

Modeling Solder Crack and the Relationship with Resin Delamination in a Power Leadframe Package

Jefferson S. Talledo

New Product Development and Introduction, Back-End Manufacturing & Technology, STMicroelectronics, Inc.
Calamba City, Laguna, Philippines 4027

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I. OVERVIEW

- A leadframe package for power device applications usually needs excellent thermal performance.
- Recent trend is to use dual side cooling where an exposed copper clip acting as heat sink is attached to the die using solder material in addition to the leadframe as shown in Fig. 1.

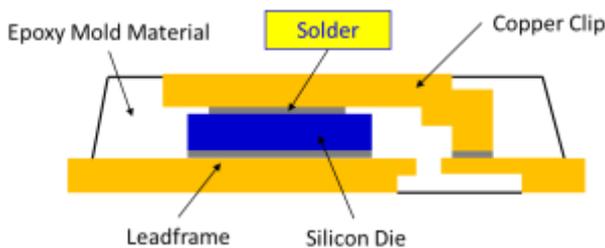


Fig. 1. Schematic of a power leadframe package.

II. PROBLEM IDENTIFICATION

- With the soldered copper clip, solder crack was encountered under the copper clip after thermal cycling of the package as shown in Fig. 2.
- Resin-solder interface delamination was also observed.

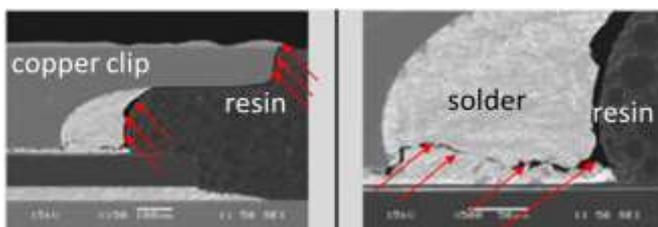


Fig. 2. Solder crack and resin delamination

III. THERMO-MECHANICAL MODELING

- To understand the problem, thermo-mechanical modeling using finite element method was conducted with 3 different design conditions as shown in Fig. 3.
- The difference between Design 1 and Design 2 is only the copper clip design.
- Stress level at the lowest temperature of the thermal cycling range (-55 °C) was analysed.

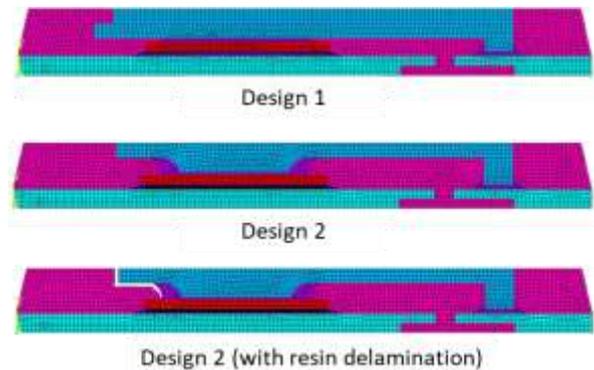


Fig. 3. Finite element models.

IV. DESIGN SOLUTION AND IMPROVEMENT

- From the stress distribution (Fig. 4) obtained by modelling, it could be seen that the interface delamination creates high stress concentration that exactly coincides with the actual solder crack location.
- Without delamination, there is no such high stress concentration that could cause solder crack.
- Stress analysis shows that clip-resin delamination (1) happens first at the top package surface before the resin-solder delamination (2) and solder crack (3).
- This implies that clip-resin delamination needs to be eliminated in order to avoid solder crack at the location shown by improving the design of the copper clip to increase clip-resin anchoring (e.g. clip anchoring slots, serrated edges). This approach was initially validated with Design 1 where the clip has some form of anchoring to the resin and no clip-resin delamination was reported.

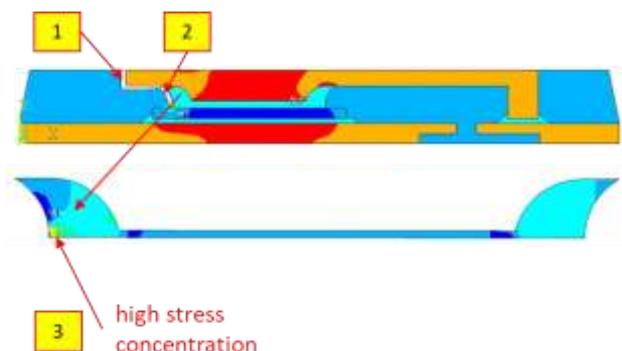


Fig. 4. Stress distribution in the solder material.