Simulation of Electro-Thermal Behavior of an Overlap Solder Interconnection

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Abstract

Solder connections are one of the most essential parts of the PCBs. Despite many well-known scientific works that have been done about overlap solder interconnection properties, such as fracture [1], fatigue [2] and reliability studies [3], little attention have been given to the investigation of the connection between effects of electrical properties and laboratory soldering shortages such as effects of solder defects on computer simulation. The importance of this issue becomes clearer when we recognize that results in the laboratory are somehow different than analytic results. Moreover, an appropriate computer model for solder, which is often used in the laboratory (Sn-Ag-Cu alloy in this investigation), is barely considered. A computer model of electro-thermal behavior of an overlap solder interconnection is important, because, this model frees us from manufacturing and analyzing each electronic board independently.

In this project, with considering many aspects, effects and constituents of a specific solder alloy, to create a suitable computer model of solder joints. In order to get closer to the real result (to simulate the real behavior of the model) the actual solder joint is manufactured and analyzed in the laboratory with two different technologies of soldering (reflow oven and solder pot); besides the results are then compared with our simulation models and the computer simulation is considered and implemented based on the scientific works (intermetallic compounds) and the empirical vision (inner deformation and temperature effects). With slight modifications, the results can be generalized to other alloys those are usually consumed in the industry. Furthermore, comparison of different samples helps us to draw a more reliable conclusion about solder alloy action in high current load.

Considering all the aspects of electronic effects, such as proper geometry, suitable solder alloy, intermetallic compounds, and internal deformations can help us to explain the solder joint behavior and enables us to develop a computer model of it in a numerical solver such as COMSOL Multiphysics® software. The simulation of electro-thermal behavior of an overlap solder interconnection could be used for predicting behaviors of solder joint for all PCB simulations with the same material or geometry that are used in scientific works or industrial researches.

Reference

[1] S. E. Yamada, A fracture mechanics approach to soldered joint cracking, IEEE Transactions on Components, Hybrids, and Manufacturing Technology, Vol. 12, No. 1, pp. 99-104 (1989)

[2] J. Seyyedi, Thermal fatigue behaviour of low melting point solder joints, Soldering & Surface mount technology, Vol. 5, No. 1, pp. 26-32 (1993)

[3] T. H. Ho et al., Linear finite element stress simulation of solder joints on 225 i/o plastic bga package under thermal cycling, Electronic Components and Technology Conference Proceedings, 45th. IEEE, pp. 930- 936 (1995)

Figures used in the abstract

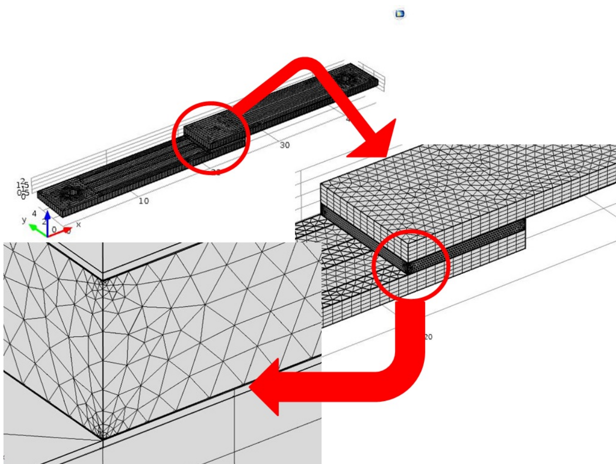

Figure 1: Mesh in COMSOL.

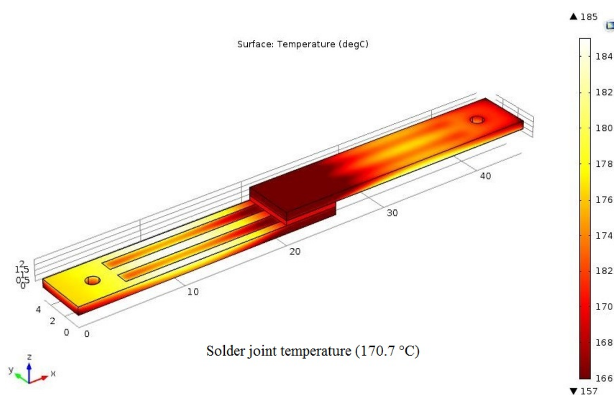

Figure 2: Temperature distribution on the model.

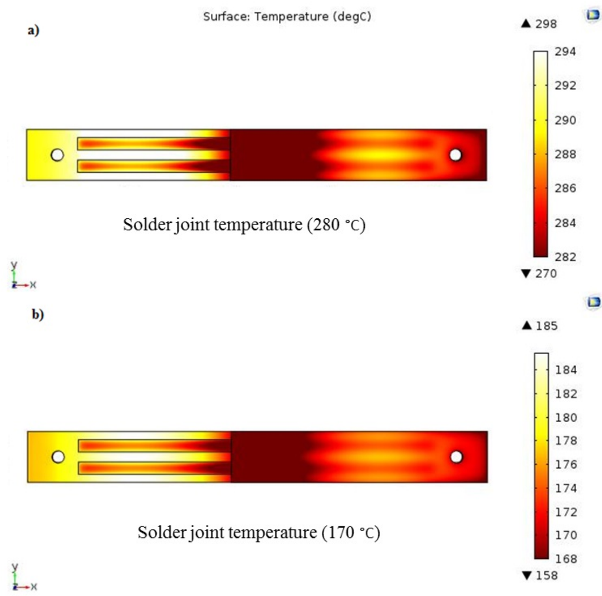

Figure 3: a) Temperature distribution with 5(W=(m2K)) heat transfer coefficient. b) Temperature distribution with free convection (10(W=(m2K))).

Figure 4: The real samples.