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MECHANICAL BEHAVIOR OF SMD SOLDER JOINT SOLDERED UNDER NITROGEN ATMOSPHERE

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Anotace:
Main aim of this work was investigate mechanical behavior of SMD soldered under nitrogen atmosphere. Several concentrations of nitrogen in soldering area were used. Shear force was established as mechanical parameter for describing of reliability of solder joint. Different sizes of SMD (0402, 0805 and 1206) were assembled on sample made from FR4 base material with HAL surface finish. Optical and X-Ray inspection were used for determination of reason of solder joint mechanical behavior.

Hlavním cílem této práce bylo prozkoumat mechanické chování SMD zapájených v dusíkové atmosféře. Bylo použito několik koncentrací dusíkové atmosféry. Střihová síla byla stanovena jako parametr pro určení spolehlivosti pájeného spoje. Různé velikosti SMD (0402, 0805 a 1206) byly připájeny na vzorku skládajícího se ze základního materiálu FR4 s povrchovou úpravou HAL. Pro analýzu a zjišťování příčiny chování pájeného spoje byla použita optická kontrola a inspekce pomocí rentgnenu.

INTRODUCTION

Solderability depends on many variable factors. The main factors here are the surface finish of PCB and component terminals, the type of flux and solder alloy, the temperature profile and the surrounding atmosphere during the soldering process. This article focuses on the study of the influence of ambient and atmosphere during the soldering process. It is known that one of the main reasons of poor solderability is the presence of oxygen. Reduced oxygen concentration can increase wetability of melted solder [1], activity of the flux, etc., which results the improvement of the reliability [2], [3]. Nitrogen is common used for establishing of inert atmosphere in the soldering process. Mechanical behavior of solder joint is also changed. Paper [4] describes better mechanical parameters achieved by soldering in inert atmosphere, for example higher shear forces of surface mounted devices (SMD's).

The main aim of this work was investigation of mechanical properties of solder joint soldered under nitrogen atmosphere.

METHODOLOGY

Test vehicle

In the first time, there was done design of the samples (Fig 1). Samples used for this work was fabricated in dimensions 50 x 50 mm and with surface finish HAL. Sizes of solder pads were designed as solder mask defined (SMD). It was suggested due to minimization of impact on destructive shear test. Different sizes of SMD (0402, 0805 and 1206) were utilized in 10 pieces per sample (Fig 1.). SMD's were placed in two rows for each size on the different location on the sample. It is drawn on the Fig. 1. Solder paste used for the SMD attachment was SCANGe071-T3 (Cobar).

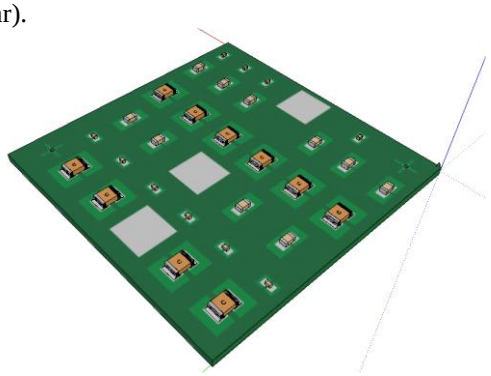

Fig. 1: Illustration of test vehicle with soldered SMDs

Equipment and methodology

First important device, which was used for the solder printing, was stencil printing semi-automatic machine Uniprint GO3V (Fig. 2). This machine, intended for solder paste deposition, have significant facilities as speed of stump, cameras for the matching, etc. After deposition of solder paste, SMT Manipulator taken place for assembling of SMD's and special soldering station (Fig. 3) was used for reflowing of solder paste. Main purpose of reflow soldering device was soldering under different nitrogen atmosphere. More information about soldering station is described in [4]. Concrete concentration of nitrogen inside station was established by oxygen analyzer Zr-Ox MKII

Ridzewski GmbH. Fabricated samples were Mechanical tests were provided by DAGE PC2400. For optical inspection were used microcope Carl Zeiss Jenavert and X-Ray machine.

Fig. 2: Semiautomatic stencil printing machine Uniprint GO3V

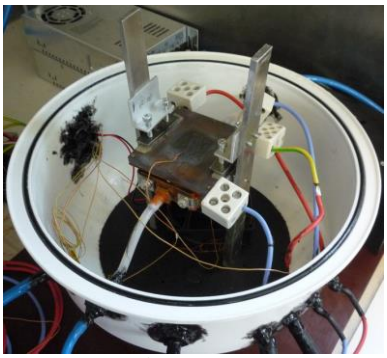

Fig. 3: Reflow soldering station

RESULTS

Shear force

Shear force was measured during destructive test. Head with tool for shear test had moved at speed 50µm/s. Height of tool from substrate was 50 µm for SMD0402 and 100 µm for SMD0805 and SMD1206.

On the Fig. 2 is graphical representation of the results for SMD0402. Shear force is Y axe and concentration of nitrogen atmosphere is X axe. Trend of the shear force had falling character due to increasing of the nitrogen atmosphere.

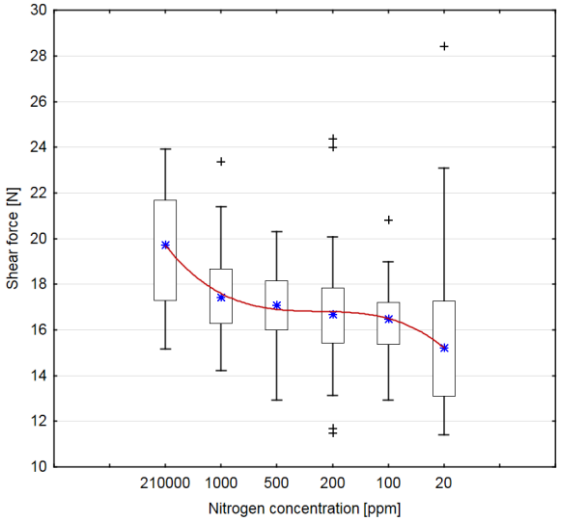

Fig. 4: Dependence of SMD 0402 shear force on the nitrogen concentration

Dependence of SMD 0805 shear force on the nitrogen concentration is shown on Fig. 5. There is same behavior like in figure 4. Shear force is slightly falling with rising of nitrogen atmosphere. Excessive values for samples soldered in 1000ppm nitrogen atmosphere were occurred probably during destructive shear testing.

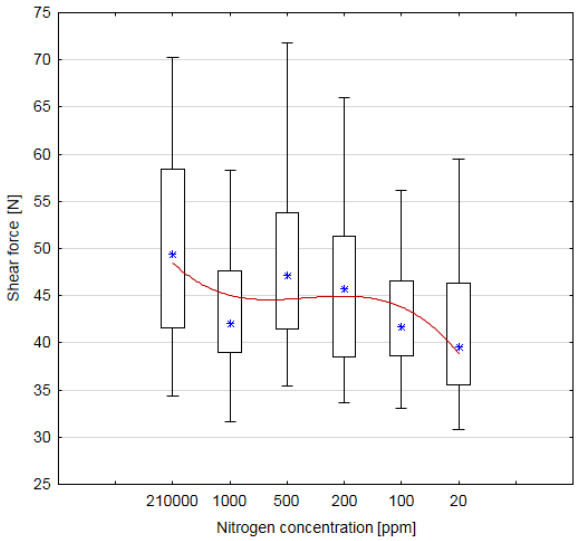

Fig. 5: Dependence of SMD 0805 shear force on the nitrogen concentration

Dependence of shear force and nitrogen atmosphere for SMD1206 is described in Fig. 6. There is not proven influence of changing nitrogen concentration on the shear force.

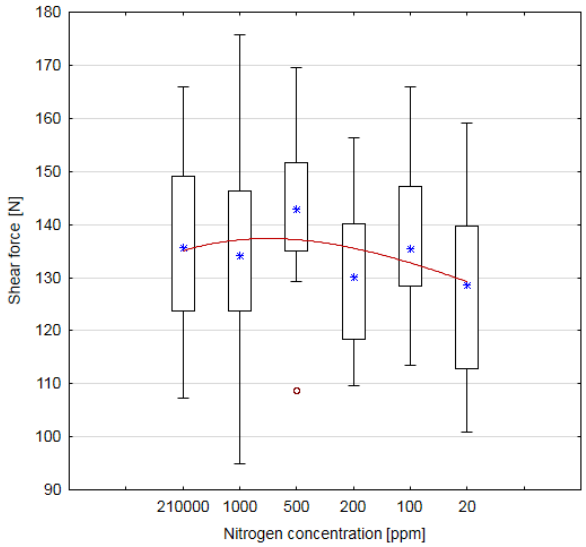

Fig. 6: Dependence of SMD 1206 shear force on the nitrogen concentration

Optical inspection

Fig. 7 shown photos of SMD1206 soldered under normal atmosphere (left) and under 100ppm of nitrogen atmosphere (right). Photos point to causes thermal stress during soldering under normal atmosphere (210000ppm). Thermal stress rises due to higher concentration of oxygen in process atmosphere. Flux was burned more in the normal atmosphere than in the nitrogen.

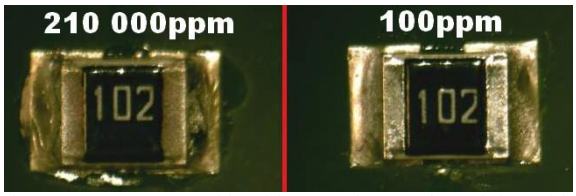

Fig. 7: SMD's (1206) soldered in normal atmosphere (left) and in 100ppm nitrogen atmosphere (right)

X-Ray was used for inner inspection of structure of the solder joint. On the Fig. 8 are shown photos of voids in solder joints of SMD soldered in normal atmosphere (left) and in 20ppm nitrogen atmosphere. Smaller amount of voids was indicated in solder joints soldered under nitrogen atmosphere. These photos can explain the shear force behavior too, it is probably due to design of solder pads on the PCB, better wetting caused smaller amounts of solder in area near SMD solder joint (Fig. 3).

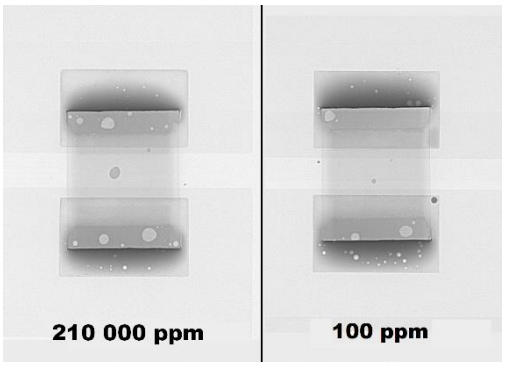

Fig. 8: X-Ray inspected SMD's soldered in different nitrogen atmosphere

CONCLUSIONS

Solder joint mechanical behavior (shear force in this case) is depended on the nitrogen atmosphere. When concentration of nitrogen is increasing shear force is decrease. A step gradient of shear force is changing more slightly with increasing of SMD size. SMD 1206 had not uniform course of shear force. Therefore, the using of nitrogen atmosphere during soldering of smaller SMD's is crucial

For better understanding of this shear force behavior there will be done more tests. Changes in the solder joint structure for different concentration of nitrogen in atmosphere can be investigated in the next work.

ACKNOWLEDGMENTS

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