Ultramid® T 4381 LDS

Ultramid® in the web: www.ultramid.de
Ultramid® T 4381 LDS is a semi-crystalline, partially aromatic high-temperature polyamide (PA6/6T) for laser direct structuring (LPKF-LDS®). As the material is reinforced with 10% fiberglass and 25% mineral filling, high-strength mechatronic plastic parts can be manufactured efficiently, quickly and flexibly with LDS. The innovative material offers a broad processing window for optimal results regarding:

- laser activation
- metallization
- adhesion of the conductors

Ultramid T 4381 LDS is based on Ultramid T and offers an ideal combination of high melting temperature, good processability and low water absorption. This specialty from BASF’s engineering plastics is already being used in electrical engineering and automotive construction, especially where high heat distortion temperature is required.

### What is Ultramid® T 4381 LDS?

#### The tried-and-true properties of the base polymer Ultramid® T (PA6/6T)

- High toughness values
- Low water absorption
- Outstanding resistance against chemicals
- Excellent heat distortion temperature (HDT)
- High melting temperature (295°C [563°F])
- Suitable for lead-free soldering (RoHS)
- Good processability
- Good dimensional stability

Circuit carrier by Kromberg & Schubert
With the current laser technology, components measuring up to 220 x 220 x 50 mm³ can be structured. The design of the conductor pattern is only restricted in terms of the areas which the laser beam cannot access. Slanted surfaces and flanks up to an angle of 70° can be structured without having to additionally turn the part.

The advantages of the LPKF-LDS® method:
- Only three process steps: single-component injection molding, laser direct structuring, electroless metallization
- Very high degree of geometric freedom of design
- Great potential for miniaturization (line widths < 200 micrometers)
- Very high flexibility when changing the circuit layout
- Low tool costs

Ultramid® T 4381 LDS is equipped with an extra additive, a metal complex that can be split by a laser. This additive does not alter the electrical insulating properties of the polymer and remains stable at the usual processing temperatures. The additive is split into elementary metal and radical groups, only when exposed to an infrared laser beam at a wavelength of 1064 nanometers.

Ultramid T 4381 LDS can be employed to create all sorts of molded parts by means of the standard injection-molding process. The surfaces are then structured with a laser at exactly the places where conductors are to be created later. In this process, the conductor pattern is practically engraved into the three-dimensional surface. A computer adjusts the laser in such a way that only slight amounts of polymer are removed and, at the same time, enough additive constituents are split. This creates a defined micro-roughness on the surface with embedded metal atoms, which ensures the adhesion of the conductors. The conductors are structured in an electroless, galvanic process using copper, nickel and gold.

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Ultramid® T 4381 LDS is a material intended for injection-molded three-dimensional circuit carriers, so-called MIDs (Molded Interconnected Devices), which are produced by means of laser direct structuring. Such plastic components offer numerous advantages when it comes to designing and manufacturing mechatronic assemblies.

MIDs constitute a novel way to combine electronics with mechanics. With MID technology, the conductors and the electronic components are applied directly onto the surface of a plastic component. Such a 3D-MID integrates the entire contacting, so that wiring or a conventional, separate conductor board becomes completely redundant.

Thanks to the comprehensive design possibilities offered by plastic injection-molding, there are virtually no limits to the shapes of three-dimensional circuit carriers that can be created. Moreover, typical mechanical functions such as holders, guides, buttons, plugs or other connection elements such as cables can all be integrated. The ingenious combination of electronic and (precision) mechanical components into a single unit opens up completely new levels of freedom in terms of design. Function integration often also reduces the requisite installation space and the weight.

The advantages of 3D-MIDs made with Ultramid T 4381 LDS by means of the LPKF-LDS® method:
- High degree of function integration
- Short process chains
- Fewer materials
- Lower number of individual parts
- Design freedom

### Applications
- Automotive electronics (sensors)
- Telecommunications (antenna modules)
- Computer technology
- Household appliance technology
- Medical technology
- Industrial automation (sensors)
- Entertainment electronics (toys)
## Typical values of Ultramid® T4381 LDS

<table>
<thead>
<tr>
<th>Properties</th>
<th>Symbol</th>
<th>Unit</th>
<th>Test method</th>
<th>Condition</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Density</strong></td>
<td>-</td>
<td>g/cm³</td>
<td>ISO 1183</td>
<td>-</td>
<td>1.57</td>
</tr>
<tr>
<td><strong>Viscosity number</strong> (solution 0.005 g/ml sulfuric acid)</td>
<td>ml/g</td>
<td>ISO 307</td>
<td>-</td>
<td>-</td>
<td>130</td>
</tr>
<tr>
<td><strong>Colour: natural (n), coloured (c), black (bk)</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>bk</td>
</tr>
<tr>
<td><strong>Water absorption, equilibrium in water at 23 °C</strong></td>
<td>%</td>
<td>ISO 62</td>
<td>-</td>
<td>-</td>
<td>4.2 - 5.2</td>
</tr>
<tr>
<td><strong>Moisture absorption, equilibrium (23 °C/50% r.h.)</strong></td>
<td>%</td>
<td>ISO 62</td>
<td>-</td>
<td>-</td>
<td>0.8 - 1.2</td>
</tr>
</tbody>
</table>

### Processing

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit</th>
<th>Test method</th>
<th>Condition</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Melting temperature, DSC</td>
<td>°C</td>
<td>ISO 3146</td>
<td>-</td>
<td>295</td>
</tr>
<tr>
<td>Melt temperature, injection molding and extrusion</td>
<td>°C</td>
<td>-</td>
<td>-</td>
<td>310 - 330</td>
</tr>
<tr>
<td>Mold temperature, injection molding</td>
<td>°C</td>
<td>-</td>
<td>-</td>
<td>70 - 100</td>
</tr>
<tr>
<td>Molding shrinkage, constrained*</td>
<td>%</td>
<td>-</td>
<td>-</td>
<td>0.47</td>
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</tbody>
</table>

### Mechanical properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit</th>
<th>Test method</th>
<th>Condition</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tensile modulus</td>
<td>MPa</td>
<td>ISO 527 - 2</td>
<td>dry/cond.</td>
<td>9000</td>
</tr>
<tr>
<td>Stress at break (v = 5 mm/min)</td>
<td>MPa</td>
<td>ISO 527 - 2</td>
<td>dry/cond.</td>
<td>110</td>
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<tr>
<td>Strain at break</td>
<td>%</td>
<td>ISO 527 - 2</td>
<td>dry/cond.</td>
<td>2</td>
</tr>
<tr>
<td>Charpy unnotched impact strength, +23 °C</td>
<td>kJ/m²</td>
<td>ISO 179/1eU</td>
<td>dry/cond.</td>
<td>35</td>
</tr>
<tr>
<td>Charpy unnotched impact strength, -30 °C</td>
<td>kJ/m²</td>
<td>ISO 179/1eU</td>
<td>dry/cond.</td>
<td>35</td>
</tr>
</tbody>
</table>

### Thermal properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Unit</th>
<th>Test method</th>
<th>Condition</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deflection temperature 0.45 MPa (HDT B)</td>
<td>°C</td>
<td>ISO 75 - 2</td>
<td>-</td>
<td>265</td>
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<tr>
<td>Thermal coefficient of linear expansion, longitudinal/transverse (-40 °C to 80 °C)</td>
<td>10⁻⁴/K</td>
<td>DIN 53752</td>
<td>-</td>
<td>0.3/0.5</td>
</tr>
</tbody>
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### Electrical properties

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<thead>
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<tr>
<td>Dielectric constant at 1 MHz</td>
<td>-</td>
<td>IEC 60250</td>
<td>dry/cond.</td>
<td>4.4/4.2</td>
</tr>
<tr>
<td>Dissipation factor at 1 MHz</td>
<td>10⁻⁴</td>
<td>IEC 60250</td>
<td>dry/cond.</td>
<td>150/380</td>
</tr>
<tr>
<td>Volume resistivity</td>
<td>Ω·m</td>
<td>IEC 60093</td>
<td>dry/cond.</td>
<td>&gt;10⁶/5 &gt;10¹²</td>
</tr>
<tr>
<td>Surface resistivity</td>
<td>Ω</td>
<td>IEC 60093</td>
<td>dry/cond.</td>
<td>&gt;10⁶</td>
</tr>
<tr>
<td>CTI, solution A</td>
<td>-</td>
<td>IEC 60112</td>
<td>cond.</td>
<td>600</td>
</tr>
</tbody>
</table>

* Test box with central gating, dimensions of base (107 x 47 x 1.5)mm, processing conditions: Tmelt = 320 °C, mold surface temp. MST = 120 °C
Note
The data contained in this publication are based on our current knowledge and experience. In view of the many factors that may affect processing and application of our product, these data do not relieve processors from carrying out own investigations and tests; neither do these data imply any guarantee of certain properties, nor the suitability of the product for a specific purpose. Any descriptions, drawings, photographs, data, proportions, weights etc. given herein may change without prior information and do not constitute the agreed contractual quality of the product. It is the responsibility of the recipient of our products to ensure that any proprietary rights and existing laws and legislation are observed. (August 2010)