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

EK1000
EK2000 New advanced, single or two component adhesive
- Long pot life, low outgassing & exceptional ThK

EK1000-1 Newest, version of EK1000 designed for a longer dry time
- Extended working time and exceptional ThK

EPOXY TECHNOLOGY®

Innovative Epoxy Adhesive Solutions for Over 45 Years™

EPOTEK™ Products for Thermal Management

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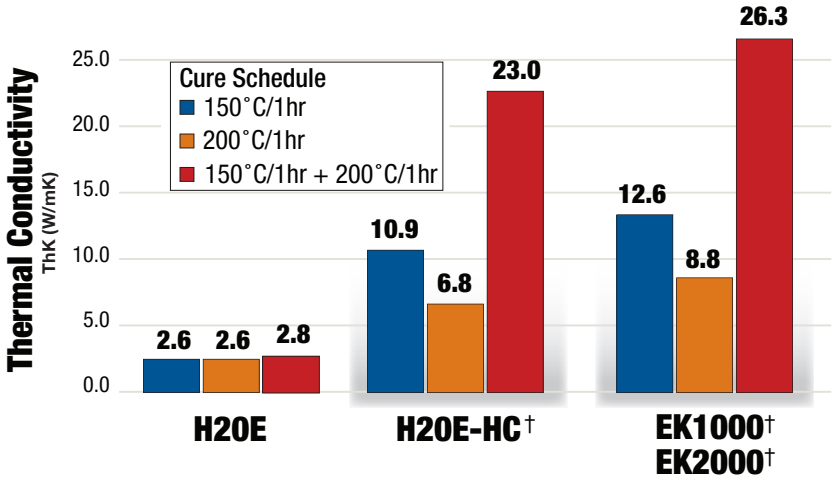
Increased Thermal Conductivity Through Cure



† Significantly higher thermal conductivity values can be achieved with a stepped-cure for H20E-HC, EK1000/EK2000 and EK1000-1.

Note: EK1000-1 will reach 22.7 W/mk during a stepped cure.

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

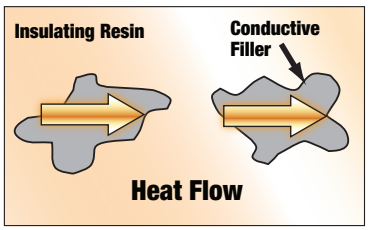
Curing and Thermal Resistance

Particle Co

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



High Resistance

EPOXY TECHNOLOGY

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	H20E	H20E-HC	EK1000/ EK2000	EK1000-1
Thermal Conductivity (W/mK) cured 150°C/1hr	2.6	10.9	12.6	12.1
Thermal Conductivity (W/mK) cured 150°C/1hr + 200°C/1hr	2.8	23.0	26.3	22.7
Type	Two Component	Two Component	Single & Two Component	Single Component
Pot Life (days)	2.5	2.5	14	14
Tg (°C)	80	50	98	103
CTE below Tg (in/in/°C)	34	48	38	41
Volume Resistivity (ohm.cm)	0.00019	0.000023	0.000029	0.00007
Modulus (psi)	808,700	217,731	273,599	609,195
Degradation Temperature (°C)	425	372	357	357
Die Shear (kg) initial	15.4	8.0	10.1	≥10
Die Shear (kg) After 1000hrs 85°C/85%RH	9.3	9.5	6.4	≥5

Thermal Resistance Comparisons*

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

Product	Measured Thermal Resistance (°C/W)
H20E	0.79
H20E-HC	0.63 ***Best Result***
Competitive Adhesive A (advertised ThK is 60 W/mK)	0.73
Competitive Adhesive B (advertised ThK is 10 W/mK)	1.58

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

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

Product	Measured Thermal Resistance (°C/W)
H20E	26.80
EK1000	22.00 ***Best Result***
Competitive Adhesive C (advertised ThK is 10 W/mK)	24.00

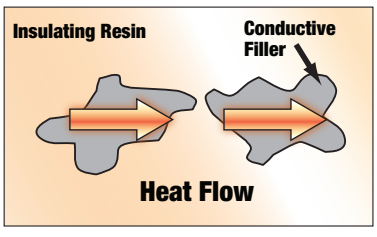
* See back page for the difference between thermal resistance and thermal conductivity.

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 product data sheet.

ntact Resistance Model

Cured Adhesive

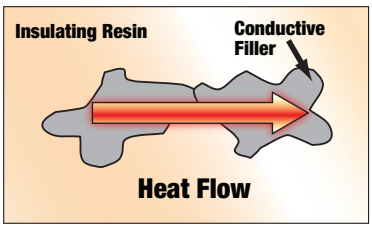
Low shrinkage



Medium Resistance

Cured Adhesive

Optimal shrinkage

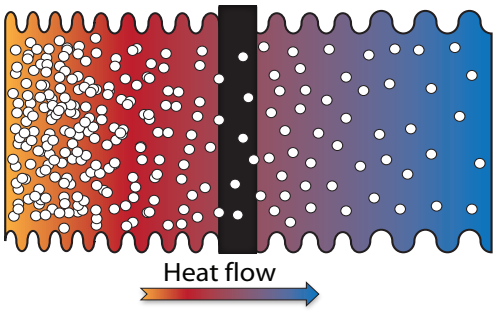


Low Resistance

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.

What is Thermal Conductivity?



In the continued quest for miniaturization, thermal conductivity is playing an even more important role in today's products. More and more adhesives are relied upon to dissipate generated heat away from active components.

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:

$$\frac{\text{Watts}}{\text{meter} * \text{Kelvin}} \left(\frac{\text{W}}{\text{m} * \text{K}}\right)$$

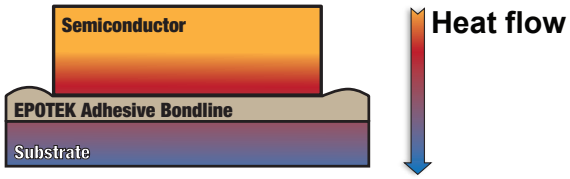
The most common test method for measuring thermal conductivity is Laser Flash Diffusivity.

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.

Thermal Resistance Contribution of a Die Attach Adhesive



NOTE: 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
EK1000 **EK2000**	Newest, most advanced, single or two component adhesive
EK1000-1	Newest, version of EK1000 designed for a longer dry time

Consult our *Application Experts* to discuss your specific technical challenges at: techserv@epotek.com.

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