## CASE STUDY:

# One Word Sums Up Performance Requirements for Plastics in Deep Space: Reliability

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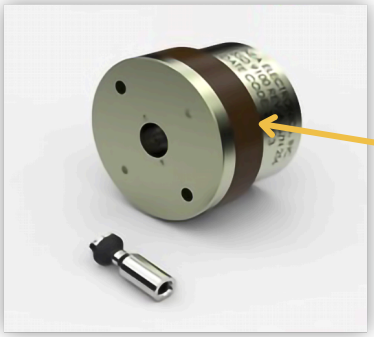
*From launch through deployment sequences, the James Webb Space Telescope required uncompromised performance from all operating mechanisms. The demand for reliability in conditions of deep space narrowed the field of candidate materials for mission-critical components. Torlon 5030 emerged as the solution for devices crucial to various deployment stages of the telescope.*

Among the mission-critical components aboard the James Webb Space Telescope are the non-explosive actuators (NEAs) utilized in the Hold Down Release Mechanisms (HDRMs). The HDRMs are essential to deploying various systems of the telescope.

Engineers at Ensign-Bickford Aerospace & Defense (EBAD) who developed the non-explosive actuators evaluated several materials for components of their devices. Their work with Drake Plastics' applications team led to the specification of Torlon 5030, a 30% glass fiber reinforced polyamide-imide (PAI) polymer supplied by Syensqo*.




*Non-explosive actuator for Webb Telescope Hold Down Release Mechanism (HDRM) relies on components machined from Torlon 5030 rod.*

***Photo**: Ensign-Bickford Aerospace & Defense*

## TORLON 5030 PERFORMANCE CHARACTERISTICS

Torlon 5030 provides superior strength and stiffness relative to other high performance polymers. For example, its flexural modulus exceeds that of 30% glass-reinforced Ultem PEI and Vespel PI. (*Table 1)*. The high-performance Torlon 5030 grade also maintains high structural strength even as temperatures rise to over 200°C. In addition, it has superior resistance to creep, or deformation under high physical loads, at high temperatures. Further, the material's exceptionally low coefficient of liner thermal expansion translates to high dimensional stability in components experiencing the wide temperature swings from launch through deep space deployment.

***Table 1: Performance Comparison - High-Performance Polymers***

| Properties | Torlon 5030 [1] 30% glass fiber | PEEK GF30 [1] 30% glass fiber | Ultem 2300 [2] 30% glass fiber | Vespel SP-21 [3] *See note[4]* |
|---|---|---|---|---|
| Flexural Modulus MPa @ 23°C | 11,700 | 10,300 | 9,000 | 3,792 |
| Flexural Modulus MPa @ >200°C | 9,860 @ 232°C | NA *(Tg = 150)* | 8,000 @ 217°C | 2,551 @ 260°C |
| Tensile Strength MPa @ 23°C | 221 | 158 | 158 | 65.5 |
| Compressive Strength MPa @ 23°C | 264 | 169 | 221 | 133 |
| Glass Transition Temp. (Tg) °C | 280 | 150 | 218 | None[5] |

*[1-3] Data Sources:*
*[1]Syensqo ( Formerly Solvay Specialty Polymers); [2]SABIC Innovative Polymers; [3]E.I DuPont de Nemours*
*[4]Graphite additive. No glass-reinforced grades available.*
*[5]No observable Tg (softening point) below PI decomposition temperature of over 400°C*

### *Torlon PAI Cryogenic Properties, Radiation Resistance*

Two important factors associated with a polymer's reliability in the telescope's deep space operating environment are its performance in cryogenic temperatures, and its tolerance to extended radiation exposure.

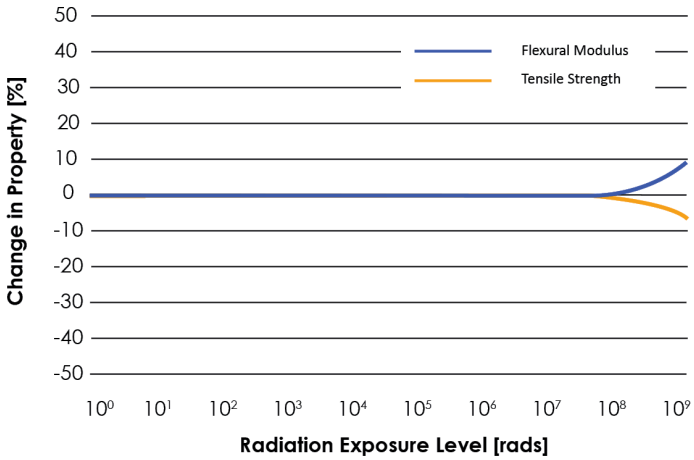
Among high-performance polymers, Torlon 5030 is recognized for its ability to maintain high levels of strength and toughness at low temperature extremes *(Table 2)*. Torlon PAI also retains its mechanical properties very well after extended exposure to high levels of radiation. Graph 1 illustrates the[9]strength and ductility retention of a typical Torlon grade after exposure to 10  rads.

***Table 2: Torlon 5030 Cryogenic Property Retention****

| Property | @23°C / 73.4°F | @ -196°C / -321°F |
|---|---|---|
| Tensile Strength, MPa | 221 | 203 |
| Elongation at Break, % | 7 | 4 |
| Flexural Strength, MPa | 333 | 374 |
| Flexural Modulus, MPa | 11,700 | 14,000 |

*Data Source: Syensqo (formerly Solvay)**

***Graph 1: Torlon 5030 PAI Radiation Resistance****




**Data source: U.S. Department of Energy Study*

## DRAKE AND EBAD COLLABORATIVE PROJECT

Drake Plastics extrudes semi-finished shapes in several advanced polymers including Syensqo's Torlon PAI family of polymers. The company precision-machines the actuator components from their Torlon 5030 rod for the Ensign-Bickford application.

According to the engineering team at EBAD, its unique combination of performance characteristics made Torlon 5030 the ideal choice for applications in space where materials must perform reliably for long periods in harsh and sometimes unknown environments.

**Syensqo is the new corporate designation for the former Solvay Specialty Polymers business.*

DRAKE

**Drake Plastics Co, Ltd.** is a Syensqo-approved Torlon PAI injection molder with over 25 years' experience in extruding, injection molding, post-finishing and machining ultra high-performance polymers. Its expertise includes Torlon PAI, Vespel® PI, PEEK, high-temperature PEEK, PEK and PEKK, Ryton® PPS, PAEK and Ultem PEI. The company also serves precision machining customers worldwide with an unmatched size range of semi-finished machinable shapes in multiple grades of these advanced materials.