Reworkable Underfills and BGA Reliability

OBJECTIVES:
- To develop physics-based models and methodologies
- To evaluate the thermo-mechanical reliability of BGA’s with reworkable underfill, conventional underfill, and no underfill
- To study failure modes such as solder joint fatigue, underfill delamination, underfill cracking, and die cracking
- To recommend design guidelines for BGA packages with reworkable underfills for use in harsh environment.
- To extend the methodology to other area-array devices and to SOP to be able to make suitable choice with respect to reworkable and conventional underfills
- To use the methodology to upfront select material, geometry, and process parameters for SOP module testbed, and to validate the modeling results with experimental data from the testbed

ACCOMPILISHMENTS:
- Feature based parametric models developed
- Performed parametric studies to determine the effect of different underfill materials and geometry
- Damage metric-based mapping of field-use conditions are demonstrated for harsh filed-use conditions
- Identified failure modes such as solder joint fatigue, underfill delamination, die cracking
- Model validation for the effect of underfills on BGA reliability is done with similar literature results

<table>
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<tr>
<th>Underfill</th>
<th>Creep-Fatigue Life, Cycles to 50% failure</th>
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</thead>
<tbody>
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<tr>
<td>A</td>
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<tr>
<td>B</td>
<td>3228</td>
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<tr>
<td>C</td>
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APPROACH
- Develop feature-based parametric models
- Use time and temperature dependent material models
- Use phenomenological and Mechanics - based life prediction models
- Develop damage metric-based mapping methodology for harsh field-use conditions
- Model validation for the effect of underfill on BGA reliability