INFLUENCE OF MECHANICAL STRESS ON PROPERTIES OF LEAD AND LEAD FREE SOLDERED JOINTS

Karel Dušek, Jan Urbánek

Department of Electrotechnology, Faculty of Electrical Engineering, Czech Technical University in Prague, Technická 2, 166 27, Prague 6, e-mail : dusekk1@fel.cvut.cz, urbanek@fel.cvut.cz

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Abstract: *This article deals with mechanical stress of the lead and lead free soldered joints. Soldered joint have influence on total quality of electronic assembly equipment (electronic assembly equipment on PCB – print circuit board). Mechanical tests are mainly used for resistance evaluation of components, parts and whole products against mechanical stress, which is applied on objects during function, transport and storage. Mechanical stress also changes electrical properties of the soldered joints, such as electrical resistance. Mechanical stress could cause the occurrence of cracks on the surface of the soldered joints. Proportions and frequency of cracks is possible evaluation by the image analysis.*

1. INTRODUCTION

Current pressure on limitation and eventual exclusion of lead from used materials of the soldered joints means searching ecologically, technically and economically acceptable lead free solders.

Mechanical tests are mainly used for resistance evaluation of components, parts and whole products against mechanical stress, which is applied on objects during function, transport and storage. Mechanical stress is caused by external forces that have been applied on the object. In practice, low mechanical resistance of products is one of the most frequent problems. That's why an investigation of mechanical stability and resistance is very important.

2 MEASUREMENTS AND EXPERIMENTAL RESULTS

For samples we used PCBs (printed circuit board) of the same properties. On PCBs ware applied lead (Sn62Pb36Ag2) and lead free solder paste (Sn96Ag2). Samples were set up by SMD resistors (1206, 0Ω). All the samples were put into a continuous furnace with the temperature profile, which is shown in figure 1. Both solders – lead (Sn62Pb36Ag2) and lead free (Sn96Ag2) were reflowed.

Before mechanical stress was applied on the samples electrical resistance of the soldered SMD resistors had been measured by tetra-point method. Compared to values in measurements with lead solders the values of the electrical resistance of SMD resistors soldered by lead free solder was on average 2mΩ higher.

In the figure 2 is the way of mechanical stress of the sample. One side of PCB is hold tightly and the other side of PCB is oscillated with the amplitude dl.

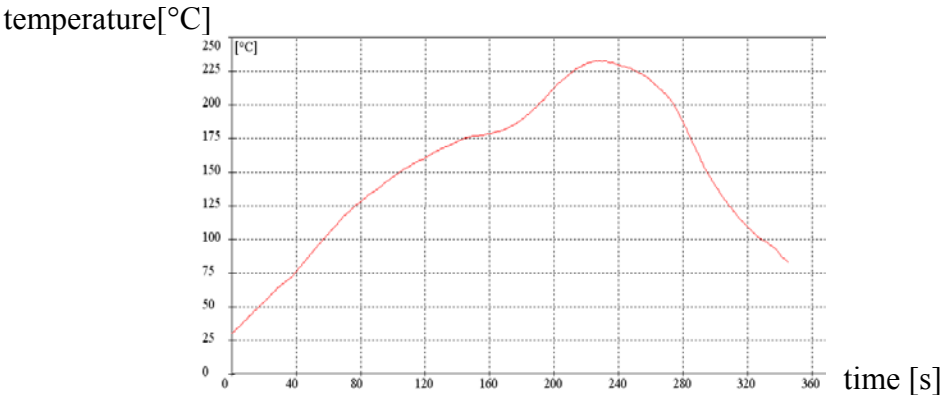

Fig. 1: temperature profile of the continuous furnace

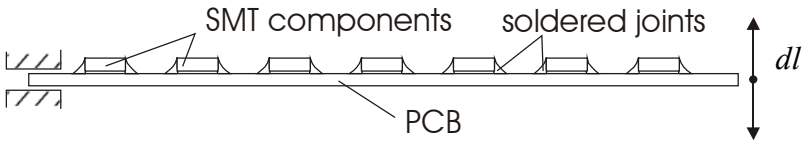

Fig. 2: mechanical stress of the sample

In the figure 3 is the graphical dependence of change of electrical resistance on oscillations number applied on samples with lead (Sn62Pb36Ag2) and lead (Sn96Ag2) free solder with the amplitude 1 cm. From the graph is perceptible that value of electrical resistance increase with increasing number of oscillations applied on samples with lead and lead free solder. Increasing number of oscillations or increasing amplitude can also cause disconnection of the electrical conductive way.

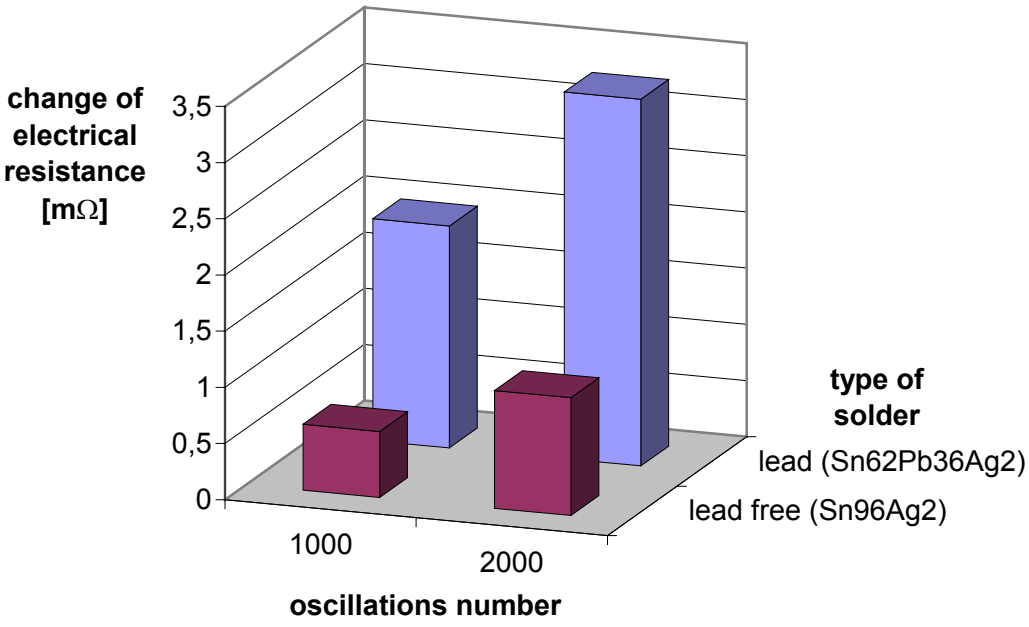

Fig. 3: dependence of change of electrical resistance on oscillations number applied on samples with lead (Sn62Pb36Ag2) and lead (Sn96Ag2) free solder with the amplitude 1 cm

We have also done image analysis of the soldered joints. In the first step images ware created by a microscope and digital camera. Each image was made several times with a different focus depth. The next step is creation of a sharp image via software. The sharp image is created from the sequence of images with different focus depth. For creation of the sharp images and for image evaluation we used LUCIA IMAGE software with EDF (extended focus depth) module.

In the figure 4 is an example of soldered SMD resistors before mechanical stress.

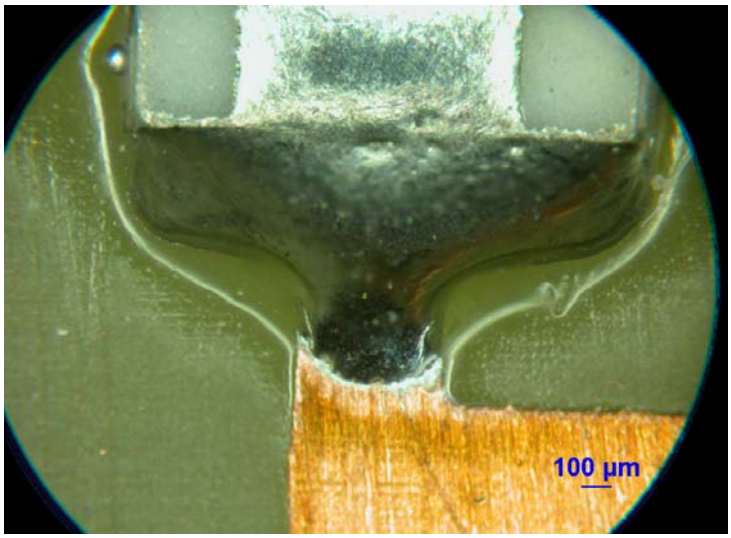

Fig. 4: mechanical stress of the sample

In the figure 5 is an example of soldered SMD resistors after mechanical stress, when amplitude *dl* was 1.6cm and the number of oscillations was 2000. From the figure of the stressed joint is perceptible longitudinal crack between SMD component and soldered connection. And there is also perceptible difference between surfaces of the soldered joints before and after mechanical stressed.

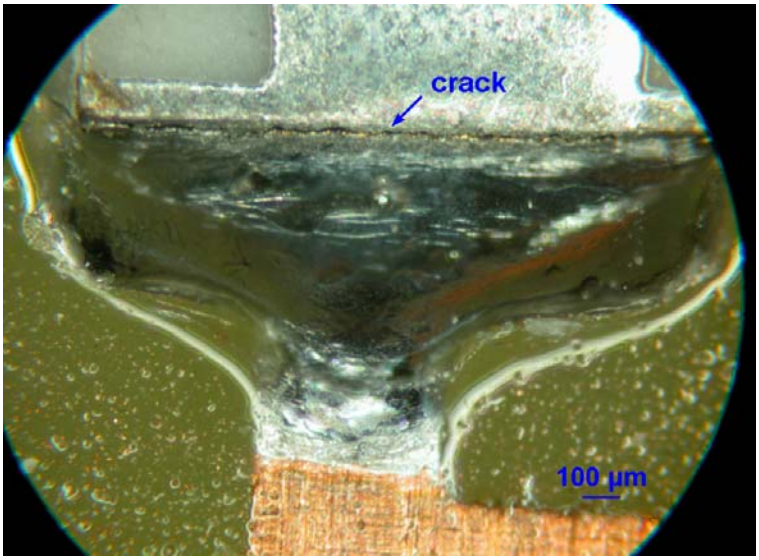

Fig. 5: mechanical stress of the sample

In the figure 6 is a detail of the longitudinal crack from the previous figure. Width of the crack is 17,1 μm. This longitudinal crack causes disconnection of the electrical conductive way.

Cracks could influence other electrical properties like: noise or non-linearity of voltage and current characteristics.

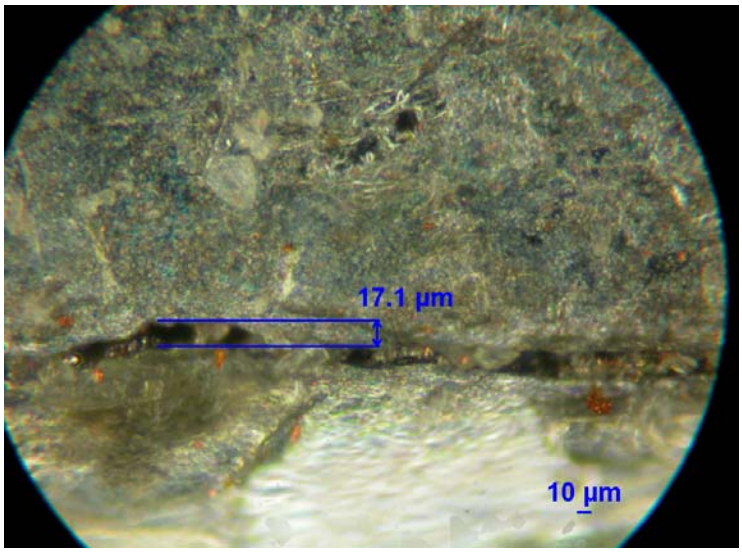

Fig. 6: mechanical stress of the sample

3 CONCLUSIONS

Mechanical stress applied on the samples could cause the occurrence of cracks on the surface of the soldered joints. Proportions and frequency of cracks depend on the number of oscillation and on amplitude *dl.* Proportions and frequency of cracks is possible evaluation by the image analysis.

Mechanical stress also changes electrical properties of the soldered joints, such as electrical resistance. Electrical resistance of the soldered joints increases with increasing oscillations number or amplitude *dl*.

The value of the electrical resistance of the lead free (Sn96Ag2) soldered connection is higher than the value of the electrical resistance of lead (Sn62Pb36Ag2) soldered connection. Nevertheless the influence of mechanical stress on the value of the electrical resistance is more perceptible at the lead solder. Too strong mechanical stress can also cause disconnection of the electrical conductive way.

Moreover, we can also evaluate conductive adhesives in the same way.

4 ACKNOWLEDGEMENT

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