



# MOMENTIVE

performance materials

## TPG<sup>®</sup> Thermal Management Material

TPG (thermal pyrolytic graphite) is a unique form of pyrolytic graphite manufactured from thermal decomposition of hydrocarbon gas in a high temperature chemical vapor deposition reactor.

### Benefits

- Thermal conductivity to 4 times copper
- Lighter than aluminum
- Compatible with many encapsulating techniques
- Sizes from dies and packages to PWB's
- Passive, high performance heat transfer

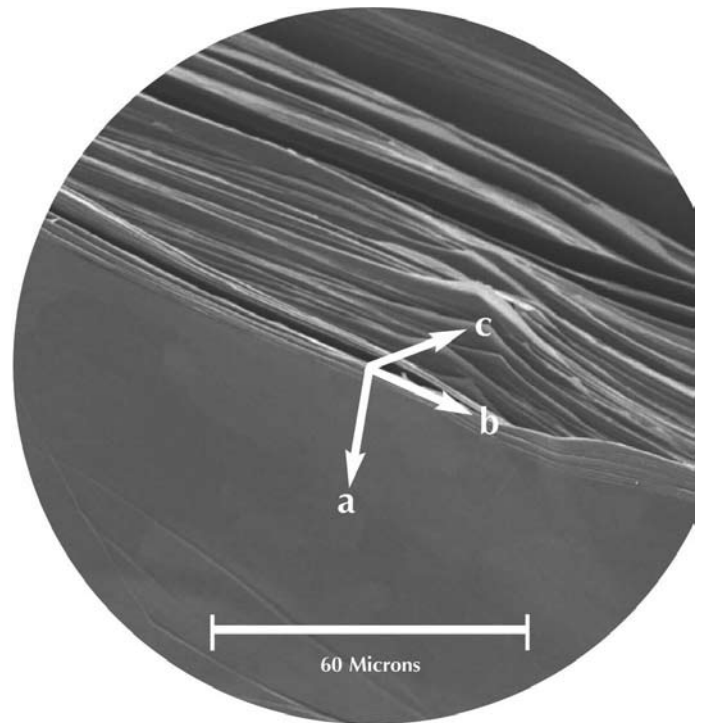
### Features

- Highly oriented crystals in a layered structure
- In-plane conductivity typically 1350 to 1700 watts/m-K
- Fully dense ceramic
- High c-direction modulus, contributing to improved section properties in composite structures
- Layered structure avoids brittle, catastrophic failure
- Easily machined, provided as plates or as final shapes
- Thickness ranges from less than 0.010" (0.25 mm) to over 0.200" (5 mm)
- Plate sizes up to 5" (125 mm) x 20" (500 mm)
- Special sizes can usually be provided upon request

### Applications

The high thermal conductivity of TPG comes from a crystal structure that usually requires capturing the TPG material in some structural member. Final products typically include encapsulations such as aluminum, copper, AISiC and carbon fiber composite to solve thermal problems in such needs as:

- Heat spreaders in packages
- Thermal cores for PWB's
- Heat spreaders for improved performance of finned sinks
- Laser diode mounts

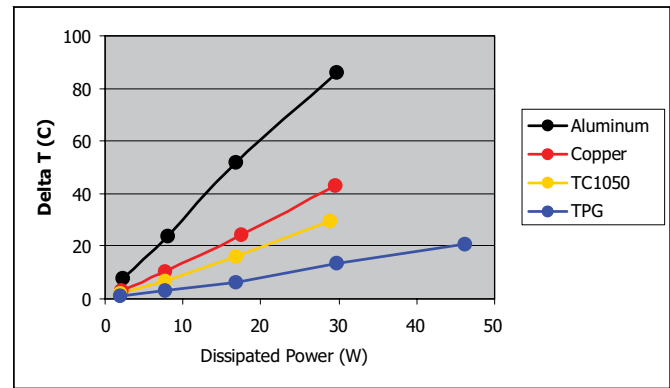


**ITRS Impact** - The International Technology Roadmap for Semiconductors shows power dissipation increasing by 10 watts per year from 130 watts in 2002 at the 130 nm node to 160 watts in 2005 at the 100 nm node. TPG can enable transparent thermal solutions without the need for dramatic changes in fans or forced cooling.

## Typical TPG Properties

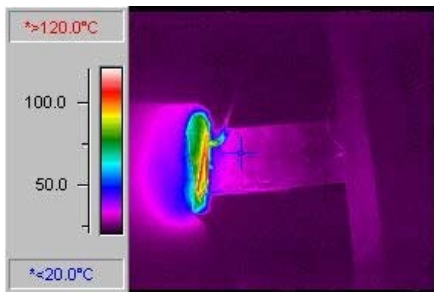
Thermal Conductivity	1500 <20	Watts/m-K, a-b axis Watts/m-K, c axis
Density	2.26	gm/cc
Thermal Expansion Coefficient	0 to -1 25	ppm/°C, a-b axis ppm/°C, c axis
Specific Heat	0.71	J/gm-°C @ 25° C
Flexural Strength	36.7 38.5	+/-4%, MPa, ab +/-4%, MPa, ab
Stiffness	1050 36	+/-2%, GPa, c <sub>11</sub> +/-3%, GPa, c <sub>33</sub>
Compressive Strength	nil	ab
Tensile Strength	nil	ab

## Typical Thermal Performance

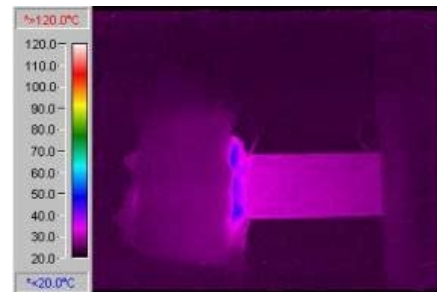


TPG shows over 5X the power dissipation capability of aluminum

## Thermal Images



6061 Aluminum  
T<sub>max</sub> = 115°C



TPG  
T<sub>max</sub> = 44°C

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