**Analysis of High Power LED**

- High junction temperature
- Heat sink slug with low thermal resistivity
- Silicone-based encapsulant which prevents yellowing effect

**Reduced resistance network model of an LED package**

\[ q = \frac{T_j - T_s}{R_{jc}} \iff T_j = \left( R_{jc} + R_{sc} \right) q + T_a \]

- Junction temperature can be obtained by using thermal resistance network.

**Design trade-off HP LEDs**

- Higher drive current
- Higher \( T_j \)
- Higher strength
- Higher allowable \( T_j \)
- Higher cost
- Higher package failure risk

**Validation of thermal conduction model**

- The result from the FE analysis agrees reasonably well with the measurement data considering uncertainties associated with material properties and contact resistance as well as leads that are not included in the model.
Validation of thermo-mechanical model

- Moiré interferometry is utilized to validate the in-plane displacement of the LED package

Parametric study using FEM

The 3-D model is used to investigate the effect of the thickness and thermal conductivity of the top adhesive layer on the junction temperature and the maximum effective strain.

Adhesive parameters affecting the junction temperature and stresses of high power LEDs

\[ R_{\text{eff}} = \frac{t}{kA} \]

\[ \gamma = f(\Delta \alpha, \Delta T, \text{DNP}, t, \text{constraint}) \]

Design guidelines of HP LED

- Performance limit, manufacturing yield, etc.
- Available ranges
- Trade-off considering performance and cost
- Trade-off considering junction temperature and stress
- Guideline of heat sink for end users