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Modeling Study on Die-to-Pad Ratio and Its Relationship with QFN Delamination

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Keywords— *Die-to-pad ratio; QFN delamination; die pad; interface stress; package crack; finite element modeling.*

I. OVERVIEW

- The continuing trend in IC (integrated circuit) packaging is miniaturization or package size reduction.
- However, there is also a need to increase die functionality and a larger die is being forced to fit in a smaller die pad and this results in higher die-to-pad ratio for QFN (quad flat no lead) package.
- Die-to-pad ratio (DPR) is the ratio of the die size to the leadframe die pad size as illustrated in Fig. 1.

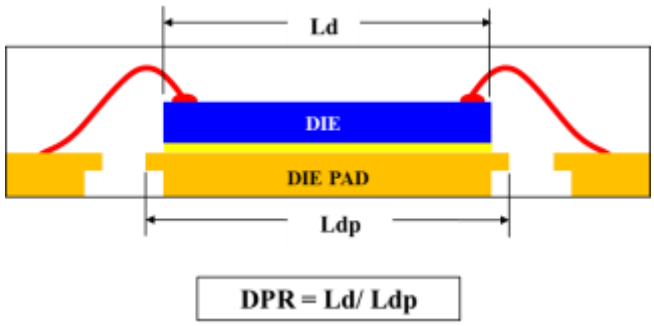

Fig. 1. Die-to-pad ratio (DPR) calculation for a QFN package.

II. PROBLEM IDENTIFICATION

- One common problem encountered with higher DPR is leadframe interface delamination and package crack as shown in Fig. 2.
- To better address this problem, there needs to be a better understanding of how higher DPR results in delamination and package crack.

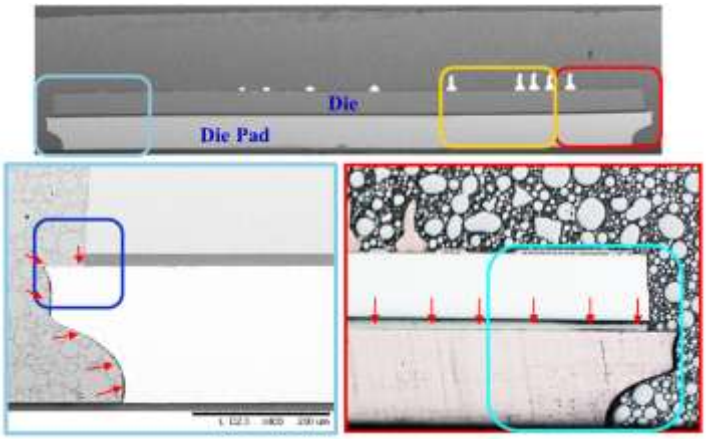

Fig. 2. QFN package leadframe interface delamination and package crack.

III. FINITE ELEMENT MODELING

- Finite element modeling (Fig. 3) was used to study the relationship between DPR and interface stress.
- Mold-leadframe interface stress was extracted at a specific location considered to be the usual delamination initiation area based on failure analysis results.

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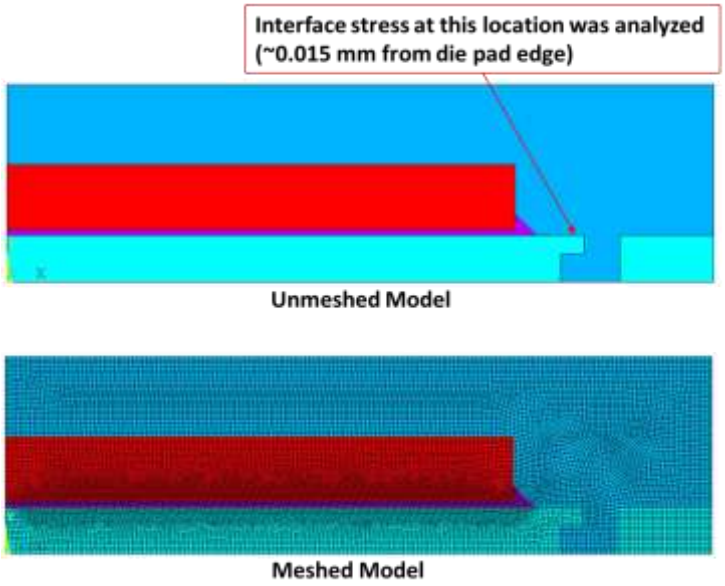

Fig. 3. Finite element model of the QFN package analyzed.

IV. Stress Results and The Relationship with Delamination

- Based on the modeling results (Figs. 4-6), leadframe interface stress is higher with higher DPR.
- Higher interface stress means a higher tendency of the interface to delaminate.
- This relationship explains why delamination is usually encountered when the package design has higher DPR.
- The relationship between DPR and interface stress also appears to vary with package size.
- When interface delamination happens, package crack could also occur as delamination propagates along the interface.
- For designs with higher DPR (especially around DPR = 90%), some strong leadframe-mold anchoring and leadframe adhesion improvement are needed (e.g. anchoring holes, slots, leadframe roughening, surface treatment).

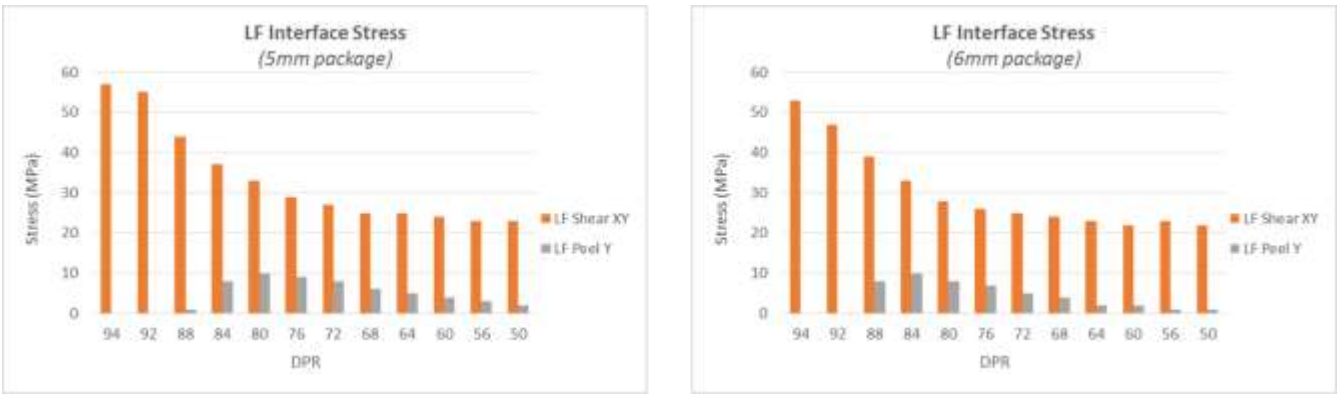

Fig. 4. Leadframe interface stress vs DPR for package size = 5 mm and 6 mm.

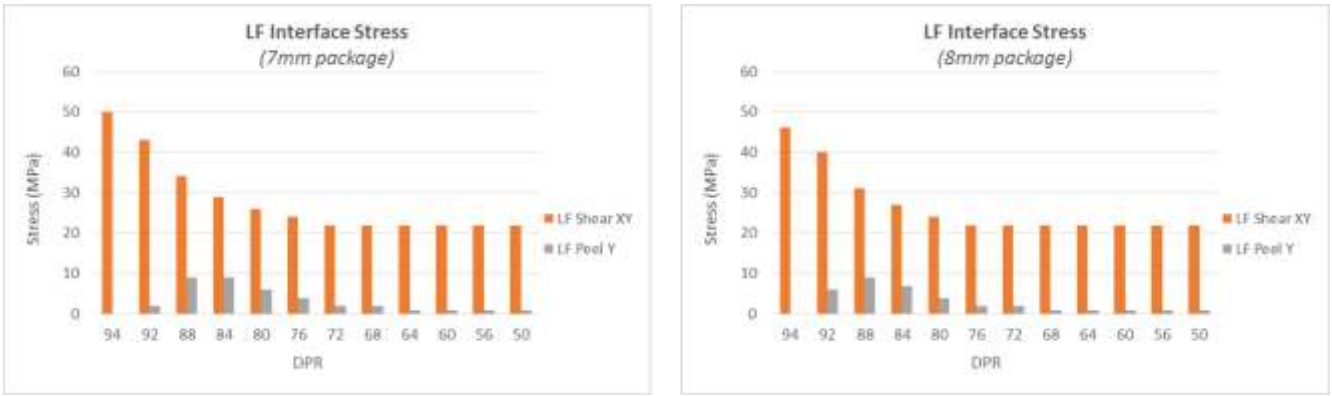

Fig. 5. Leadframe interface stress vs DPR for package size = 7 mm and 8 mm.

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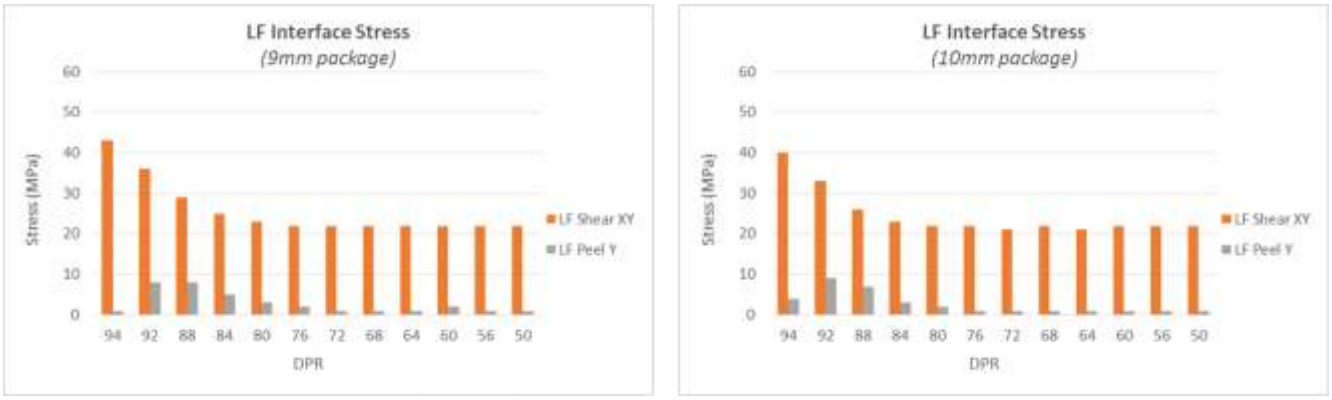

Fig. 6. Leadframe interface stress vs DPR for package size = 9 mm and 10 mm.

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