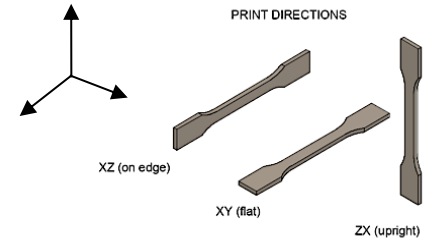


### General Information

TenneT PI

Material class: Polyimide



### Product Highlights

- Highest Z-strength
- Inherent flame retardant
- Easy to print Polyimide
- Material meets EN45545-2 with HL1/2/3 according to requirements R22/R23

| Property                                    | Method           | Units             | Value         |                   |                    |
|---|------------------|-------------------|---------------|-------------------|--------------------|
|   |                  |                   | XY*<br>(flat) | XZ**<br>(on edge) | ZX***<br>(upright) |
| * Print orientation -45°/45°                |                  |                   |               |                   |                    |
| <b>Mechanical properties</b>                |                  |                   |               |                   |                    |
| Tensile Strength *                          | ISO 527 Type 1BA | MPa               | 83            | 89                | 68                 |
| Tensile Modulus*                            | ISO 527 Type 1BA | GPa               | 2.73          | 2.89              | 2.56               |
| Strain at Break *                           | ISO 527 Type 1BA | %                 | 4.8           | 4.8               | 3.5                |
| Tensile Strength **                         | ISO 527 Type 1BA | MPa               | -             | 100               | 54                 |
| Tensile Modulus **                          | ISO 527 Type 1BA | GPa               | -             | 2.87              | 2.42               |
| Strain at Break **                          | ISO 527 Type 1BA | %                 | -             | 5.4               | 2.6                |
| Tensile Strength ***                        | ASTM 1708        | MPa               | -             | -                 | 96                 |
| Tensile Modulus***                          | ASTM 1708        | GPa               | -             | -                 | 2.29               |
| Strain at Break ***                         | ASTM 1708        | %                 | -             | -                 | 4.88               |
| Impact Strength Izod (notched) **           | ISO 180          | KJ/m <sup>2</sup> | 5.3           | 5.3               | 4.3                |
| Impact Strength Izod (unnotched) **         | ISO 180          | KJ/m <sup>2</sup> | 29            | 28                | 26                 |
| <b>Thermal properties</b>                   |                  |                   |               |                   |                    |
| Flammability 0,75 mm                        | UL 94            | -                 | -             | -                 | -                  |
| Flammability 1,6 mm                         | UL 94            | -                 | -             | -                 | -                  |
| Melting point                               | DMA              | °C                | -             |                   |                    |
| Glass transition temperature (Tg)           | DMA              | °C                | 195           |                   |                    |
| Temp. of deflection under load (1.80 MPa) * | ISO 75-1/-2      | °C                | 167           |                   |                    |
| Temp. of deflection under load (0.45 MPa) * | ISO 75-1/-2      | °C                | 175           |                   |                    |

\* Printed flat on bed representing XY 90°C Chamber

\*\* XZ/ZX Bars cut out of 3D printed plates on edge and in Z direction printed according to guidelines

\*\*\* Single wall data on Z-strength printed according to guidelines

## Standardized Technical data sheet

| Property                             | Method   | Units   | Value    |                               |
|--------------------------------------|----------|---------|----------|-------------------------------|
| <b>Thermal properties</b>            |          |         |          |                               |
| * Print orientation -45°/45°         |          |         | XY* Flat | XZ (on edge) and ZX (upright) |
| CTE (-45/45 infill) -50 °C to 60 °C  | ASTM 831 | ppm/°C  | 43.05    | 46.64                         |
|                                      | ASTM 831 | ppm/°F  | 23.92    | 25.91                         |
| CTE (-45/45 infill) 60°C to 120 °C   | ASTM 831 | ppm/ °C | 53.95    | 58.52                         |
|                                      | ASTM 831 | ppm/°F  | 29.97    | 32.51                         |
| CTE (-45/45 infill) 120 °C to 190 °C | ASTM 831 | ppm/ °C | 62.51    | 67.74                         |
|                                      | ASTM 831 | ppm/°F  | 34.73    | 37.63                         |
| CTE (90° XZ infill) -50 °C to 60 °C  | ASTM 831 | ppm/ °C | 50.15    | 44.68                         |
|                                      | ASTM 831 | ppm/°F  | 27.86    | 24.82                         |
| CTE (90° XZ infill) 60°C to 120 °C   | ASTM 831 | ppm/ °C | 61.07    | 58.30                         |
|                                      | ASTM 831 | ppm/°F  | 33.92    | 32.38                         |
| CTE (90° XZ infill) 120 °C to 190 °C | ASTM 831 | ppm/ °C | 68.64    | 65.23                         |
|                                      | ASTM 831 | ppm/°F  | 38.13    | 36.23                         |
| Td at 1% loss                        | DMA      | °C      | 343      |                               |
| Td                                   | DMA      | °C      | 460      |                               |

| Property                      | Method                            | Units | Value                |      |
|-------------------------------|-----------------------------------|-------|----------------------|------|
| <b>Flame Characteristics*</b> |                                   |       |                      |      |
| Smoke opacity                 | ISO 5659-2<br>25kW/m <sup>2</sup> | -     | $D_s(4)$             | 0.7  |
|                               |                                   |       | VOF <sub>4</sub>     | 0.8  |
|                               |                                   |       | Dm                   | 80.6 |
| Limit Oxygen Index            | ISO 4589-2                        | -     | CIT <sub>NLP</sub>   | 0.45 |
| Smoke Toxicity                | NF X 70- 100                      | -     | ILO % O <sup>2</sup> | 32.6 |

\* Tennet PI was printed in XY orientation (4mm thick) and tested according EN45545-2. These tests show that this material meets the requirements for:

R22 HL1/2/3 XY orientation 4 mm thickness  
R23 HL1/2/3 XY orientation 4 mm thickness



| Property                       | Method     | Units | Value  |
|--------------------------------|------------|-------|--------|
| <b>Physical properties</b>     |            |       |        |
| Filament diameter (+/- 0,05mm) | -          | mm    | 1.75   |
| Density                        | ISO 1183-1 | g/cm3 | 1.51   |
| <b>Electrical properties</b>   |            |       |        |
| Dielectric constant (1GHz)     | ASTM D150  | -     | 2.87   |
| Dielectric constant (10GHz)    | ASTM D150  | -     | 2.85   |
| Dielectric loss (1GHz)         | ASTM D150  | -     | 0.0094 |
| Dielectric loss (10GHz)        | ASTM D150  | -     | 0.0083 |
| Breakdown voltage              | ASTM D149  | MV/m  | 172    |

| <b>Recommended Processing conditions</b> |  |
|--|--|
| Nozzle temperature                       | Recommended: 405°C (390°C - 410°C)                 |
| Bed temperature                          | Recommended: 160°C (120°C - 160°C)                 |
| Chamber temperature                      | Recommended: 160°C (80°C - 160°C)                  |
| Bed material                             | Glass, PEI Sheet, Carbon plate                     |
| Adhesion promoter                        | Magigoo HT, Nano Polymer Adhesive, GeckoTec EZ-Hot |
| Nozzle diameter                          | ≥ 0.4 mm, Ruby or Hardened recommended             |
| Print speed                              | Recommended 30 mm/s (15-150 mm/s)                  |
| Drying instructions filament             | 120°C, 4-8 Hours                                   |

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