Thermally Conductive Polymers

Authors thank

Cool Shield

for information and photos
Thermally Conductive Polymers

- Injection-molding grade polymers
- A composite material consisting of high conductivity reinforcements, and engineering or commodity thermoplastics
- Grades range from 10 W/mK (stainless steel) to over 100 W/mK (die cast aluminum)
- Electrically conductive or insulating
- Manages thermal and EMI performance

Courtesy of Cool Shield Inc.
Thermal Conductive Plastic

$\Delta T = 4^\circ C$

$\Delta T = 24^\circ C$

Thermally Conductive Plastic

Conventional Plastic

Courtesy of Cool Shield Inc.
<table>
<thead>
<tr>
<th>Material</th>
<th>Thermal Conductivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foamed plastic</td>
<td>0.02 W/mK</td>
</tr>
<tr>
<td>Plastic</td>
<td>0.2 W/mK</td>
</tr>
<tr>
<td>Glass</td>
<td>2.0 W/mK</td>
</tr>
<tr>
<td>CoolPoly® thermally conductive plastic</td>
<td>20 W/mK</td>
</tr>
<tr>
<td>Aluminum</td>
<td>200 W/mK</td>
</tr>
<tr>
<td>Diamond</td>
<td>2000 W/mK</td>
</tr>
</tbody>
</table>

Courtesy of Cool Shield Inc.
Applications

- Composite Injection Molded Heat Sinks
- Thermal Interface Materials
- Molded EMI Shielding
- Hybrid Assemblies including, but not limited to, over-molding of heat pipes

Courtesy of Cool Shield Inc.
Heat Sinks

21 mm high Series of Heat Sinks optimized for lower airflow or non-ducted applications

Forced Convection

°C / Watts

Airflow LFM

18mm

30mm

43mm

56mm

3mm

21mm

Courtesy of Cool Shield Inc.
**EMI Shield**

**Absorption**: Energy loss as electromagnetic waves pass through a material.

**Reflection**: Energy reflection when electromagnetic waves encounter a material.

**Transmission**: Energy passing through a material with minimal disturbance.

*Most conventional heat sinks are antennas*

*Courtesy of Cool Shield Inc.*
3D Gap Pads

- Injection molded to net shape
- Ideal for multi-chip applications
- 3 Dimensional shape ensures the lowest thermal resistance possible
- Zero waste
- Extremely durable and highly serviceable

Courtesy of Cool Shield Inc.
# Over-molded Heat Pipe

<table>
<thead>
<tr>
<th>Die Cast Magnesium (glued on heat pipe)</th>
<th>Composite Overmolded Heat Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sink Weight (g)</strong></td>
<td>26</td>
</tr>
<tr>
<td><strong>Heat Pipe</strong></td>
<td>12</td>
</tr>
<tr>
<td>Heat pipe (mm)</td>
<td>3x160</td>
</tr>
<tr>
<td>Embedded length-source (mm)</td>
<td>14</td>
</tr>
<tr>
<td>Free length (mm)</td>
<td>51</td>
</tr>
<tr>
<td>Embedded length-sink (mm)</td>
<td>95</td>
</tr>
<tr>
<td>Thermal couple to sink</td>
<td>adhesive</td>
</tr>
<tr>
<td><strong>Thermal</strong></td>
<td>none</td>
</tr>
<tr>
<td>Power (W)</td>
<td>5.5</td>
</tr>
<tr>
<td>Die/Source temperature (°C)</td>
<td>71</td>
</tr>
</tbody>
</table>

*Courtesy of Cool Shield Inc.*
Microstepper Motor

- Integrated motor and controller
- Molded housing / heat sink
- 50% cost reduction compared to die cast aluminum
- Tighter tolerances and better aesthetics than metal

Courtesy of Cool Shield Inc.
Enclosures

- Thermal management
- EMI / RFI shielding
- Portable electronics, automotive

Courtesy of Cool Shield Inc.
Laptop Frame

• Reduced thermal resistance
• Stiff / rigid frame
• Intricate design and features
• EMI/RFI shielding

Courtesy of Cool Shield Inc.
Radio Frequency (RF) Module

- Controlled CTE
- Dimensionally stable
- Low thermal resistance
End Polymer Heat Sinks

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