improvement when using this material. Following are two pictures, Figure 8 shows a solder dip test without the material in the process and figure 9 shows the improved wetting with the material employed.



(Figure 6, note the poor fill on the top plane, no material used)



(Figure 7, Note the improved top fill)

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(Figure 8, no material in use)

(Figure 9, using the dross elimination material, n ote imporved wetting)

Significant testing has been undertaken at various well known and respected test and reliability sites, far more testing than there is room to discuss here. There have been no issues with reliability or contamination. All test conducted by these facilities as well as by numerous using companies for SIR electrical performance and ion chromatography testing have passed with levels well above the SIR criteria of J-STD-001C (1E8Ω).

This material does not attack the board, the solder mask, the wave solder equipment of anything else. All it does is reduce dross back into useable metal and prevent new dross from forming. This material has been submitted to leading wave solder machine manufactures for testing and it has been confirmed there have been no observed detrimental effects to the board, the solder mask, the wave machine or anything else.

In Conclusion

The use of this new material provides a path to reduce at least part of the increased costs associated with lead free soldering while standard leaded soldering also benefits from the use of this material.

There is data generated by testing labs and production users that show cleaner, brighter solder joints and improved wetting as well as a measurable and significant reduction in solder process related defects and improved throughput.

This process allows for a significant reduction in a using facilities hazardous waste.
This makes sense as the solder bath itself is clean and running in a steady state mode when using it AND, The Cost Savings Are Substantial.

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Prestwick International Aerospace Park,
Prestwick, KA9 2TU

Tel +44 (0)1292 834 000
Fax +44(0)1292 475 244
Email info@dross-eliminator.com

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