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Mechanical Testing of Joints Glued/Soldered on Textile Ribbons

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Abstract:
This paper deals with the assembly of SMD chip resistors onto a conductive textile ribbon by soldering or gluing. The main goal of our research was to verify the reliability of joints after jerk testing of ribbons. The results showed that soldered / glued joints on electrically conductive textile ribbon are reliable during jerking test until the destruction of whole ribbon and electrical resistance of joints is low and stable until this destruction during extreme jerking.

INTRODUCTION

Nowadays, wearable smart textiles are growing and promising field of electronics. These textiles are used in many innovative applications such as safety elements, health care or well-being, sports and also it is a field of research in the current papers, e.g. [1]–[5]. Smart textile electronics have a few important properties, e.g. flexibility, stretchability, reliability, wearing comfort and also electrical properties. One of the possible material for using in smart textiles are electrically conductive ribbons. These ribbons are flexible, stretchable but it is necessary to find reliable method for electrical connection of components onto the ribbon. The soldering or gluing by non-conductive adhesive are promising methods founded in our previous experiments. The reliability of joints prepared by these methods during the fast stretching (jerk test) of ribbons is a question which has to be solved.

MATERIALS AND PROCEDURES

The electrically conductive textile ribbons with Ag coated Cu conductive wires and 10 SMD chip resistors (0 ohm) with size 1206 for each sample were used in the experiment. The electrically non-conductive UV curable adhesive was used for electrical connection of components onto ribbons. The electrical connection is made by the direct contact of a component leads with conductive sewing thread in the ribbon, see Figure 1.
Also hand soldering with tin-bismuth solder paste was used for some samples. Also stretching of ribbons during gluing/soldering to 150% of relaxed length was used for some samples. In the experiment, four different types of samples were used (soldered - S, soldered stretched - SS, glued - G, glued stretched - GS).

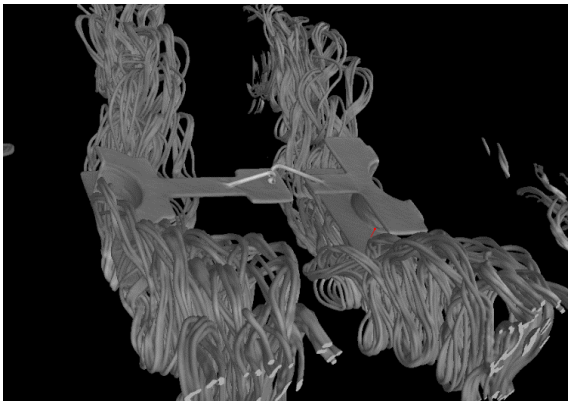

Fig. 1: The detail of SMD component glued by non-conductive adhesive onto the conductive ribbon from X-RAY device.

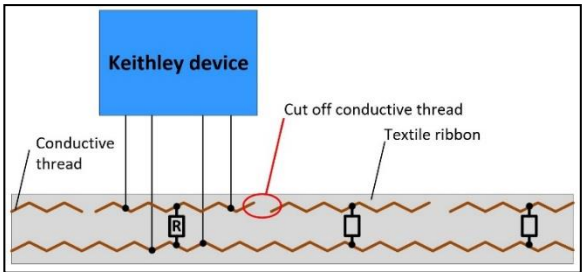

Fig. 2: The principle of electrical resistance measurement.

Firstly, the electrical resistance was measured by four-point probe method with the Keithley 2700 device connected by special designed tool (see Figure 2) for each sample (measured electrical resistance is sum of two joints resistance plus one “0 ohm” resistance). The principle of measurement can be seen in Figure 3.

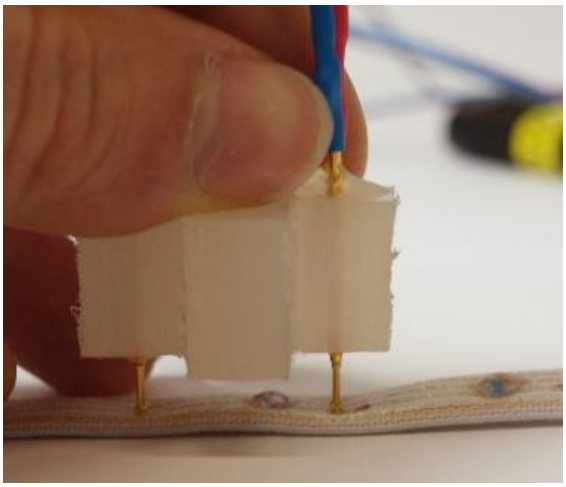

Fig. 3: The special designed tool manufactured at our Department of Materials and Technology

After the electrical resistance measurement, the jerk test was realized. For the test, ribbon was fixed to the holder on upper side, the weight was connected to the ribbon on lower side and was hold in starting position (i.e. relaxed length of ribbon), see Figure 4. In the next step, the weight was released and fell down to maximum point of stretching which caused jerking of ribbon (i.e. 1 cycle), see Figure 5. Firstly, 10 cycles with 500 grams weight was used (maximum point of stretching was 165% of relaxed length). Then 10 cycles with 1000 grams weight was used (maximum point of stretching was 210% of relaxed length). Then, 10 cycles with 2000 grams weight was used (maximum point of stretching was 240% of relaxed length). Finally the 4000 grams weight was used until the disruption of samples (maximum point of stretching was 240% of relaxed length), see Table 1.

Tab 1: The settings of jerk test.

Weight	Number of cycles
500 g	10x
1000 g	10x
2000 g	10x
4000 g	until disruption

The electrical resistance was also measure during the testing (in periodical steps). The measured values were statistically analyzed and applied to the graphs. After the test, also visual inspection was realized, see Figure 6.

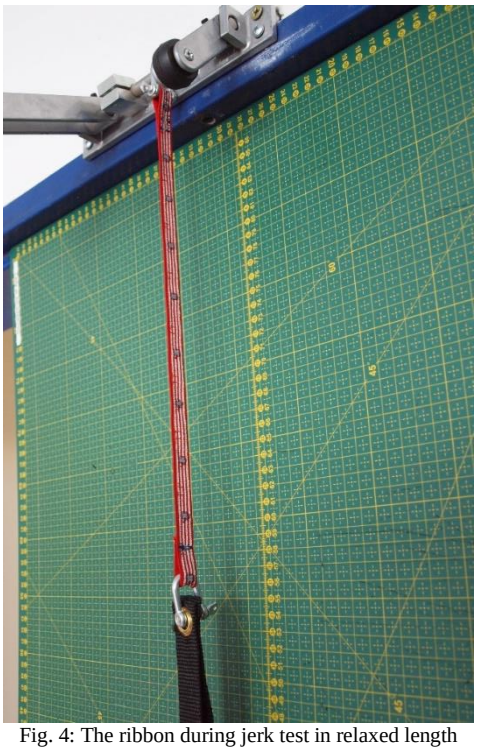

Fig. 4: The ribbon during jerk test in relaxed length

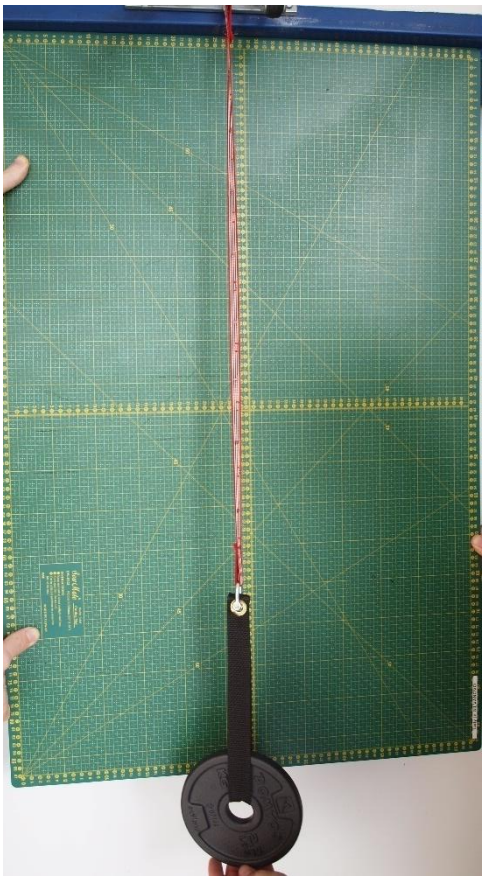

Fig. 5: The ribbon in extended position by 1 kilogram weight.

Fig. 6: Tested ribbons after the jerk test.

RESULTS AND DISCUSSION

All measured values were statistically analyzed and the results can be seen in Figure 7, 8 and 9. In figure 7, the values of broken components were replaced by 10 000 mΩ value to display results correctly. The results show that electrical resistance of samples after jerk test with 0,5 kg, 1 kg and 2 kg is stable and low with one exception. The electrical resistance of sample S (soldered without stretch) grows to the level of glued samples resistance but is still low. After testing with 4 kg weight, the samples degrade a few jerks (S – 7x, SS – 5x, G – 6x, GS – 9x). This degradation is caused by mechanical breaking of whole ribbon (see Figure 6). The electrical contact in joints was also destroyed for samples S, SS and G, but for sample GS, the electrical resistance of joints is still dozens mΩ.

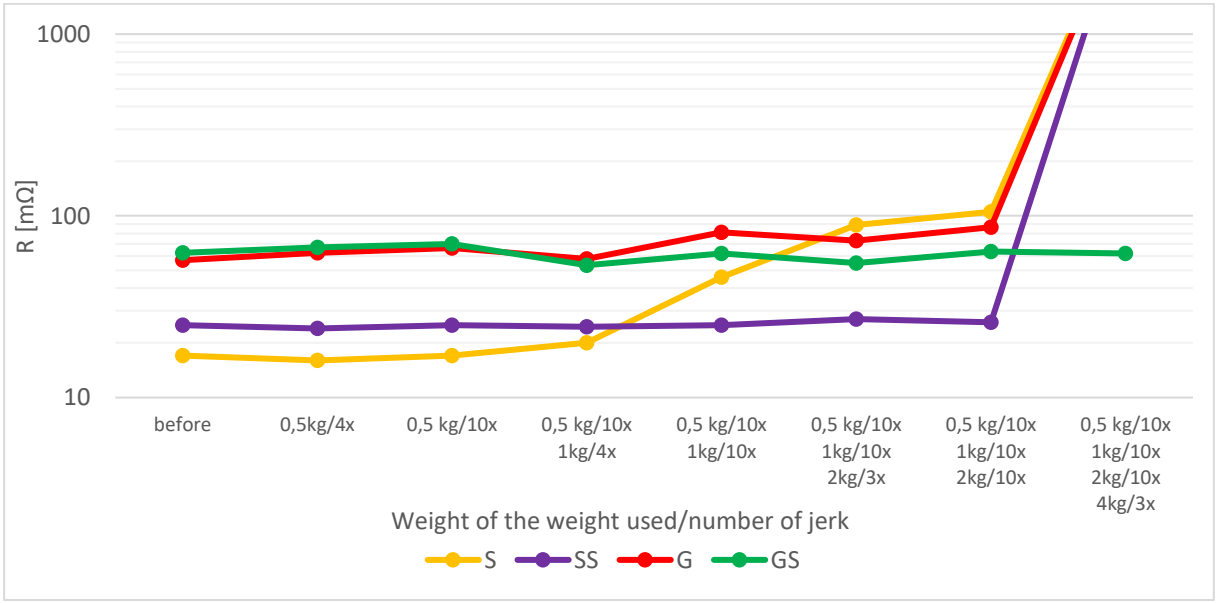

Fig. 7: Line chart of electrical resistance median of glued / soldered joints during jerking test.

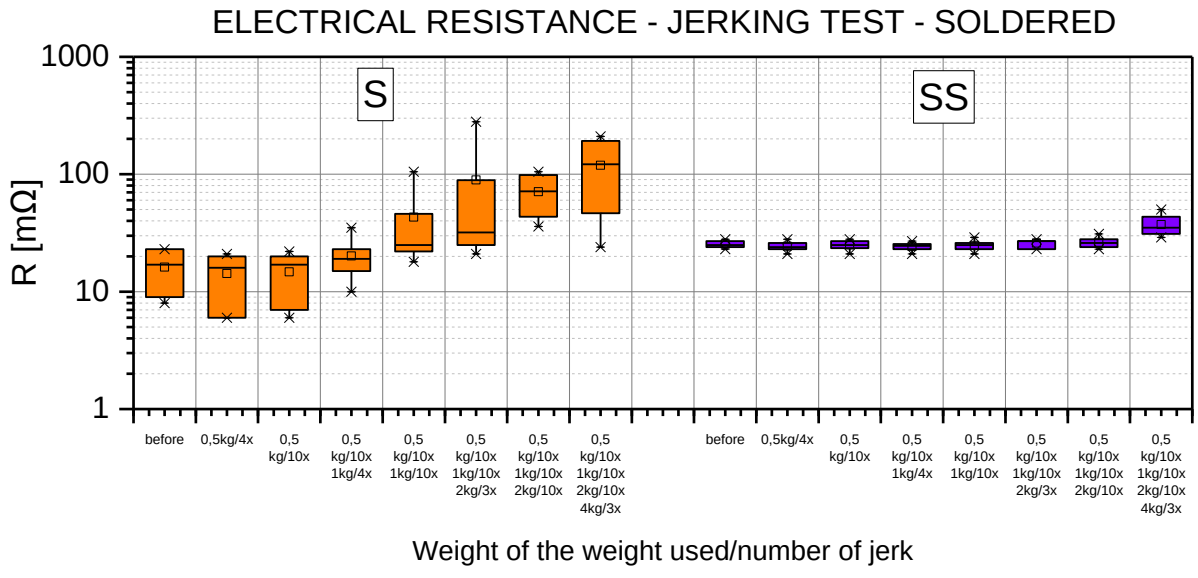

Fig. 8: Box plot diagram of soldered joints electrical resistance during jerking test.

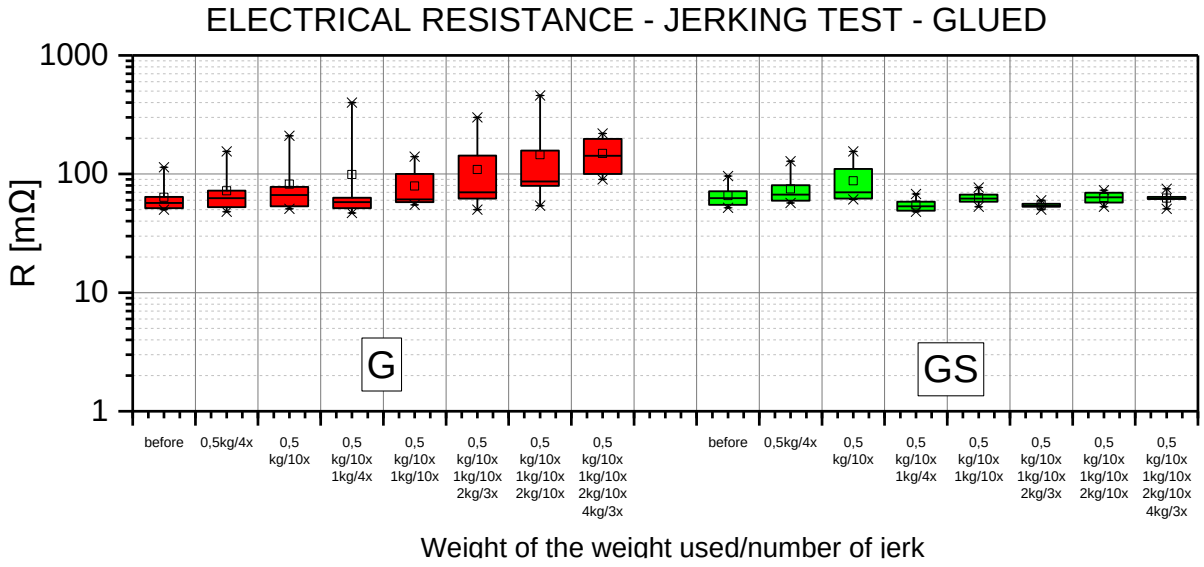

Fig. 9: Box plot diagram of glued joints electrical resistance during jerking test.

CONCLUSION

The experiment provided proof that jerking of ribbons with soldered / glued components is possible. The experiment also shows the limit of jerking strength. This limit is 4 kilograms of weight, i.e. 240% of relaxed length as maximum point of stretching. The experiment shows that joints endure the same jerking as whole ribbon, it follows that using of SMD soldering or gluing to make electrical connection of component on ribbon is reliable in case of jerking. The results also shows that better results have glued sample with stretching during gluing, but it is not important because the whole ribbon is destroyed earlier

ACKOWLEDGEMENTS

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