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Comparison of Rosin Fluxes

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Abstract:
This article will present results of activity testing of rosin fluxes. A good solderability of a component output and a soldering pad of PCB are important for the creation of a quality joint. Since it supports a melted solder wetting on a soldered surface, a flux has a definitive influence on the creation of a quality joint. Further, it removes oxides and other impurities from soldering alloys and prevents from a creation of a new oxide layer during soldering. According the technology of a solder joint creation, a flux is added into the soldering process in different ways. The aim of the test was to select a rosin flux having with the solder tube the best results during soldering of the copper surface on PCB's. Fluxes were compared by the help of two different tests. The first trial was carried out by the area of spread method, since this test is suitable for solderability testing of materials and comparison of a flux activity. The wetting balance test was chosen as the second trial. This method enables to measure the wetting force affecting the tested sample. Curves of wetting forces are the test result serving for comparison of single fluxes.

INTRODUCTION

Solderability is one of the most important properties of components and printed circuit boards in electronic assembly. Therefore, it is very important to test this property. Due to the test, it can be found how the surface is solderable and wettable by a solder. For a high quality solder joint creation, a good solderability of a component pin and a printed circuit board surface is important. For solderability testing of printed circuit boards, a lot of types of tests have been developed. The most commonly used test is the wetting balance test through which dependence of a wetting curve on time is measured. The next most commonly used test is the area of spread method where the extent of a reflowed solder ball on a copper surface is observed. Good solderability is necessary for a high quality solder joint creation thus a clean surface of connected parts without oxides is required. To remove oxides from soldered surfaces, a sufficiently active flux helps. Therefore a proper choice of a flux influences the soldered joint quality.

PARAMETERS OF THE EXPERIMENT

For the tests, seven different kinds of resin fluxes delivered in a solid state were used. Each flux was weighted and dissolved in isopropyl-alcohol for the application on the surface of printed circuit boards. The weight rate for dissolving was 3:1. All fluxes were according to ČSN EN 29454-1 type 1.1.2.B (solid state of natural rosin activated by halides) or type 1.1.3.B (solid state of natural rosin activated without halides) [5]. Marking of single types of fluxes is Flux A, Flux B, Flux C, Flux D, Flux E, Flux F and Flux G.

The lead-free solder alloy SAC305 was chosen for the test. This is one of the most commonly used solder alloy. Its weight compound contains 96,5% of tin, 3% of silver a 0,5% of copper. The melting temperature of this alloy is 217 °C. Wetting balance test was applied with lead solder alloy SnPb40 for the better comparison of rosin fluxes. Its weight compound contains 60% of tin and 40% of lead. This alloy has the smaller melting temperature. The melting temperature of this alloy is 183 °C.

Wetting balance test

Activity of seven different kinds of resin fluxes were compared via results of solderability tests. Tests were carried out by using of MUST System II the wetting solderability tester. This method allows measuring of the wetting force affecting the tested sample. The results of the tests are wetting forces which are used for comparison of single types of fluxes.

Testing procedure consisted in immersion of a tested sample in a bath of molten lead-free solder alloy SAC305. Test sample was a copper wire with the diameter of 1 mm and a length of 1.5 cm (Fig. 1). On each tested sample, one of the fluxes was applied before immersion into the molten solder. During the test, five samples tested for each type of flux. From the five measured values for one type of a flux, average value was always calculated due to better results evaluation. The procedure of wetting balance test and the wetting force chart is illustrated in Fig. 2.

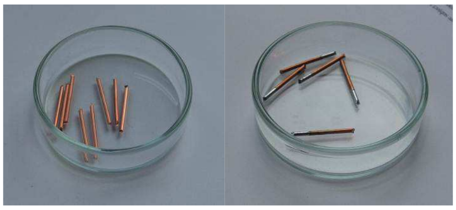

Fig.1:Tested samples

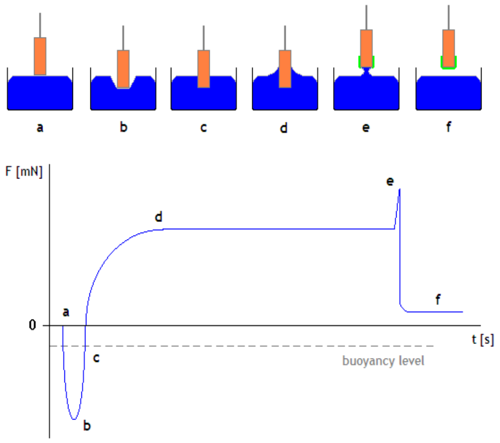

Fig.2: Procedure of wetting balance test

In order to oxidize the surface of the samples, another factor that had been selected for comparison of flux activities was exposure of the tested samples to accelerated aging. The noticeable difference in the activity of individual fluxes should be observed. Prior to testing, half of the samples were exposed to accelerated aging in hot air at 125 ° C for 72 hours. After removal from the hot furnace, the samples cooled to ambient temperature and then tested in the same way as the samples which were not exposed to accelerated aging.

Test parameters for SAC305 alloy [6]:

- bath temperature: 245 °C
- immersion speed: 20 mm/s
- test time: 10 s
- immersion depth: 2 mm

Test parameters for SnPb40 alloy [6]:

- bath temperature: 235 °C
- immersion speed: 20 mm/s
- test time: 10 s
- immersion depth: 2 mm

Area of spread method

The most soldered surface for PCB is copper, therefore it was chosen for this test. The samples were made of printed circuit boards with dimensions of 25 mm x 15 mm and thickness of 0.6 mm. Copper theme was on each coupon from both sides. Each side of the coupon contained six boxes with dimensions of 3 x 6 mm. The test coupon is shown in Figure 3.

Fig.3: Testing coupon

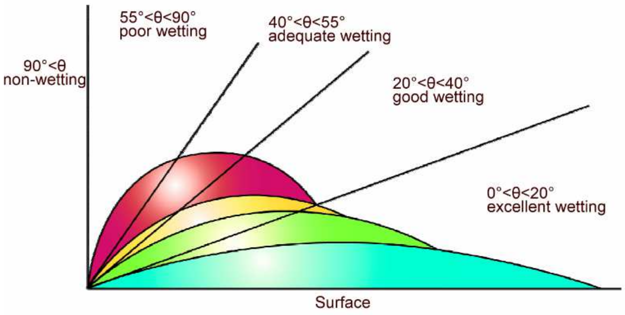

Fig.4: Evaluation of wetting ange

For the test, the same lead-free solder alloy SAC305 was used. But it was used in a form of solder ball with diameter of 500µm. On the tested coupon, it was applied a flux and a solder ball of SAC 305 alloy. The flux was applied by dipping of the tested PCB into the prepared solution. The prepared sample consequently re-melted in hot vapors at the temperature of 230°C. The soldered samples were measured by using a microscope to find out dimensional parameters. Size of melting of each ball was measured in axis x, y (d1, d2) and height (h) was measured by using a micrometer. From the measured values of diameters d1 and d2, average value d was calculated for each ball. As assumed, solder balls of defined diameters melted into a spherical cap. From the geometric dimensions of a spherical cap, the contact angle θ was calculated according to equation 1. The sample has a good wettable surface for the contact angle between 0° to 55°, poorly wettable surface for angle between 55° to 90°, and non-wettable surface for contact angle greater than 90° (see Fig 4). [1]

$$\theta = arctg\left(\frac{4dh}{d^2 - 4h^2}\right) \tag{1}$$

MEASUREMENT RESULTS

Wetting balance test

As mentioned above, the principle of the method of wetting balance test consists in immersing into a bath of molten solder and consequent observation of forces affecting the sample.

Figure 5 presents the results of measured wetting forces for individual types of fluxes for the samples.

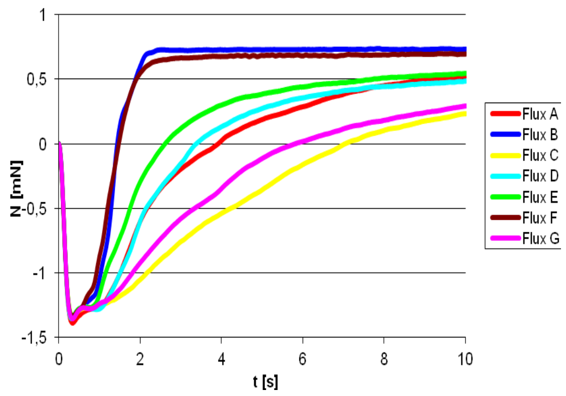

Fig.5: Wetting force curves with SAC305

Figure 6 presents the results of measured wetting forces for individual types of fluxes for the samples with solder alloy SnPb40.

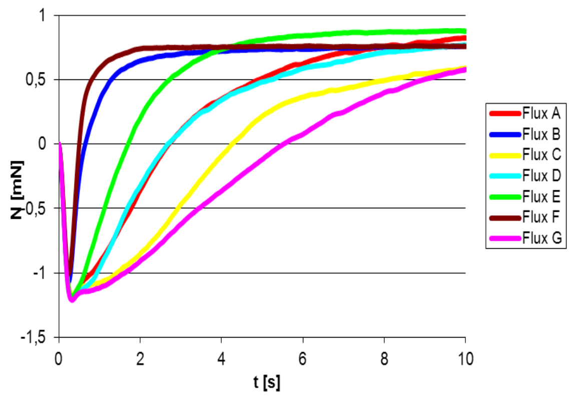

Fig.6: Wetting force curves with SnPb40

Figure 7 presents the results of measured wetting forces for individual types of fluxes for the samples were not exposed to accelerated aging.

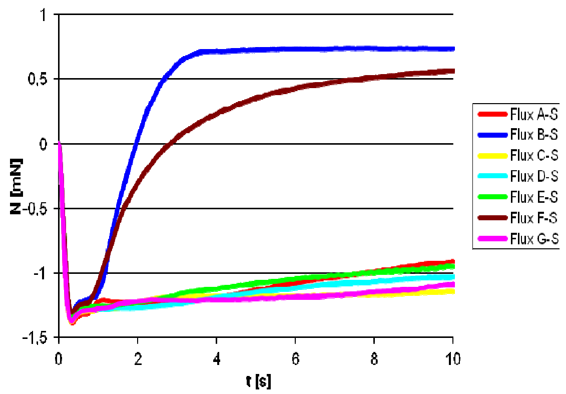

Fig.7: Wetting force curves - the samples were exposed to accelerated aging

Area of spread test

For each flux, six reflowed ball were measured and the results are calculated as the arithmetic mean of measured dimensional parameters. The ball was always photographed. The illustration of reflowed balls can be seen in Figure 8.

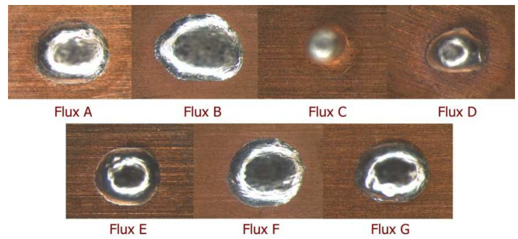

Fig. 8: Illustration of reflowed balls

Average values of dimensions of reflowed balls and calculated values of contact angles are published in Table 1.

Tab. 1: Dimensions of reflowed balls and contact angles

Flux	Diameter [µm]	Height [µm]	Contact angle [°]
Flux A	841,25	185,75	47,65
Flux B	968,75	164,75	37,57
Flux C	457,50	416,75	57,52
Flux D	595,00	310,75	87,50
Flux E	581,25	353,25	78,89
Flux F	940,00	163,25	38,31
Flux G	803,75	256,50	65,10

Graphical illustration of the size of calculated contact angles is shown in Figure 8.

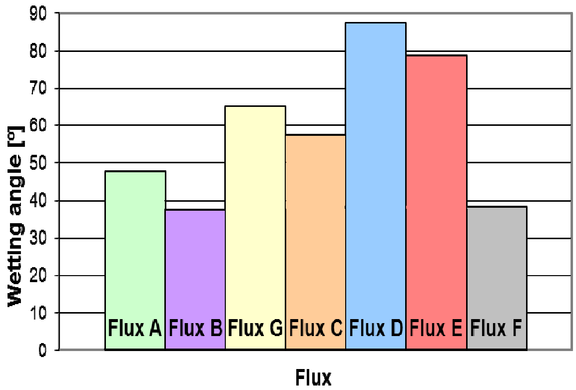

Fig. 8: Graphical illustration of contact angles

CONCLUSIONS

From the results of measured values of the wetting balance test (Fig. 3 and 4), it is shown that the greatest activity thus the best course of the wetting force reached the flux marked as Flux F. For this flux, the wetting force reached the greatest values in both types of samples. Next flux which showed a good wetting of the surface of the PCB by the solder alloy in all samples is the Flux B. The graphs also show that the worst fluxes are Flux C and Flux G. Further, it can be seen a slower increase of the wetting forces for all aged samples which is due to the oxide layer. This layer was not sufficiently removed by any flux except Flux F and B. The same results were obtained with SnPb40 as well as with SAC305 solder alloy during wetting balance test.

From the calculated values of contact angles of the area of spread test, the most convenient fluxes appear to be Flux F and B. When using these fluxes, the wetting of the surface of a tested PCB by the solder alloy is good. On the contrary, the PCB surface seems to be poorly wetted when using fluxes D and E. These two types of fluxes are only suitable for the use on an easily solderable surface of the PCB.

Comparison of the results of both test methods confirmed that the most active fluxes were Flux B and F. Its results were the best in both tests. When comparing results of the other fluxes, it is possible to find differences in the results of both tests. It may be due to the suitability of wetting balance test for the solderability testing of components and PCB designed for the wave soldering. Conversely, the spread-area test is preferable to use for the reflow technology and preheating affects the function of a flux in both types of soldering technologies. It is not taken into consideration in this study.

ACKNOWLEDGMENTS

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