

## Review report of the Diploma thesis

### Influence of mechanical stress on properties of conductive adhesive joints

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The Diploma thesis submitted to the review is focused on the influence of a mechanical stress on properties of electrically conductive adhesive joints. The thesis has 57 pages including two attachments.

The theoretical part is proportional to the whole. It contains several statements. Some of which the author should explain. On the page 10 the author describes properties of filler in electrically conductive adhesives (ECA) and gives the main reason, why aluminum, due to oxide layer formation, is not possible to use as filler for these adhesives. However, it is also not possible to forget about the price of the adhesives. The author presents that parameters requested for fillers usable in ECA, meets, instead other metals, also silver. Is it, according to the opinion of the author, the price of silver on the market significantly lower than the price of tin that forms the basic component of lead-free solders? Does silver form oxide layers?

Claiming that conductive adhesives are usable in more applications than lead-free solders is under discussion. The author also states, on page 11 that conductive adhesives with thermoplastic matrix having better electrical conductivity than solders are under development at present. Could the author mention more data especially to this comparison of electrical conductivity?

It was more appropriate to quote the contemporary legislative standards. Quoted Directive EU 2002/95/EC was substituted by newer Directive 2011/65 / EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment. In connection with this section (p. 12) it would be useful to explain the sentence: „*For most common applications, the use of lead soldering was banned in Europe starting 1<sup>st</sup> July 2006 under 'EU Directive ROHS on the restriction of the use of certain hazardous substances in electrical and electronic equipment (2002/95/EC)', with primary goal to cut down the release of lead into the atmosphere*“. This directive is aimed, among other things, at leakage of lead to the environment throughout the life cycle of the product, not only to its evaporation into the atmosphere during technological operations in the manufacture or subsequent recycling of the product.

The experimental part of the thesis is focuses on the influence of mechanical treatment on properties of conductive adhesive joints. The work is based on examination of the joints formed on printed circuit boards (PCB) by adhesive assembly of surface mount resistors (SMD) of the type 1206 having the „zero“ resistance (0R0 resistors). Quality of the joint is evaluated by electrical resistance and by nonlinearity of the current vs. voltage characteristic of the system PCB-adhesive joint-SMD resistor-adhesive joint-PCB.

On the page 31 the author presents that after application of the higher deflection of the assembled PCB several resistors broke. Where does he see the problem? The reason was in adhesive assembly or in the adhesive used? How frequent were these failures?

I consider the experimental part to be very interesting and beneficial. In particular, it is necessary to evaluate application of the stresses of the adhesive joints created by ultrasound. I would recommend using not only the median or mean, but also other statistics (dispersion, variance, etc.) to provide readers with more information about the variability of measured values. Without this information, it is sometimes difficult to make deeper analyzes.

Due to the relatively short conclusion of the thesis, I would recommend during the defense to discuss in more details the further gained knowledge gained by the author, especially in the area of application of the ultrasound stress of the joints on their properties. These experiments, given the nature of the joint and the used organic materials, can be regarded as fundamental in terms of the thesis.

The diploma thesis is undoubtedly beneficial, the influence of mechanical stress on the properties of adhesive joints is dealt by a number of papers, but the very important effect of application of stress on the basis of ultrasound is in practice somewhat neglected.

Overall, I consider the diploma thesis to be of good quality, both in terms of factual and typographical aspects. The author demonstrated his ability to plan and implement a larger experimental task on a very good level.

I recommend the diploma thesis for defense and I evaluate it by the degree

„B“ - very good

Ing. Vratislav Žák, CSc.

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