Celazole® T–Series

Injection Molding Thermoplastic Polymers

**TU-60 — Unfilled**
— high temperature performance, chemical resistant, V-0 flame rating

**TL-60 — Self lubricating**
— superior wear resistance, low friction and cool running... even under load

**TF-60V — Glass fiber reinforced**
— thermal and electrical insulation, low creep, high strength

**TF-60C — Carbon fiber reinforced**
— highest strength, very low fatigue; a mechanical workhorse in the heat
Celazole T-Series Overview

T-Series Explained

T-Series products are composites of Celazole PBI and polyaryetherketones and come in formulations designed for some of the most demanding industrial, chemical, petrochemical and semiconductor applications imagined.

At the heart of the T-Series compound is Polybenzimidazole (PBI) – the world’s highest performing thermoplastic; a highly stable linear heterocyclic polymer known for its exceptionally high (427°C) glass transition temperature, high strength, thermal stability and broad chemical resistance. Tractability for injection molding and extrusion is obtained by compounding the PBI with polyetheretherketone (PEEK). Independently, PEEK is a high performance thermoplastic with excellent mechanical properties, chemical resistance and thermal stability, but when compounded with PBI, certain performance advantages of PBI carry through to the composite, while the processability of PEEK makes the products more functional.

T-Series Value Proposition

The advantage of T-Series over ordinary PEEK is the unexpected property set that results from the combination with PBI and other fillers (when present) that yield higher heat deflection temperatures (HDT), higher moduli, higher strength, improved wear resistance and lower creep. In the T-Series composites, HDT’s can be raised to 330°C, just below the crystalline melting point of PEEK. The effect can be observed in the accompanying dynamic mechanical analysis (DMA) chart for TU-60 on this page.

A desirable balance of performance and tractability is obtained with the T-Series products that place the group’s thermo-mechanical performance above PEEK, but below PBI. T-Series is designed for injection molding of parts that perform, but are cost effectively produced.

Celazole TU-60 DMA Storage Modulus compared with PEEK and PBI
Celazole T-Series is ideal for parts at elevated temperature

Celazole T-Series products:
- have excellent mechanical properties that are maintained well above the Tg of the PEEK component;
- exhibit particularly low strain over time as compared to polyimide and filled PEEK’s, even at 300C;
- allows users to enjoy improved levels of equipment performance, weight savings and/or thinner smaller profiles;
- are particularly suited for mechanical service applications with high load at elevated temperatures;
- have excellent thermal stability — enabling metal replacement;
- self-lubricating TL-60 displays low wear rates under conditions of high pressure (P) and velocity (V), a high limiting PV and cool operating temperatures in a lubricant free environment.

Comparing DMA Creep Resistance at 300C
Celazole TL-60 has exceptional tribological performance

Comparative Wear

In a thrust washer configuration wear test of high performance engineering plastics used in tribological applications, Celazole TL-60 proved itself an exceptional wear grade material. Over the range of 50 — 800 ft/min, TL-60 exhibited the lowest wear factors, the lowest coefficients of friction and the coolest counter-surface running temperatures in the group including wear grades of: polyetheretherketone (PEEK), polyamide-imide (PAI) and polyimide (PI).

Because TL-60 is such a low friction material, it runs the coolest. That means longer part life. TL-60’s counter surface temperature averaged more than 50F cooler than PAI wear grade and 150F cooler than PI wear grade.

PBI adds strength and thermal resistance to TL-60, making it the ideal choice for high load applications at moderate and low speeds. In the wear test, TL-60 was the only material to endure PV’s of 125,000 — 200,000 at the 50 ft/min speed and loads of 2500 — 4000 psi. All other materials failed by breaking or melting at these conditions.

Note: Figures at left show only the 3 best performing grades tested.
## Celazole T-Series Injection Molding Recommendations

### Set-up

<table>
<thead>
<tr>
<th>Equipment Requirement</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine Temperature Capability</td>
<td>450°C (845°F)</td>
</tr>
<tr>
<td>Cylinder &amp; Screw</td>
<td>Abrasion Resistant; HRC hardness 56-60</td>
</tr>
<tr>
<td>Injection Pressure</td>
<td>200-250 MPa (26 – 36 kpsi)</td>
</tr>
<tr>
<td>Injection Speed</td>
<td>High speed; up to 400 cm³/sec</td>
</tr>
<tr>
<td>Temperature Control</td>
<td>Cartridge heater for molds</td>
</tr>
</tbody>
</table>

### Temperature Profile (°C)

<table>
<thead>
<tr>
<th>Cylinder Nozzle</th>
<th>TU-60</th>
<th>TF-60C</th>
<th>TF-60V</th>
<th>TL-60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder Front</td>
<td>430</td>
<td>450</td>
<td>450</td>
<td>450</td>
</tr>
<tr>
<td>Cylinder Middle</td>
<td>420</td>
<td>420</td>
<td>420</td>
<td>420</td>
</tr>
<tr>
<td>Cylinder End</td>
<td>380</td>
<td>380</td>
<td>380</td>
<td>380</td>
</tr>
<tr>
<td>Mold</td>
<td>200</td>
<td>210</td>
<td>210</td>
<td>210</td>
</tr>
</tbody>
</table>

### Injection Speed

- **Typical**: 200 cm³/sec or less
- **Thin parts (.4-.5mm)**: 400 cm³/sec

### Mold Requirements

- **Mold Surface**: Cr Steel; HRC hardness 50-60
- **Sprue**: Taper 2-5 degrees; mirrored face

### Pellet Storage/ Drying

- **Storage**: Keep dry; use soon after opening
- **Dry before use**: 6hr @ 210°C (410°F); -40°C dew point
Celazole® T-Series Application Space

Bearing cages
Bushings
Compressor vanes
Conveyor systems
Dynamic load bearing components
Dynamic seals
Electrical connectors
End effector pads
Gears
Glass handling
Metal spinning rollers
Office equipment
Oil field equipment
Oven conveyors
Piston rings
Plane bearings
Planetary gears
Plasma torch tips, insulators, swirl baffles
Pump bearings
Semiconductor wafer transportation
Sliding surfaces
Soldering equipment
Synchronizer rings
Temperature sensor housings
Textile equipment
Thrust washers
Tilt pad bearings
Turbines
Turbo charger bushings
Valve seats, stem seals, packings