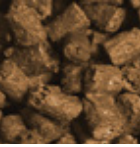


# Celazole<sup>®</sup> T-Series

Injection Molding  
Thermoplastic  
Polymers





## 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

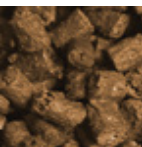
#### **TF-60C – Carbon fiber reinforced**

- Highest strength, very low fatigue; a mechanical workhorse in the heat

### Celazole T-Series Applications

- 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





## Celazole T-Series Overview

### T-Series Explained

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

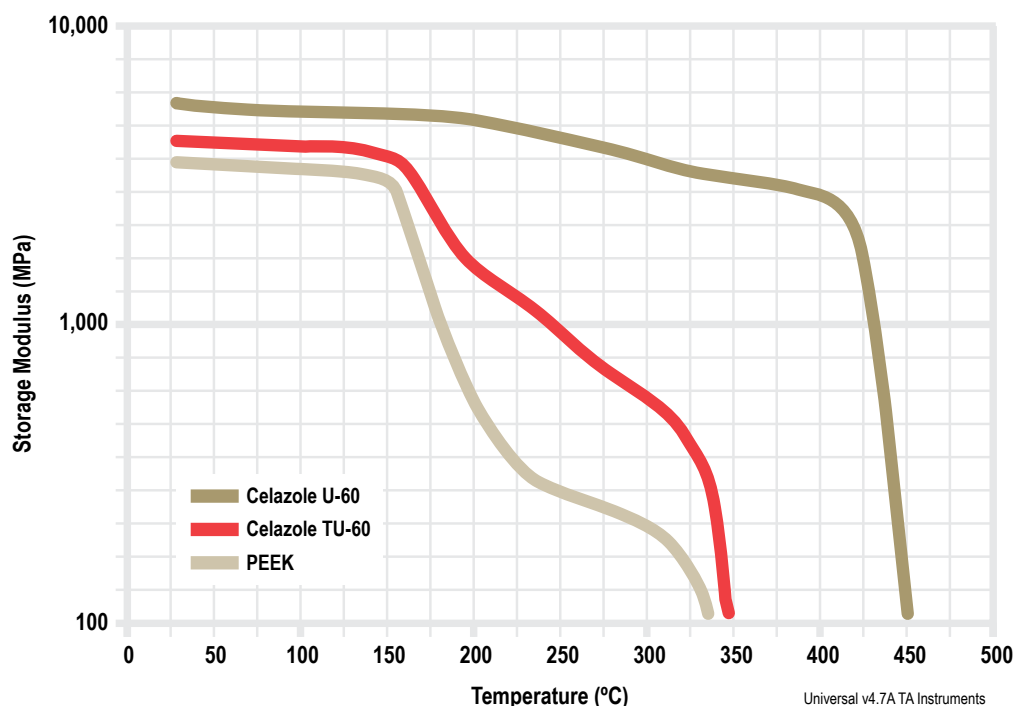
At the heart of the T-Series compound is Polybenzimidazole (PBI) – the world's highest performing thermoplastic; a highly stable linear heterocyclic polymer known for its exceptionally high (427°C) glass transition temperature, high strength, thermal stability and broad chemical resistance. Tractability 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

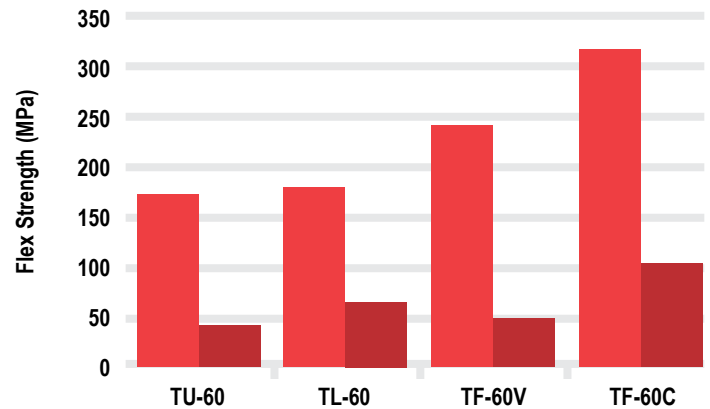


# Celazole T-Series is ideal for parts at elevated temperature

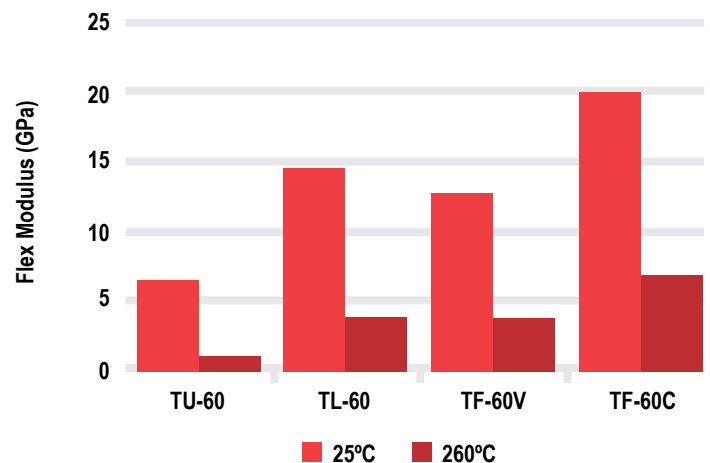
## Celazole T-Series Products:

- Have excellent mechanical properties that are maintained well above the 143°C Tg of the PEEK component
- Exhibit particularly low strain over time as compared to polyimide and filled PEEK's, even at 300°C
- 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

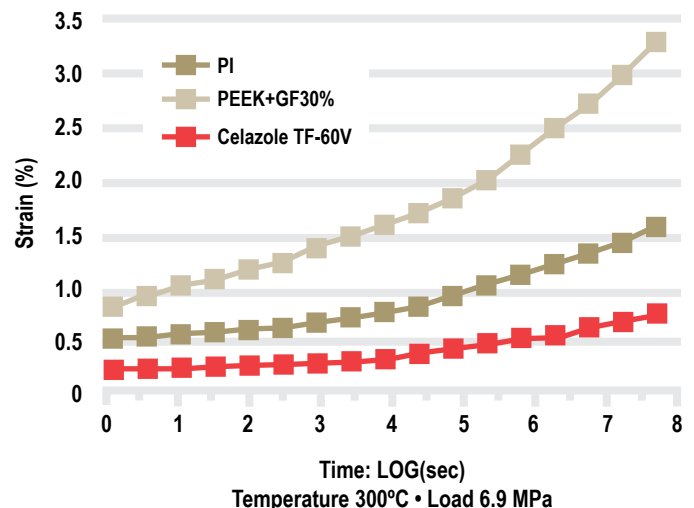
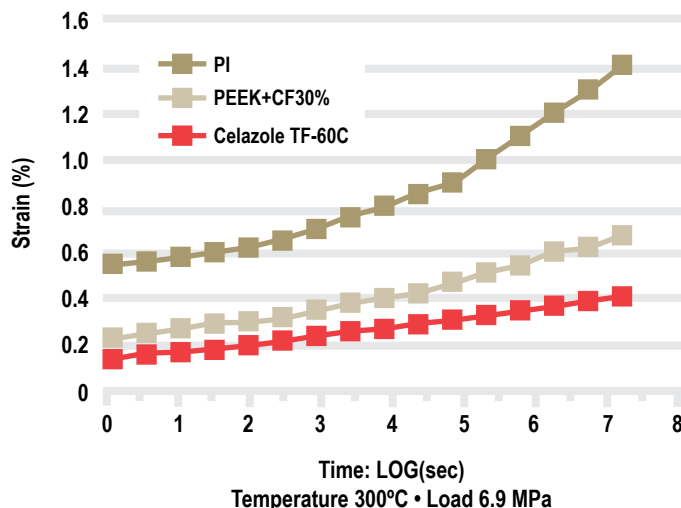
## Celazole T-Series – Strength vs. Temperature

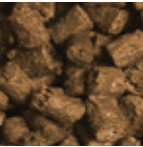


## Celazole T-Series – Modulus vs. Temperature



## Comparing DMA Creep Resistance at 300°C





# Celazole TL-60 has exceptional tribological performance

## Comparative Wear

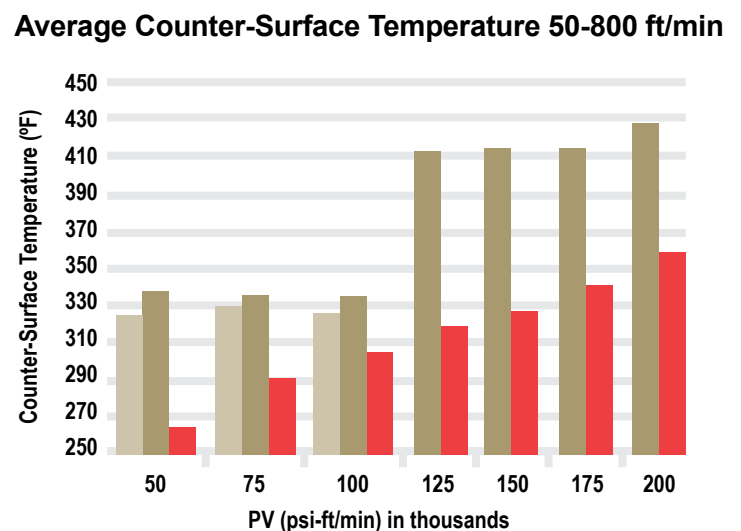
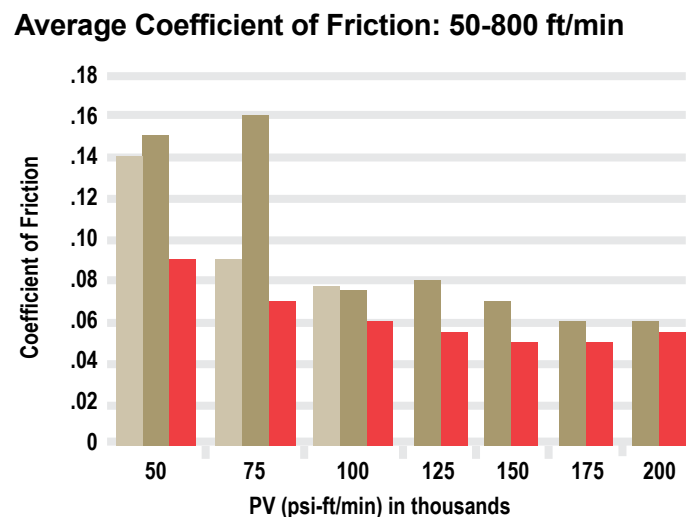
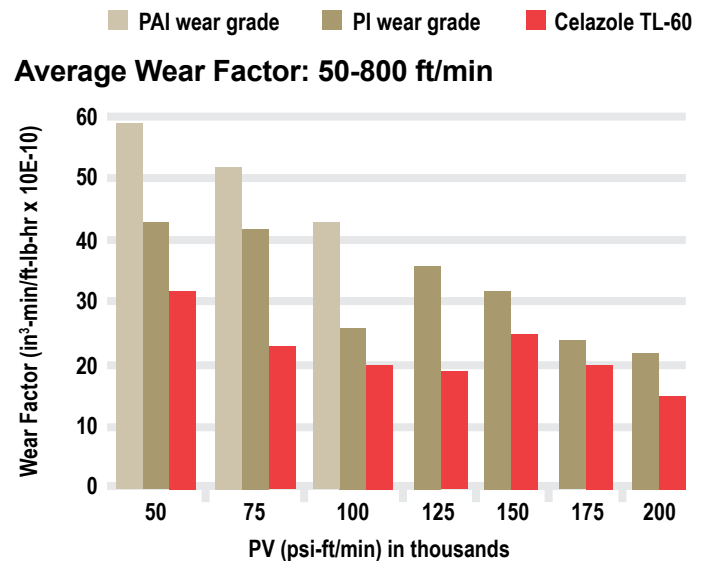
In a thrust washer configuration wear test of competitive engineering plastics used in tribological applications, Celazole TL-60 proved itself an exceptional wear grade material. Over the range of 50 — 800 ft/min, TL-60 exhibited the lowest wear factors, the lowest coefficients of friction and the coolest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

Between 50 and 100,000 PV, the Wear Factors for wear grade PEEK were 4.6 times those of TL-60; wear grade PAI was 2.1 times higher; and wear grade PI 1.5 times higher than TL-60. The lower value (e.g. TL-60) is better, as a lower wear factor means less wear.

Because TL-60 is such a low friction material, it runs the coolest. That means longer part life. Between 50,000 and 100,000 PV across the full range of speeds, TL-60 ran nearly 100F cooler than wear grade PEEK; 50F cooler than wear grade PI; and more than 40F cooler than wear grade PAI.

TL-60 is both strong and thermal resistant – 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. The other materials failed by breaking or melting at these conditions.

*Note: The data set for wear grade PEEK is not depicted in the Figures at right since it was well outside the group of the best 3 materials. Data for PAI does not continue beyond 100,000 PV because it melted during the 125,000 PV test. For complete data set and full details download the High PV Wear Study on [www.CelazolePBI.com](http://www.CelazolePBI.com).*



# Celazole T-Series Injection Molding Recommendations

## Set-up

### Equipment Requirement

|                                |                                            |
|--------------------------------|--------------------------------------------|
| Machine Temperature Capability | 450°C (845°F)                              |
| Cylinder & Screw               | Abrasion Resistant; HRC hardness 56-60     |
| Injection Pressure             | 200-250 MPa (26–36 kpsi)                   |
| Injection Speed                | High speed; up to 400 cm <sup>3</sup> /sec |
| Temperature Control            | Cartridge heater for molds                 |

## Recommendation

| Temperature Profile (°C) | TU-60 | TF-60C | TF-60V | TL-60 |
|--------------------------|-------|--------|--------|-------|
| Cylinder Nozzle          | 430   | 450    | 450    | 450   |
| Cylinder Front           | 430   | 450    | 450    | 450   |
| Cylinder Middle          | 420   | 420    | 420    | 420   |
| Cylinder End             | 380   | 380    | 380    | 380   |
| Mold                     | 200   | 210    | 210    | 210   |

### Injection Speed

|                      |                                  |
|----------------------|----------------------------------|
| Typical              | 200 cm <sup>3</sup> /sec or less |
| Thin parts (.4-.5mm) | 400 cm <sup>3</sup> /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 |

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