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Ageing Properties of Organic Solderable Preservatives

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ABSTRACT

With the increasing use of surface mount technology, the need for flat, planar surfaces for fine pitch surface mount components has meant that alternative finishes with superior properties to Hot air solder levelled (HASL) tin-lead are required. A study of Organic Solderable Preservatives (OSPs) was carried out at the NPL, with the support of ten leading companies who were either PCB manufacturers using OSPs or an OSP supplier with facilities for coating boards. Several non-OSP finishes were examined as benchmarks.

The project set out to qualify the robustness of OSP coatings in terms of solderability during multiple reflows. The techniques used to achieve this were the wetting balance, solder dot method, Sequential Electrochemical Reduction Analysis (SERA) and a yield analysis. A significant number of OSP coatings performed extremely well in the study and were comparable to the non-OSPs in performance.

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Organic Solderable Preservatives Project

1 An Overview of the OSP Project

1.1 Introduction

Bare copper tracks that are etched from a copper clad board require coating to protect the bare copper from oxidising. The most popular coating at present is hot air solder levelled (HASL) tin-lead. This universal popularity is slowly changing with the increasing use of surface mount technology (SMT). With SMT, the need for flat, planar surfaces for fine pitch surface mount components has meant that alternative finishes with superior properties to HASL are required. Coatings now available include gold over nickel, Immersion-silver, immersion tin, Palladium over Nickel (PdNi) and organic solderable preservatives (OSPs). The choice of finish is a compromise between performance, cost and prejudice.

Organic solderable preservatives (OSP) finishes are not new to the interconnection industry. They have long been used as alternatives to HASL coatings to provide solderable printed wiring boards for wave soldering. The original OSPs were thick (3-5 microns) rosin based coatings when rosin flux and solvent cleaning were the assembly materials of choice. The increasing concerns for the environment and the change to no clean, low solid fluxes produced problems for the rosin based coatings. Their poor solderability performance led to the development of a new generation of OSPs. Benzotriazole and Imidazole based OSPs were introduced and have been used by companies for many years.

The new OSPs are relatively thin (30-500Å) organic nitrogen azole compounds chemically bonded to the copper surface. They protect the surface by retarding the copper-oxygen reaction. The advantages of using OSPs compared to the HASL finish include a flat, planar surface ideal for SMT, a relatively low production cost and the simplicity of re-coating. Unfortunately, there was a severe limitation in the use of early OSPs. This stigma has stuck in certain parts of the industry, to the last generation of OSPs which are very resistant to multiple reflow cycles.

The main purpose of this project was to examine the resilience of the new OSPs to multiple reflow processing and storage. The study also included a number of non OSP finishes, some of which are also new.

1.2 Participants

The work has been carried out at NPL with DTI financial support, and the support of ten leading companies who were either a PCB manufacturer using OSP finishes or an OSP supplier with facilities for coating boards. The companies involved were Atotech, GSPK, Philips, Exacta, Lea Ronal, Prestwick Circuits, Signum Circuits, MecEurope, Enthone OMI and Shipley Europe. The OSP finishes examined are shown in Table 1. Several non-OSP finishes were examined as benchmarks. They are listed in Table 2.

Company:	Trade Name:	Company Type:	Finish Type:
MecEurope	MecSeal	Supplier	Benzimidazole
GSPK	Mecseal	PCB Manufacturer	Benzimidazole
Enthone OMI	Entek Plus	Supplier	Substituted Benzimidazole
Prestwick	Gliccoat E3	PCB Manufacturer	Alkylbenzimidazole
Signum Circuits	Entek plus	PCB Manufacturer	Substituted Benzimidazole
	Gliccoat SMD F1		Alkylbenzimidazole
	Copper Guard 117		Unknown
Exacta Circuits	Gliccoat SMD F1	PCB Manufacturer	Alkylbenzimidazole
Lea Ronal	Ronacoat	Supplier	Imidazole
Atotech	Shercoat	Supplier	Benzimidazole
Philips Printed Circuits	M-Coat+	PCB Manufacturer	Substituted Benzimidazole
Shipley Europe	Protecto	Supplier	Imidazole

Table 1. Participating companies and the OSP finishes studied in the project.

Supplier:	Trade Name:	Coating:	Number of coatings submitted:
Atotech	Aurotech	Electroless Nickel/ Immersion Gold	4 (one coating duplicated)
Enthone OMI	Sel-Rex SMT		
Lea Ronal	Ronamerse SMT		
Lektrachem	Omikron	Electroless tin	3
MFS	APT 884		
Shipley Europe	Tinposit		
Alpha-Fry	Alpha Level	Electroless silver	1
Atotech	Pallatect	Electroless palladium	2
Lea Ronal	Pallamerse SMT		

Table 2. A list of the non-OSP finishes with their suppliers used as a benchmark.

1.3 Brief description of project

The project consisted of three stages:

(1) Board design and manufacture.

NPL designed and generated PCB artwork for the test board as shown in Figure 1. The board layout includes four types of test patterns: wetting balance, SERA, solder dot coalescence and assembly yield. The test patterns were arranged around the edge for ease of testing and for uniformity checks on the PCB.

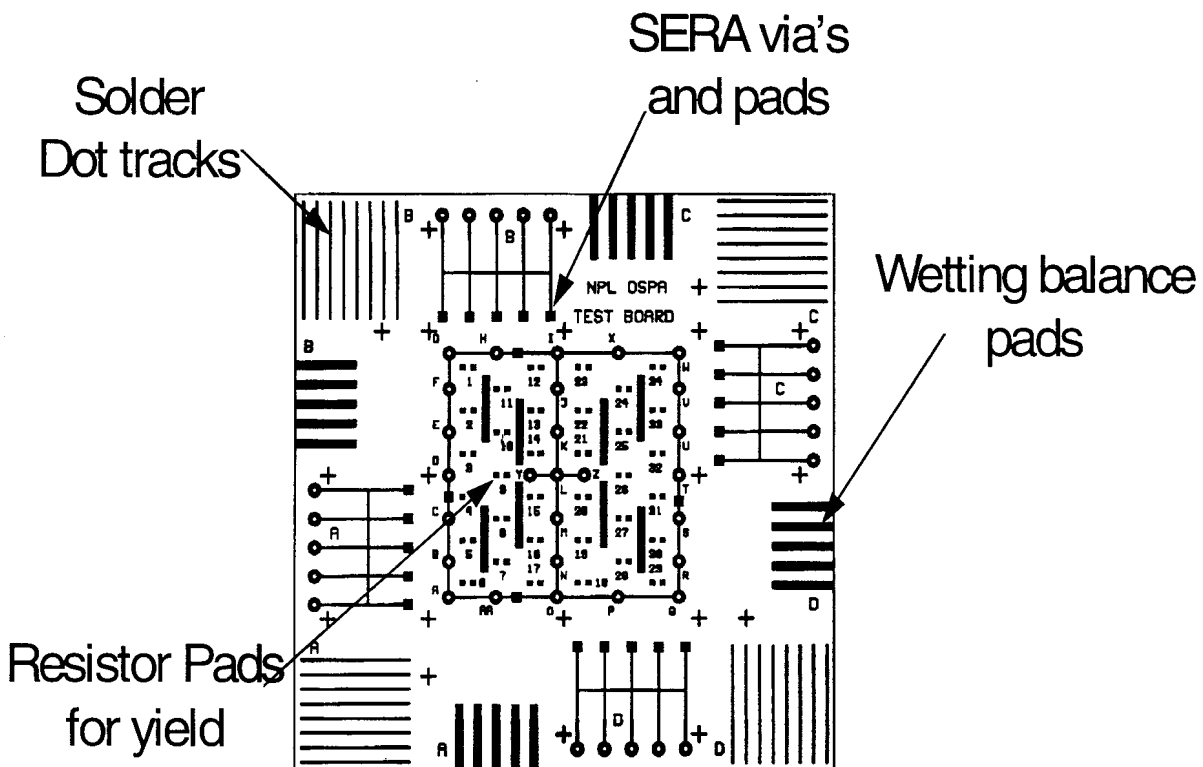


Figure 1. Test board design for OSP project. The four sections of the design used in the coating evaluation are indicated.

The PCB artwork was forwarded to the participating companies. The companies produced 50 test boards and returned them to the NPL for testing.

(2) Evaluation of boards.

The 50 boards were received in various types of packaging. The time of arrival was logged and the boards were divided into several groups. Table 3 shows the sub-divisions of the boards.

Packaging:	Atmosphere:
Boards wrapped in as-received packaging (eg Tissue). Exposed to atmosphere.	Laboratory atmosphere: Stable temperature & humidity
Boards wrapped in as-received packaging. Sealed in plastic bag.	
Boards re-wrapped in tissue. Sealed in plastic bag.	
Boards re-wrapped in tissue. Exposed to atmosphere.	'Industrial' atmosphere: Temperature & humidity variable.

Table 3. Conditions of storage of test boards.

Performance testing of the OSPs consisted of two sections: Assessment after multiple reflow and natural aging.

(a) Performance of the OSPs after multiple reflow processing.

Figure 2 shows the temperature profile of the convection reflow oven used in the processing. The ramp time of the preheat was less than 2°C/second and the sample was above 185°C for ~45 seconds.

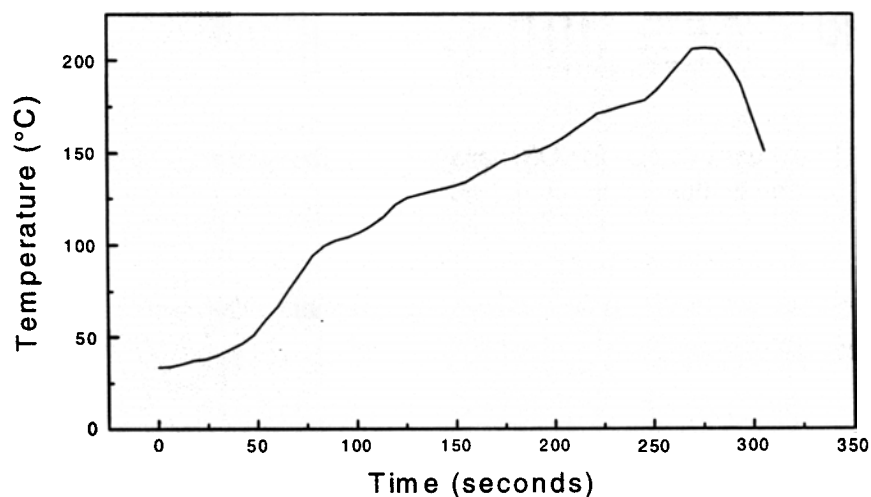


Figure 2 The temperature profile of the convection oven used in the multiple reflow processing of the OSP boards.

The boards were exposed to a number of reflow cycles (0, 2, 4 and 6 reflows) and sectioned. The sections were examined using a wetting balance, Sequential Electrochemical Reduction Analysis (SERA), solder dot tests and a yield assessment. The four techniques are discussed in detail in appendix A.

(b) Performance of the OSP after long-term storage.

The as-received boards will be stored for a period of eighteen months. The solderability of the boards will be assessed using a wetting balance at periodic intervals.

2 Experimental Results

2.1 Wetting Balance Results

The two types of flux used in the wetting balance analysis were in accordance with IEC 68-2-20. They were a pure rosin flux and a rosin flux with 0.5% halide and were purchased from Multicore Solders as SMNA and Actiec 5, respectively.

Figure 3 shows a plot of the force at 2 seconds vs the number of reflow passes for the OSP coatings tested with Actiec 5. After 2 reflows, the majority of the samples show little change in wetting performance. At 6 reflows, the solderability of ~75% of the coatings has degraded significantly.

The wetting balance tests for the non-OSP finishes tested with Actiec 5 are shown in Figure 4. The performance of the individual coating types (e.g. NiAu or immersion Sn) is mixed. This is observed later in Figures 6 and 7.

A comparison of the OSP and non-OSP coatings reveals several points. There is a greater spread of results for the non-OSPs at zero reflow compared to the OSP coatings. Also, as the number of reflows for the OSPs is increased, it can be seen that the solderability of many of the coatings gradually degrades. This is in contrast to the non-OSPs which tend to be very stable, showing very little degradation. However, there are several OSPs that show a similar robustness to the non-OSPs with very little degradation of solderability with multiple reflows.

Effect of OSP Thickness

There are several important factors to be considered when coating a PCB with an OSP coating. These factors include the preparation of the surface before application and the thickness of the OSP coating applied. Three of the OSP coatings were represented by two different companies in the study. Their coating thickness was measured to observe any correlation with solderability. In Figure 5, samples from two different companies for OSP X are shown. The sample with better wetting is approximately three times thicker than the poorer coating. Both samples perform well up to 2 reflows. However, the solderability of the thinner OSP coating deteriorates rapidly after 4 and 6 reflows whilst the thicker coating continues to show good wetting characteristics. Thus, the coating thickness may influence the ability of the OSP coatings to withstand multiple reflows.

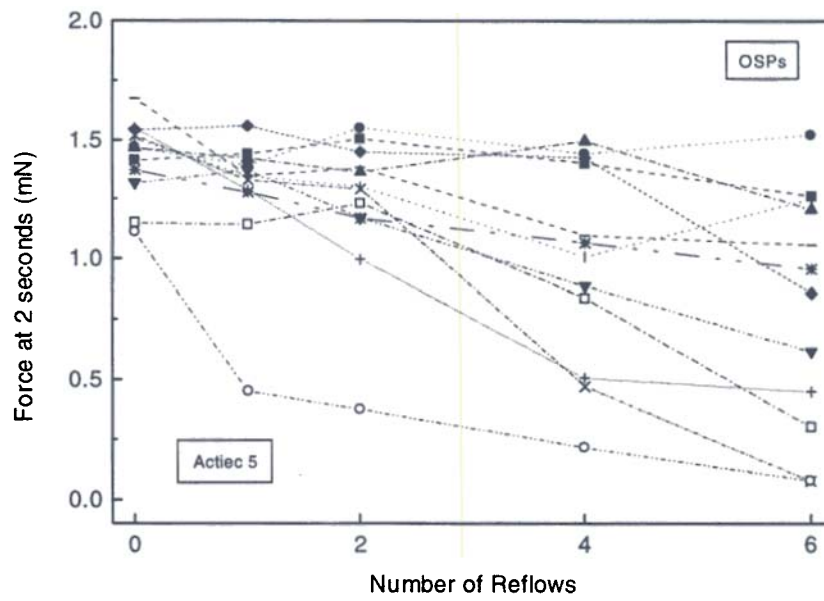


Figure 3 Solderability results for OSP coatings after multiple reflows using Actiec 5.

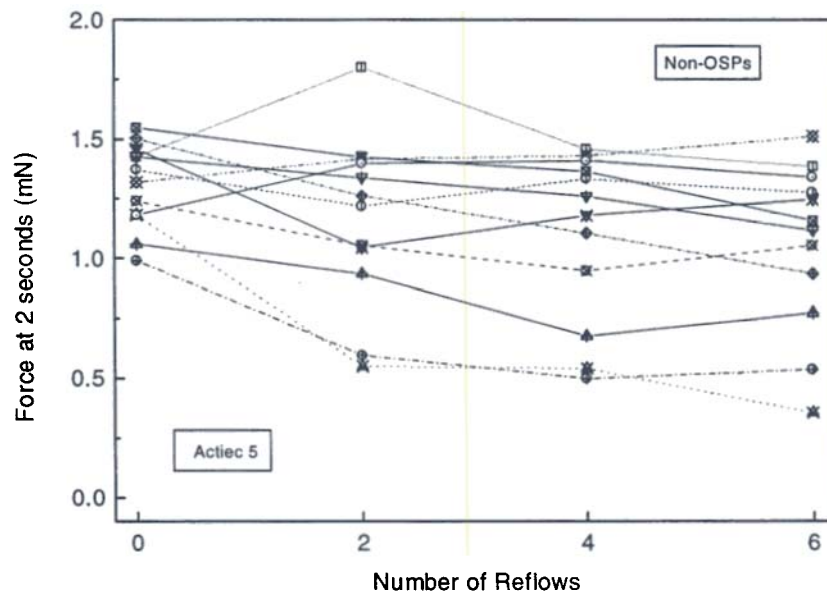


Figure 4 Solderability results for non-OSP coatings after multiple reflow using Actiec 5.

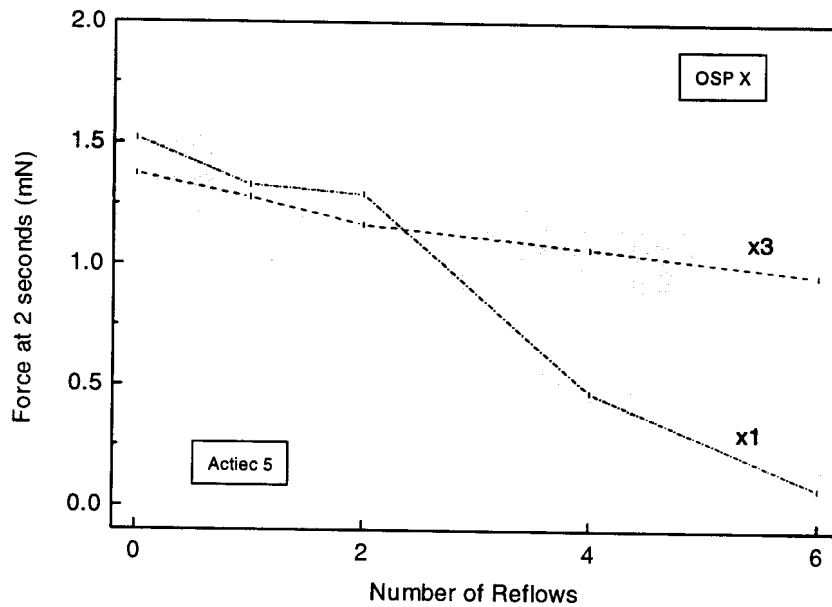


Figure 5 A comparison of the same OSP coating from two different companies.

Comparison of similar non-OSP finishes

It was possible to make a comparison of the four NiAu and three Immersion Sn finishes (Figures 6 and 7, respectively). Again, there was a wide variation between the coatings of the same type, as observed previously with the OSPs.

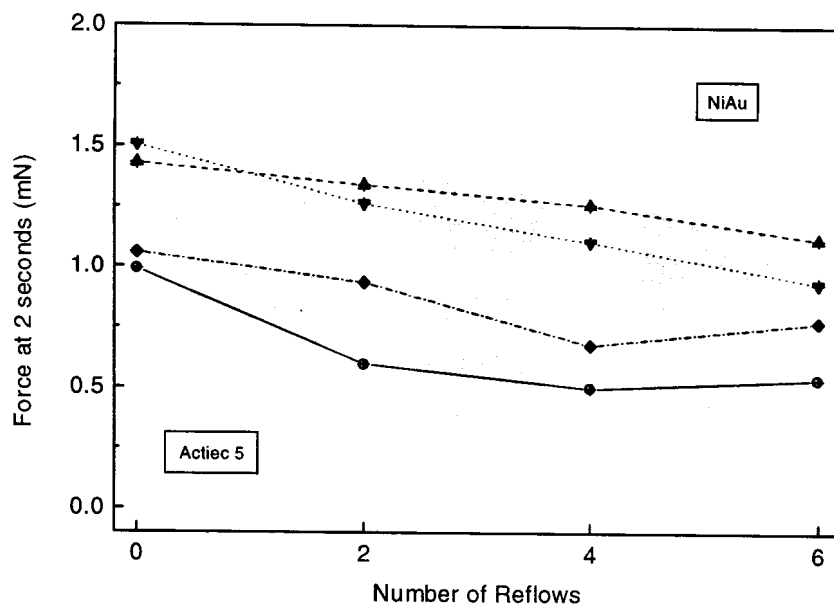


Figure 6 A comparison of NiAu finishes tested with Actiec 5.

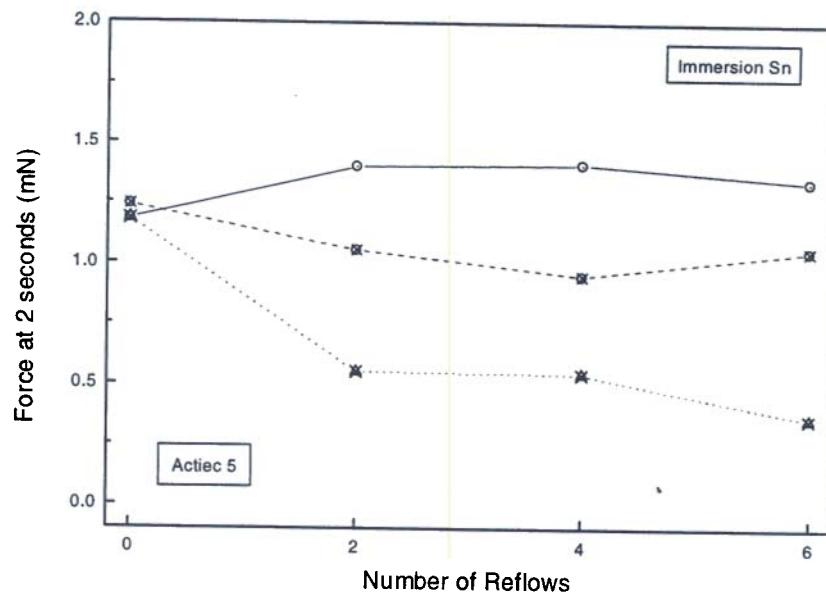


Figure 7 A comparison of Immersion Sn tested with Actiec 5.

The Effects of Flux

The wetting performance of all the coatings was assessed with SMNA at zero and six reflows. A comparison of the two fluxes was made and the results for the force at 2 seconds are shown in Figures 8 to 11. This data is shown by coating with the different fluxes in Appendix B. The scatter diagrams indicate the relationship between the two fluxes for the individual coatings. Coatings P, T, V and W are NiAu and coatings N, O and X are immersion Sn.

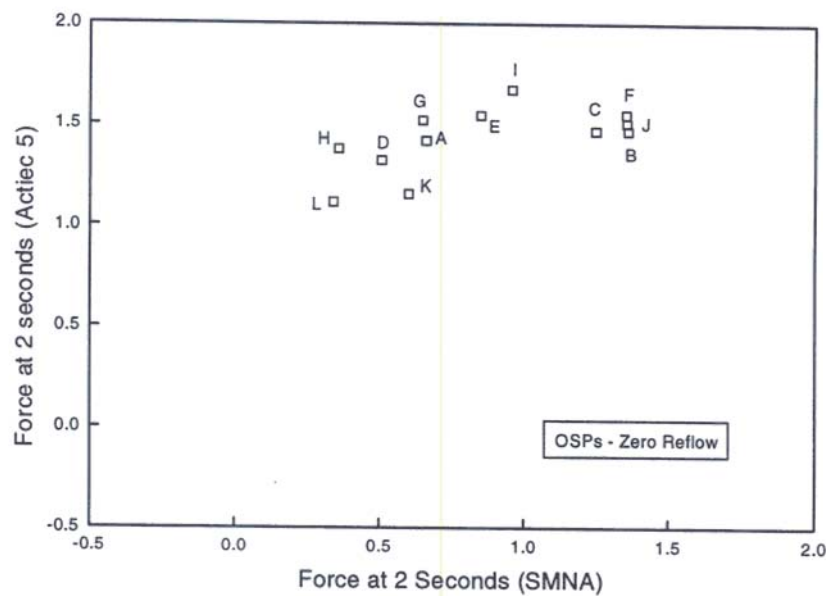


Figure 8 A scatter diagram of the two fluxes, SMNA and Actiec 5, for the OSP coatings at zero reflow.

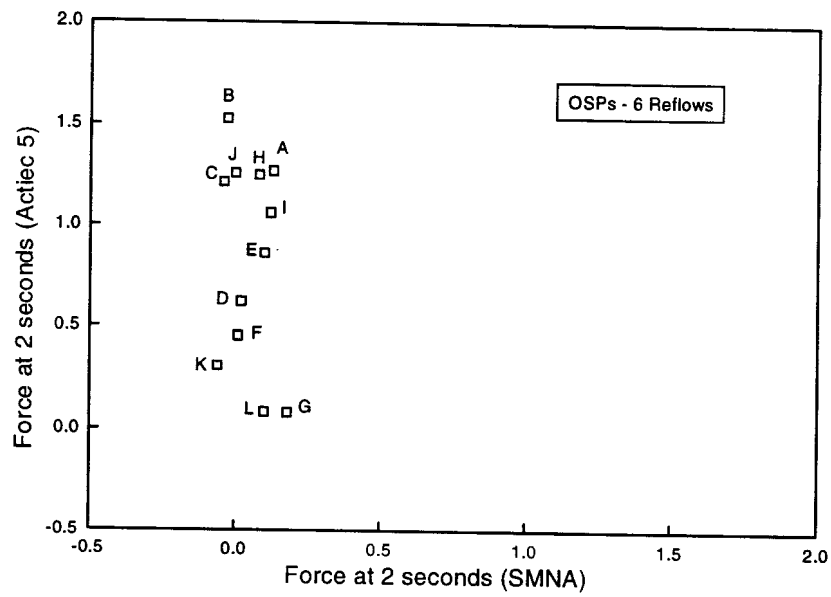


Figure 9 A scatter diagram of the two fluxes, SMNA and Actiec 5, for the OSP coatings at 6 reflows.

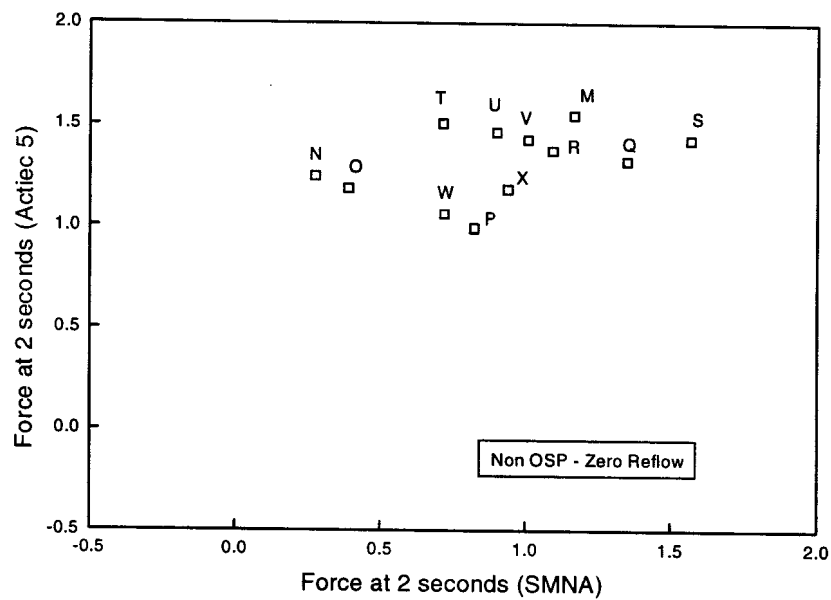


Figure 10 A scatter diagram of the two fluxes, SMNA and Actiec 5, for the non-OSP coatings at zero reflow.

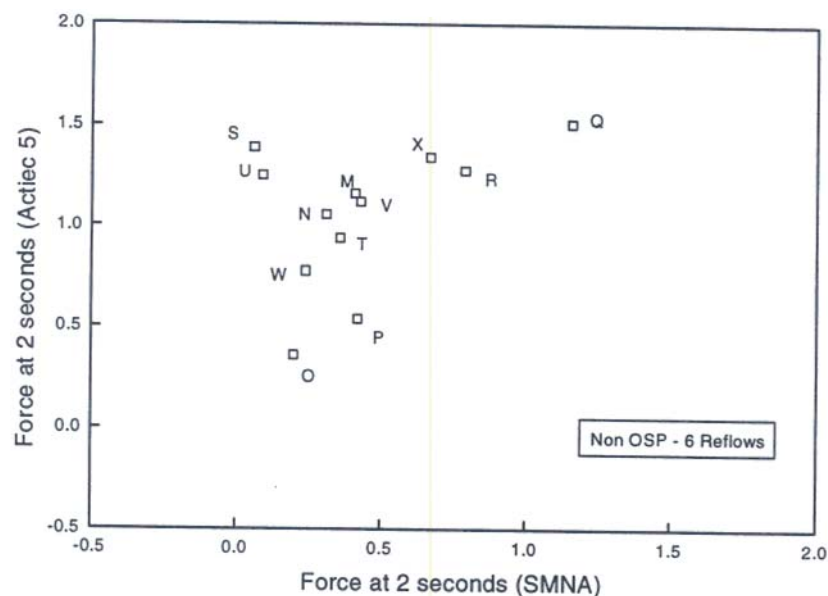


Figure 11 A scatter diagram of the two fluxes, SMNA and Actiec 5, for the non-OSP coatings at 6 reflows.

For the OSP coatings at zero reflow, the SMNA flux clearly differentiates between the various samples over a wide range, whereas the Actiec 5 flux gives a similar value of wetting for all of the samples. At 6 reflows, however, the trend is for the Actiec 5 flux to differentiate and the SMNA range has collapsed showing very little variation. The results also indicate that at 6 reflows, a flux is required for the OSPs with a greater activity than SMNA, to avoid poor solderability.

For the non-OSP coatings, there is a similar differentiation at zero reflow to that found with the OSP coatings. At 6 reflows many of the non-OSP coatings continue to show good solderability even with SMNA, although there is a general trend of values to the lower left quarter of the graph, indicating poorer wetting. However, the wetting for SMNA is greater than zero, and better than that observed for the OSPs.

2.2 Solder Dot Results

The solder dot method is described in Appendix A. Three companies, Alpha-Fry, Multicore Solders and Litton Precision supplied RMA and no-clean pastes for the solder dot study. Litton are the UK agents for Kester solder pastes. Only the OSP and NiAu finishes were solder dot tested. This is due to the poor contrast found with finishes with a silver colour making the visual inspection extremely difficult.

The OSP and NiAu coatings were tested for 0, 2, 4 and 6 reflows for each of the six pastes. Figure 12 shows a comparison of solder dot results for pastes A and B. A clear difference in the pastes performance can be observed. Paste A shows poor coalescence of dots at zero reflow for all of the OSP coatings whereas for Paste B, there is good coalescence at zero reflow for many of the coatings. The performance of each coating for all of the pastes are shown in Appendix C.

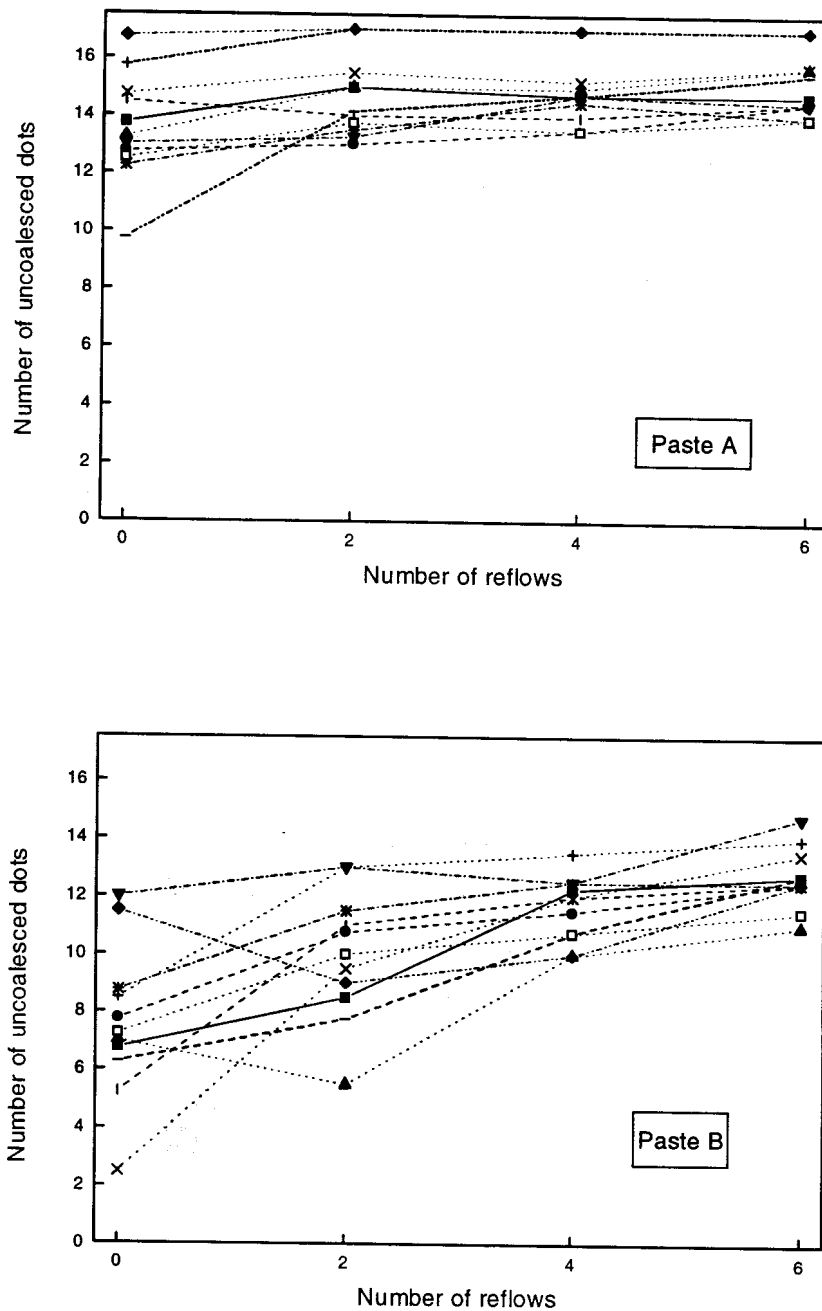


Figure 12 Pastes A and B showing a comparison of results for the solder dot analysis.

A snap-shot of three OSPs (X, Y and Z) for the 6 pastes is shown in Figure 13. The coatings show varying results. For OSPs X and Z, pastes C and D give average results compared to the other pastes. However, for OSP Y, pastes C and D give excellent coalescence of dots compared to the other pastes. This indicates that there is a compatibility issue between the pastes and the OSPs. Therefore, it is important to match the paste and the OSP to achieve the best performance.

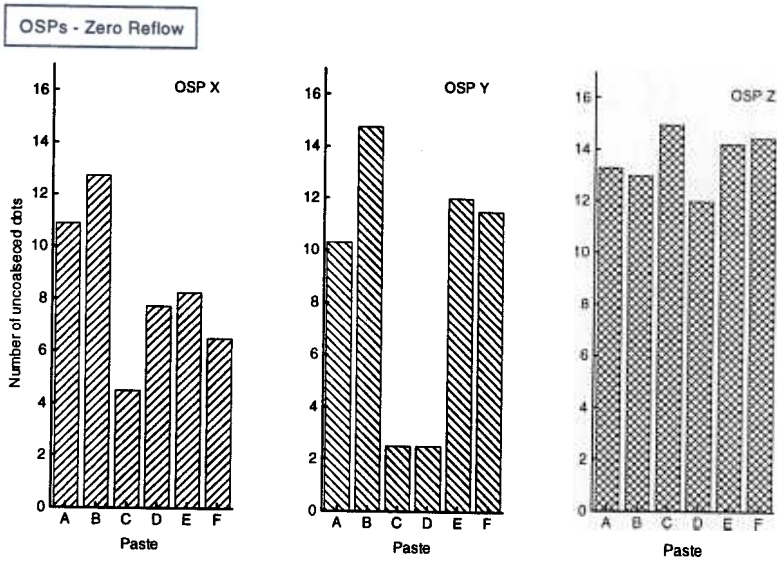


Figure 13 A comparison of three OSPs (X, Y and Z) with 6 different solder pastes at zero reflow.

In Figure 14, the 4 NiAu finishes are compared with the 6 pastes. The compatibility issue that was observed with the OSPs is not as significant with the NiAu finishes.

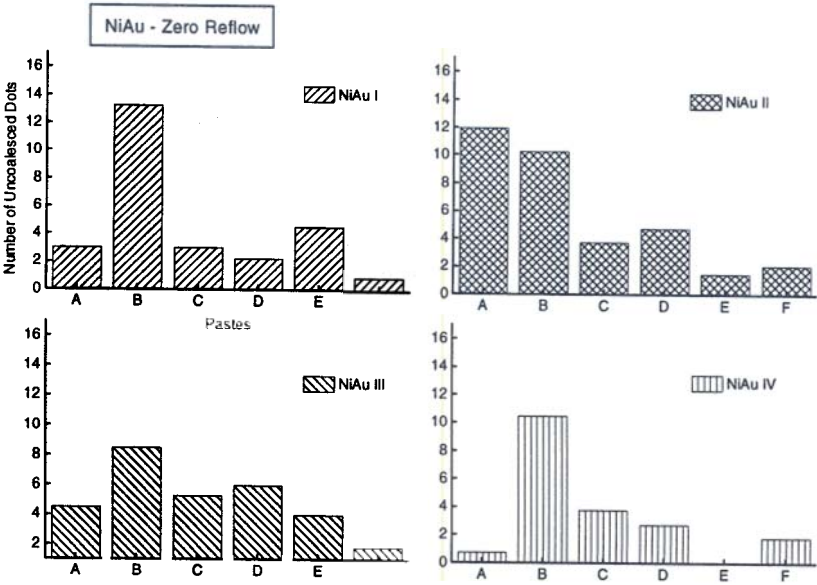


Figure 14 A comparison of the 4 NiAu finishes with 6 solder pastes at zero reflow.

2.3 Sequential Electrochemical Reduction Analysis (SERA) Results

All of the OSP coatings were reflowed for 0, 2, 4 and 6 passes and examined with SERA. The oxide state can be determined from the plateau(s) of the potential plot and the oxide thickness can be calculated from the time taken to reduce the oxide to the hydrogen potential. This reduction time is buffer solution dependent.

The time to reach the hydrogen potential was examined as a function of number of reflows using a formic buffer solution. The results are shown in Figure 15. Figure 16 shows an expanded section of Figure 15. The decrease in the value of time at one reflow compared to the zero reflow value is possibly due to the effects of polymerisation of the OSP on the first pass through the reflow oven. For one reflow and greater, a general trend of increasing time with number of reflows can be observed. This correlates with increasing oxide thickness growth.

In Figure 17, the time to reach the hydrogen potential is plotted against the number of reflows for OSP I using two different buffer solutions. The formic acid buffer solution is more aggressive than the borate solution and therefore the reduction time is reduced. This in turn reduces the sensitivity of the measurement. However, the borate solution is ineffective with many of the OSP coatings and the more aggressive formic solution is required. Therefore, there is the opportunity to match the individual OSP coating with the buffer solution, and hence improve the discrimination of the technique. This is a new technique and NPL did not have enough time to explore all of the possible buffer solutions, although this library is currently being expanded.

The results clearly show that the time to reach the hydrogen potential is increasing with number of reflows for both buffer solutions. This increase in time correlates with increasing oxide thickness. Thus, SERA is a non-destructive method that can be used to monitor solderability.

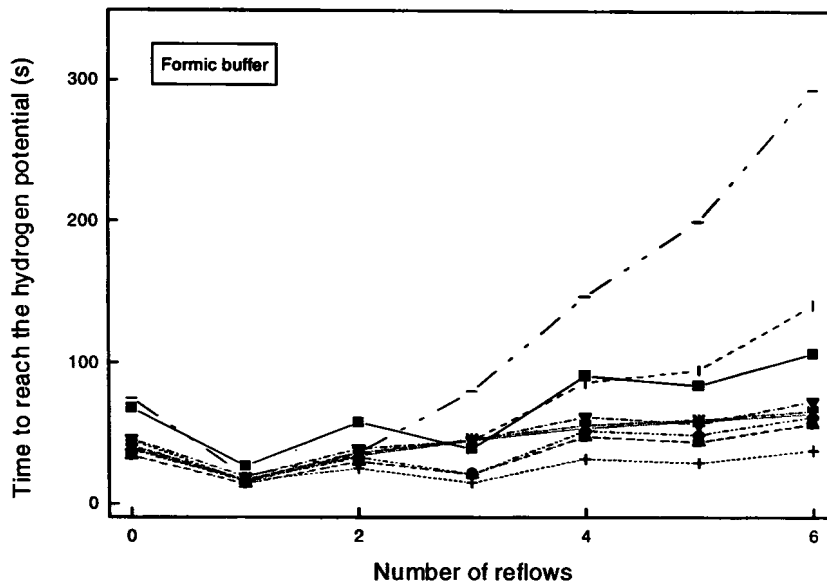


Figure 15 SERA results showing an increase in hydrogen potential reduction time with increasing number of reflows for the formic buffer solution.

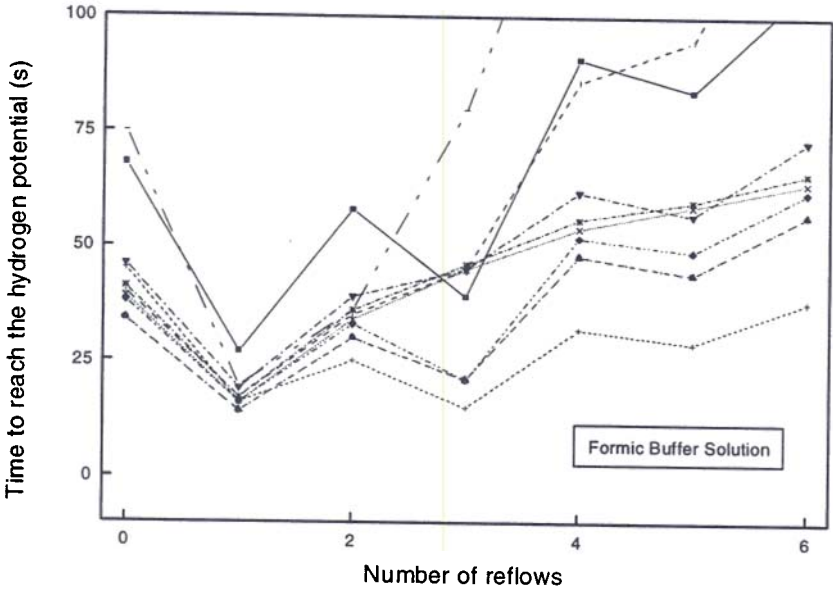


Figure 16 Expanded analysis of SERA results for formic buffer solution.

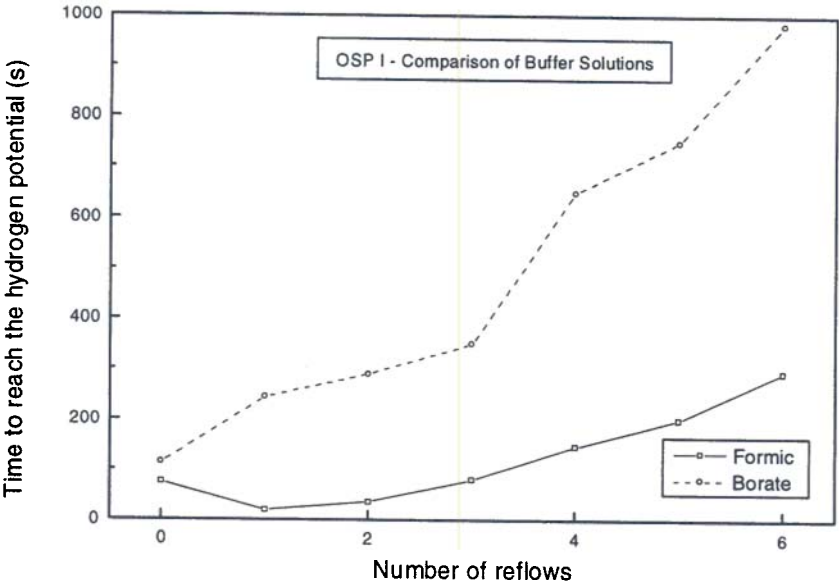


Figure 17 A comparison of buffer solutions for OSP I. The borate solution differentiates more than the formic solution for OSP I.

2.4 Yield Analysis

A limited yield analysis was undertaken for one OSP, one NiAu and one Immersion Sn coating for comparison with one solder paste. A visual inspection of the joint quality revealed one or two poor joints after 6 reflows for all of the coatings. However, it was impossible to complete a full statistical analysis since a large sample population would be required for all of the OSPs and NiAu coatings and the six pastes due to time restraints. Visual inspection of a poor joint on a board is difficult compared to inspecting the joint quality of a component. This is because the component fillet profile is easier to view than the solder pad profile.

3 Discussion

A significant number of OSP coatings performed extremely well in the study. Also, when it is considered that OSPs are low cost, planar, environmentally friendly, intrinsically cleaner than many alternative finishes and easily applied to and removed from PCBs, then the results are even more attractive. The OSP and non-OSP coatings in the study are a cross-section of both the well established and the relatively new. Further, some of the coatings have only just become available in the UK. The fact that there are several relatively new coatings may help to explain the considerable variation observed in the OSPs of the same type but from different sources. This is also a consideration for the non-OSP coatings. One or two of the immersion Sn and the immersion Ag coating are at an early stage of their product lifetime when compared to HASL and NiAu. As with any new coating, there is a high probability of not getting it right first time. This is possibly reflected in some of the test results.

The purpose of the project was to assess the robustness of the OSP coatings to multiple reflow passes and benchmark the results against non-OSP finishes. A variety of assessment techniques were used in the study to analyse the coatings. All of the techniques were able to detect the solderability deterioration of both the OSP and non-OSP coatings with increasing number of reflows. An examination of each of the techniques gives a more detailed assessment.

Wetting Balance Technique

The wetting balance is a test that allows direct solderability measurements to be made. The sensitivity of the test coupled with the ability to use any desired flux means that it is an excellent tool for assessment of PCB coatings. A disadvantage with the wetting balance is that the PCB must be sectioned. Therefore, the test is destructive.

The results from the wetting balance show several features:

First, all of the OSP and non-OSP coatings show good solderability after at least 2 reflows using Actiec 5. This flux, which is pure rosin with 0.5% halide, is a test flux and it is difficult to make accurate comparisons with production fluxes. However, Actiec 5 can be considered equivalent to a medium to high activity no-clean flux. Using the Actiec 5 after 6 reflows, 40-50% of the OSPs continued to show good solderability compared to 70-80% of the non-OSPs. Therefore, it can be concluded that some of the OSPs are as robust as many of the non-OSP finishes.

Second, a pure rosin flux, SMNA, was used to test both the OSPs and non-OSPs. SMNA is a very weak test flux and again, a comparison can be drawn with a very weak no-clean flux. The results show that the two coating types are comparable in the as-received state. At 6 reflows, however, all of the OSP coatings show very poor solderability with SMNA, with very little differentiation, whereas the results of the non-OSP finishes are spread over a wider range from good to poor solderability. From these results, it can be seen that the OSPs require a more active flux than SMNA to achieve good solderability when several reflow passes are used.

Third, the issue of coating thickness of the OSPs and its relationship with solderability was addressed. This is an important factor for the OSP coating and ranks alongside other factors such as surface preparation and pre-treatment which have a very large influence on the OSP finish. Three OSPs were represented twice in the study from two different sources. The results indicated that the two companies did not produce identical OSP coatings on the PCBs. For one OSP, the coating thickness was measured for both samples and a difference of ~300% was observed. The thickness and solderability was correlated and it was shown that the thinner coating gave significantly poorer solderability measurements. Thus, coating thickness is an issue for good solderability.

Solder Dot Technique

The solder dot method requires a non-silver finish so there is contrast for visual inspection of the dot coalescence. There is also a requirement for solder dot strips to be present on the PCB for printing of the paste. However, the technique requires no apparatus other than a stencil printer and reflow oven and has the big advantage of testing with production pastes.

The solder dot method has revealed a paste compatibility issue for the OSP coatings whereas the NiAu finishes used as a benchmark showed no compatibility effect. This dependency is not necessarily connected to the flux activity but could be a function of the flux vehicle.

Thus, the solder dot method is very effective in revealing paste and coating compatibility and individual OSP coatings should be matched with a solder paste to achieve the best results.

SERA Technique

The SERA technique is an excellent technique for testing boards. The method is non-destructive and requires a minimal area for analysis of the PCB. The results from the project show the excellent potential for the method.

The SERA results show an increase in the time to reach the hydrogen potential, and therefore an increase in the oxide thickness, that correlates with increasing number of reflows. Therefore, the SERA technique is an excellent technique for detecting deteriorating solderability. However, there is an issue of relating the SERA data to the solderability and the selection of the most suitable buffer solution. These issues need only be resolved once, and from then on interpretation and testing are straight forward.

4 Conclusions

● OSP Robustness

This study set out to qualify the robustness of OSP coatings in terms of solderability during multiple reflows. The testing showed that a number of the OSP coatings are as robust as the non-OSP metallic finishes in the study. In fact, some OSPs show no solderability degradation after 6 reflows. When it is also considered that OSPs are low cost, planar, environmentally friendly, intrinsically cleaner than many alternative finishes and easily applied to and removed from PCBs, then the results are even more attractive.

With the non-OSP finishes, there was a similar wide range of solderability values. This is reflected in the detailed wetting balance analysis of the NiAu and immersion Sn finishes.

● Test methods

All of the test methods followed the deterioration in solderability of the PCB surface as it was aged during multiple reflow passes. The various techniques clearly had different functionalities and attributes:

Wetting balance

The wetting balance gave solderability data directly and was sensitive to changes in solderability. The technique can also be used with any desired flux. A disadvantage is that the technique is destructive.

SERA

The SERA technique proved an excellent method for testing bare boards, and was non-destructive. It clearly picked up the deteriorating solderability of the finishes. However, there is a question of relating the SERA data to the solderability and the selection of the most suitable buffer solution. These issues need only be resolved once, and from then on interpretation and testing are straight forward.

Solder Dot Method

The dot method worked very well with finishes that had a non-silver colour. With the silver colour, it was extremely difficult to observe the solder spread. The technique required no apparatus other than a stencil printer and reflow oven and had the big advantage of testing with production fluxes. As a test, it is very effective in revealing paste and coating compatibility.

● Flux Dependency

The work has revealed a flux dependency of the OSP coatings, which is not necessarily connected to the activity of the flux but could be a function of the flux vehicle. Our results did show that a very weak rosin flux gave very poor performance after six reflows, whereas the Actiec 5 flux, a rosin flux with 0.5% halide, gave a range of results. The non-OSP finishes did not prove so sensitive to flux chemistry.

- **OSP Coating Parameters**

The OSP and non-OSP coatings in the study are a cross-section of both the well established and the relatively new. Further, some of the coatings have only just become available in the UK. Considerable variations were observed between coatings of the same type but from different sources. As with any new coating, there is a higher probability of not getting it right first time. One parameter is the coating thickness, and this can have a big influence on the coating robustness.

Appendix A

OSP Project Measurement Techniques

A.1 Introduction

The assessment of the OSP boards was achieved using four methods:

- (1) Wetting balance test
- (2) Sequential Electrochemical Reduction Analysis
- (3) Solder Dot Test
- (4) Yield analysis.

A.2 Wetting Balance

Test conditions were in accordance with the IEC standard 68-2-69. The tests were carried out on a Multicore MUST II. The instrument was used in the micro-balance mode. A 200mg pellet of 60/40 SnPb solder was used and the solder temperature was 235°C. The immersion speed was 1mm s^{-1} and the immersion depth was set at 0.2 mm. No preheat was used. A pure rosin flux and a rosin flux with 0.5% halide were used in accordance with IEC 68-2-20 and were purchased from Multicore Solders as SMNA and Actiec 5, respectively. A step and repeat method was used to test the five strips of the sectioned board. Figure A.1 shows a schematic diagram of the board being tested.

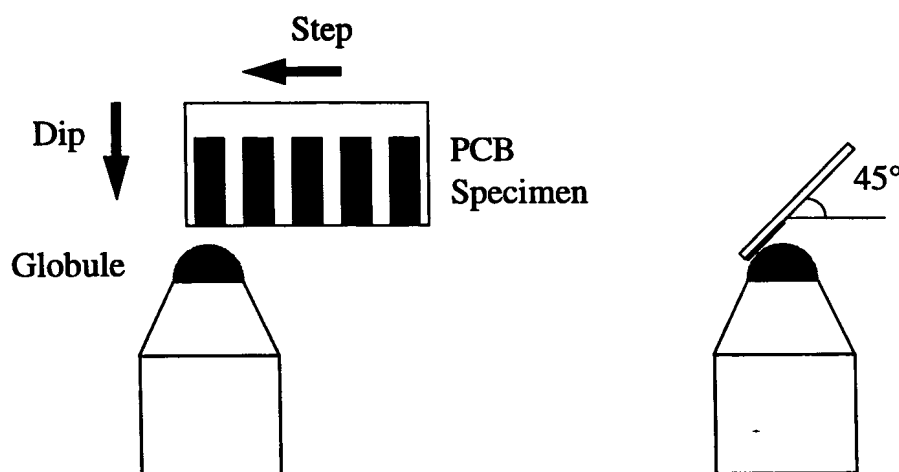


Figure 1 Schematic diagram of wetting balance test. A step and repeat method was used to analyse the five strips of the test piece.

A.2 Sequential Electrochemical Reduction Analysis (SERA)

SERA is based upon the chronopotentiometric analysis of oxides on the surface of metals. The method involves the sequential reduction of surface oxides to provide both the type and amount of each species present.

The loss of solderability of any component or PCB has been related to the type and thickness of the surface oxides on the metals. The SERA method allows a non-destructive analysis of almost any geometry including PCB pads or through-holes, electronic components, wire etc.

The principle of the SERA method, is the application of a very small, constant cathodic current, to the measured part situated in a deaerated buffer electrolyte, via an electrode. The cathode voltage is monitored with respect to a reference electrode as a function of time. The resulting curves are used to assess the solderability of the measured part. Figure A.2 shows a schematic diagram of the SERA system.

Figure A.3 (solid line) schematically illustrates the features normally observed for the chronopotentiometric reduction of oxides. The curve shows the change in measured potential as a function of time (charge) for Sn-Pb coatings on a copper substrate. For the ideal case of well-defined surface compounds, the potential rapidly decreases initially to a first plateau corresponding to the most easily reduced species. After the first species is fully reduced, the potential again decreases to the value required to reduce the next species. The process is repeated until all of the oxidised species on the surface have been reduced and the hydrogen evolution potential is reached [1].

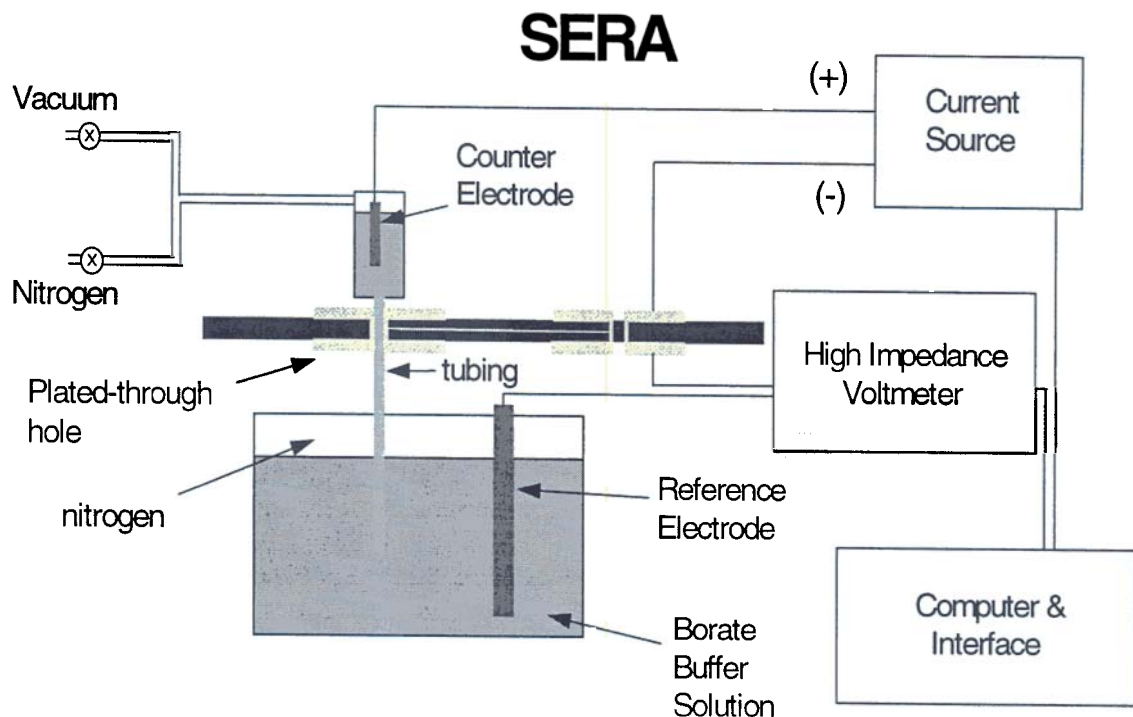


Figure A.2 Schematic diagram of SERA system analysis of plated-through hole.

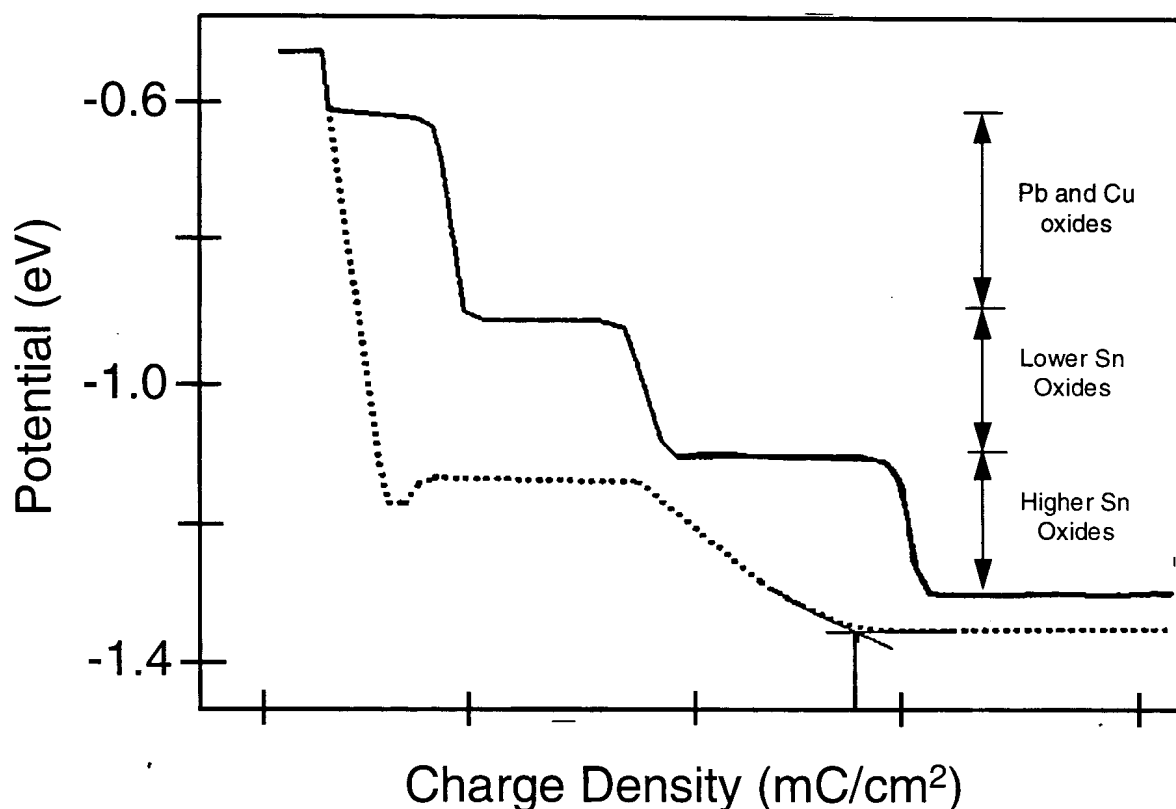


Figure A.3 Schematic representation of SERA curve for a Sn-Pb coating on a copper substrate.

Thus, a plot of potential vs time yields a series of plateaus corresponding to sequential reduction of the species on the surface. The potential of the plateau reflects the nature of the species and the passed charge is a measure of the amount of the species present.

Negative peaks sometimes occur and have been found to correspond to a duplex oxide ($\text{SnO} + \text{SnO}_2$) structure, involving an outer layer of SnO_2 that must be reduced before the reduction of the predominantly SnO underlayer. The dashed line of figure A.3 shows a real reduction curve, showing a negative peak. Table A.1 shows reduction potentials for the species that are relevant to the OSP study.

Potential	Feature	Oxide (probable formula)
-0.35	Flat plateau	Copper (Cu_2O)
-0.60	Flat plateau	Copper (CuO)

Table A.1 Reduction potentials for oxide species relevant to the OSP study.

Solder Dot Testing

The solder dot method involves solder paste dots printed on a copper track with the dot spacing increasing along the copper strip. Figure A.4 shows a schematic of the solder paste dots printed on the copper strip. When the sample is passed through the reflow oven, a number of the dots will coalesce. The number coalesced will relate to the solderability of the coating. The study correlates the number of uncoalesced dots as this is visually easier to view.

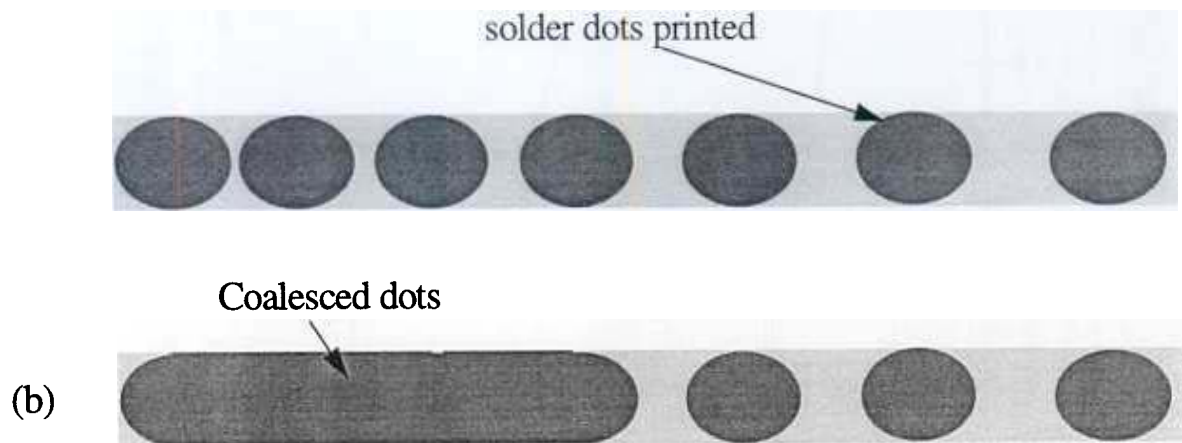
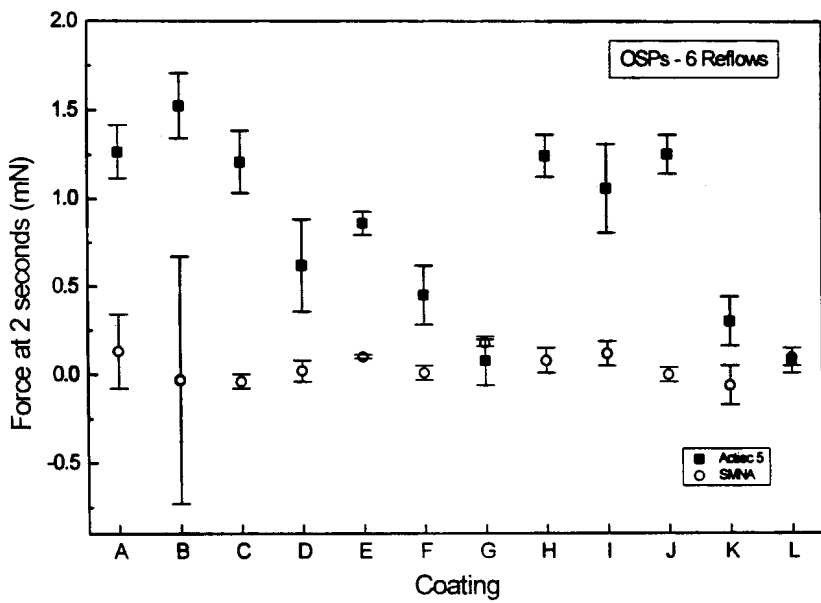
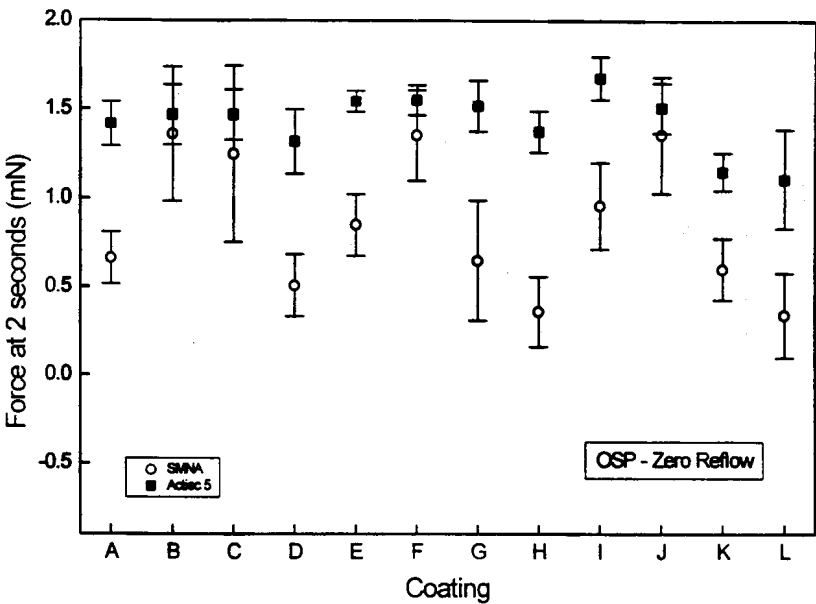
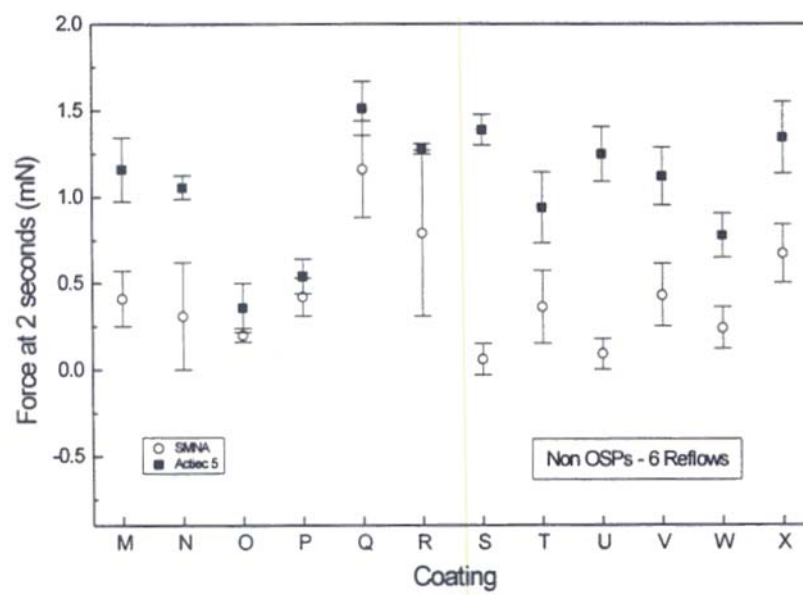
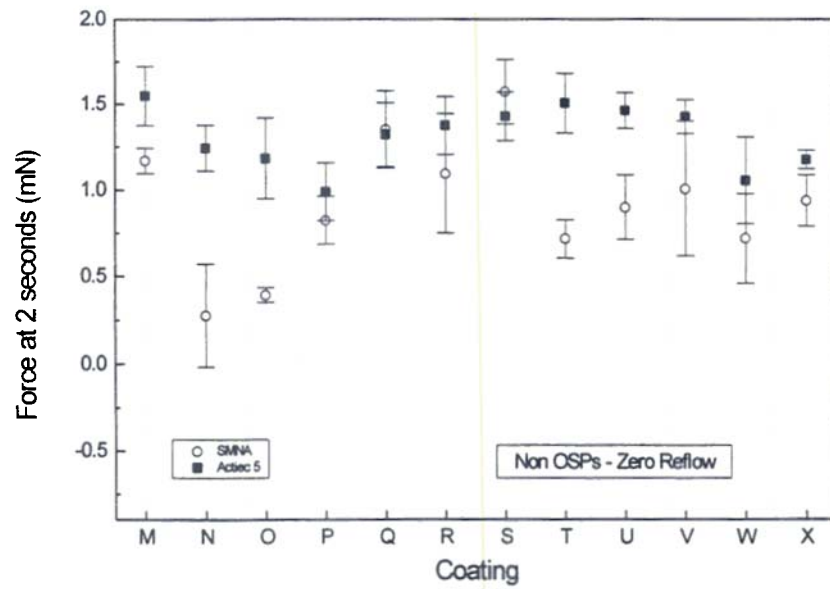


Figure A.4 (a) Solder Paste dots printed on the copper track (b) After reflow, a number of the dots have coalesced.

Appendix B

Wetting Balance Flux Comparison Results





Appendix C

Solder Dot Analysis Results

