SUPREMEX® COMPOSITES FOR LIGHTWEIGHT ROBUST HIGH PERFORMANCE PISTONS

Materion offers a range of high performance metal matrix composites (MMCs) and aluminum alloys in billet, forged, machined and coated forms. The refined microstructures from the Materion powder processing route offer a significant step change in piston performance. The advantages of using Materion SupremEX MMCs for pistons include:

**STIFFNESS**
High specific modulus offers a lighter, stiffer design with reduced distortion under load. This is beneficial to areas prone to high bending stress and wear such as the gudgeon pin boss, thus improving fatigue life.

**STRENGTH**
Increased strength can reduce piston mass by 18-20% compared to conventional piston materials with the potential to reduce the compression height and lengthen the connecting rod, further reducing friction.

**THERMAL EXPANSION**
Lower thermal expansion reduces piston-to-liner clearance, offering reduced friction, blow-by, oil carry over, piston slap and fuel dilation and increased efficiency. It also provides a better fit between the piston and gudgeon pin.

**WEAR RESISTANCE**
Increased wear resistance and a low coefficient of friction reduce ring groove wear. This allows the piston ring groove to be moved up the piston. The reduction in crevice volume improves combustion efficiency, reducing brake-specific fuel consumption (BSFC) and hydro-carbon (HC) emissions.

**FATIGUE PROPERTIES**
Increased elevated temperature fatigue properties allow for higher working temperatures (up to 400°C) and combustion pressures (180+ bar), similar combustion pressures to a diesel engine.

**THERMAL STABILITY**
Strength is maintained after extended time at an elevated temperature, enhancing piston life.
PROCESS ADVANTAGES
- Good machinability using conventional techniques
- Homogenous stable microstructure and isotropy
- High yield net shape capability

PRODUCT FORMS
- Billet
- Close to shape forgings
- Machined pistons

TYPICAL MECHANICAL PROPERTIES - MMC AND AL-SI ALLOY CHOICES DEPENDING ON REQUIREMENTS AND REGULATIONS

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>SUPREMEX 225XE</th>
<th>AMC4632</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product Form</td>
<td>Forged</td>
<td>Forged</td>
</tr>
<tr>
<td>Heat Treatment</td>
<td>T4</td>
<td>T6</td>
</tr>
<tr>
<td>R_p0.2 MPa (ksi)</td>
<td>440 (64)</td>
<td>380 (55)</td>
</tr>
<tr>
<td>R_m MPa (ksi)</td>
<td>610 (89)</td>
<td>430 (62)</td>
</tr>
<tr>
<td>Elastic Modulus GPa (msi)</td>
<td>115 (16.7)</td>
<td>94 (13.6)</td>
</tr>
<tr>
<td>Elongation to Failure %</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Density g/cm³ (lb/in³)</td>
<td>2.88 (0.104)</td>
<td>2.70 (0.097)</td>
</tr>
<tr>
<td>Thermal Conductivity at 25°C W/m·K (BTU/hr·ft·°F)</td>
<td>150 (87)</td>
<td>127 (74)</td>
</tr>
<tr>
<td>Thermal Expansion at 25°C ppm/°K (ppm/°F)</td>
<td>16.1 (8.9)</td>
<td>16.1 (8.9)</td>
</tr>
<tr>
<td>Vickers Hardness Hv10Kg</td>
<td>210</td>
<td>180</td>
</tr>
</tbody>
</table>

Data is for information purposes only, it does not constitute a guarantee. Data is typical of piston geometries.

COMPARISON OF ELEVATED TEMPERATURE FATIGUE LIMIT FOR 225XE VS. AA2618

Comparison of Elevated Temperature fatigue limit for 225XE vs. AA2618 alloy at 10 million cycles, RB test, R=-1, Kt=1.
COMPARISON OF PIN DISC WEAR RESISTANCE OF 225XE VS. AA2618

Comparison of Pin on Disc Wear Resistance 225XE vs AA2618 alloy at 50 N - 10,000 cycles against 4340 steel pin.

To learn more about SupremEX® metal matrix composites, visit www.materion.com/supremex. To speak with an engineer, call 1.216.692.3108 or 44.1252.375001.