Optimizing Thermal Management in Microelectronics

EPO-TEK Products For Optimizing Thermal Management

**H20E**  Unsurpassed performance in thermal management
- Proven reliability for 35+ years

**H20E-HC**  2nd generation thermal management product
- High ThK, low Tg and high degradation temp

**ED1003**  Single component, next generation material
- High Tg, long pot life, low outgassing & high ThK

**EK1000**  Newest, most advanced, single component adhesive
- Long pot life, low outgassing & exceptional ThK
EPOTEK™
Products for Thermal Management

Increased Thermal Conductivity Through Cure

Conductive adhesives achieve highest conductivity (ThK) when maximum shrinkage is achieved during cure.

† Significantly higher thermal conductivity values can be achieved with a stepped-cure for H20E-HC and EK1000.

Curing and Thermal Resistance

Optimal resin shrinkage pulls the particles closer together to:
- Minimize thickness of insulating resin between particles
- Maximize area of contact between two particles

Uncured Adhesive:
- Insulating Resin
- Conductive Filler
- Heat Flow
- High Resistance
Thermal Resistance Comparisons

Example 1
Large Die (4.82mm x 3.05mm) and standard BLT (50um)

<table>
<thead>
<tr>
<th>Product</th>
<th>Measured Thermal Resistance (˚C/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H20E</td>
<td>0.79</td>
</tr>
<tr>
<td>H20E-HC</td>
<td>0.63 <strong>Best Result</strong></td>
</tr>
<tr>
<td>Competitive Adhesive A</td>
<td>0.73</td>
</tr>
<tr>
<td>(advertised ThK is 60 W/mK)</td>
<td></td>
</tr>
<tr>
<td>Competitive Adhesive B</td>
<td>1.58</td>
</tr>
<tr>
<td>(advertised ThK is 10 W/mK)</td>
<td></td>
</tr>
</tbody>
</table>

Example 2
Small Die (60mil x 40mil) and thin BLT (10um)

<table>
<thead>
<tr>
<th>Product</th>
<th>Measured Thermal Resistance (˚C/W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H20E</td>
<td>26.80</td>
</tr>
<tr>
<td>EK1000</td>
<td>22.00 <strong>Best Result</strong></td>
</tr>
<tr>
<td>Competitive Adhesive C</td>
<td>24.00</td>
</tr>
<tr>
<td>(advertised ThK is 10 W/mK)</td>
<td></td>
</tr>
</tbody>
</table>

Note: Thermal Resistance measurements are device and operating condition specific — making it nearly impossible to pre-judge the actual thermal performance of an adhesive in a device by only comparing the bulk Thermal Conductivity data on a data sheet.

Impact of cure conditions:
- **Too low** of a cure temperature will result in slow cure and low crosslink density.
- **Too high** of a cure temperature can cause high exotherms that may actually cause the system to expand rather than shrink.
- **Proper** cure conditions are dependent on the chemistry of the adhesives.

Thermal Conductivity (W/mK) cured 150˚C/1hr

<table>
<thead>
<tr>
<th></th>
<th>H20E</th>
<th>H20E-HC</th>
<th>ED1003</th>
<th>EK1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal Conductivity (W/mK) cured 150˚C/1hr</td>
<td>2.6</td>
<td>10.9</td>
<td>8.5</td>
<td>12.6</td>
</tr>
<tr>
<td>Thermal Conductivity (W/mK) cured 150˚C/1hr + 200˚C/1hr</td>
<td>2.8</td>
<td>23.0</td>
<td>14.7</td>
<td>22.0</td>
</tr>
</tbody>
</table>

Type
- Two Component
- Two Component
- Single Component
- Single Component

Pot Life (days)
- 2.5
- 2.5
- 28
- 14

Tg (˚C)
- 80
- 50
- 160
- 98

CTE below Tg (in/in/˚C)
- 34
- 48
- 41
- 38

Volume Resistivity (ohm.cm)
- 0.00019
- 0.000023
- 0.000045
- 0.000029

Modulus (psi)
- 808,700
- 217,731
- 736,792
- 273,599

Degradation Temperature (˚C)
- 425
- 372
- 326
- 357

Die Shear (kg) initial
- 15.4
- 8.0
- 9.9
- 10.1

Die Shear (kg) After 1000hrs 85˚C/85%RH
- 9.3
- 9.5
- 6.4
- 6.4

Thermal Resistance Model

- **Cured Adhesive**
  - **Low shrinkage**
    - Insulating Resin
    - Conductive Filler
  - Medium Resistance
  - Heat Flow
  - **Cured Adhesive**
    - **Optimal shrinkage**
      - Insulating Resin
      - Conductive Filler
    - Low Resistance
    - Heat Flow

www.EPOTEK.com
What is Thermal Conductivity?

Thermal conductivity is a fundamental material property that is essential for characterizing this heat transfer. It is, by definition, equal to the quantity of heat that is transferred in a specific period of time through a known sample area when the sample’s opposite faces are subjected to an applied temperature gradient. Typical units of thermal conductivity are:

\[
\text{Watts} \quad \frac{\text{meter} \times \text{Kelvin}}{\text{m} \times \text{K}}
\]

The most common test method for measuring thermal conductivity is Laser Flash Diffusivity.

Thermal Resistivity vs Thermal Resistance

**Thermal Resistivity** (the inverse of Thermal Conductivity) is a material (device and geometry independent) property and refers to that material’s ability to resist the flow of heat.

**Thermal Resistance** is an object (device and geometry dependent) property. The thermal resistance between two points is defined as the ratio of the difference in temperature to the power dissipated.

Because interfaces and other geometry factors play such a large role in determining the actual thermal resistance of an adhesive in a device, a high bulk thermal conductivity value for an adhesive is important, but may not always be a sufficient predictor of low resistance.

**To achieve the most efficient thermal transfer in an actual device, low Thermal Resistance is required.**

For optimizing thermal management we recommend:

- **H20E**  Unsurpassed performance in thermal management
- **H20E-HC**  2nd generation thermal management product
- **ED1003**  Single component, next generation material
- **EK1000**  Newest, most advanced, single component adhesive

Please consult our Application Experts at Epoxy Technology to find the most suitable adhesive for your specific technical challenge.

For ordering, please contact us at:
Epoxy Technology Inc.
14 Fortune Drive • Billerica, MA 01821
Tel: 978-667-3805 • Fax: 978-663-9782

www.EPOTEK.com

DISCLAIMER: The Information, Statements and Recommendations contained herein are based on information, data, reports or tests believed to be reliable. However, Epoxy Technology, Inc. makes no warranty or guarantee of accuracy or completeness in connection therewith, nor, with respect to any Epoxy Technology, Inc. products involved, any warranty or merchantability or fitness for a particular purpose or use.