**Introduction**
This document is an introductory guide to familiarize the reader with HexPly® M79 products.

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1 General

Hexcel is a world leader in prepreg technology with a range of HexPly® prepregs developed and optimized for specific industries.

Prepregs are specially formulated resin matrix systems which are reinforced with fibers such as carbon, glass and aramid. Hexcel holds a unique advantage over many of the competitors in that it produces its own in-house supply of carbon fiber and has world-class weaving facilities for the development of optimum reinforcement technologies to complement the prepreg resin formulations.

Prepreg is the ultimate composite material. Thermoset resin cures at elevated temperatures and undergoes a chemical reaction that transforms the prepreg into a solid structural material that is highly durable, temperature resistant, exceptionally stiff and extremely lightweight.

For general information regarding prepreg manufacturing and reinforcement types please refer to the following guides (that can be found on the Hexcel website).

- HexPly® Prepreg Technology Brochure
- HexForce® and HexPly® Selector Guides

2 Benefits of HexPly® M79 prepreg

**Versatile combination material**
- Low cure temperature of 70 – 100°C (158-212°F)
- No dwell time needed
- Suitable for combination with temperature-sensitive synthetic core materials and other low temperature plastics
- No requirement for temperature resistant vacuum foams
- Usage of cost-intensive high temperature mold building materials obsolete

**Adaptive to the needs of industrial manufacturing**

**Reproducible quality**
- Controlled „ready-to-use“ product form
- Comprehensive quality tracking
- Translucent resin after cure – control of final parts possible

**Flexible**
- Different tack levels available for convenient manual handling – no influence on reactivity
- Long storage stability at room temperature: 6 weeks at 23° C (73,4°F)

**Clean & Safe**
- Simplified cure profiles & process temperature control
- Low exotherm (~70-100 J/g) ensure repeatable curing profile
- No combined heating-cooling systems required
- Environmental, Health and Safety Management
- Solvent-free
- REACH compliant
3 General Applications

The hot melt epoxy resin matrix is designed for prepreg applications where a cure temperature in the range of 70 – 100°C (158-212°F) is required.

- Good adhesion to core materials including thermoplastic PU foam or balsa
- Ideal for large industrial components which contain thin and thick segments
- Especially suited for the cure of very thick sections

Typical applications for HexPly® M79

Marine applications
- Premium segment yachts: hulls, decks, hatchways & components with carbon finish
- Speed & sport boats: hulls
- Sailing boats: masts
- Stealth ships
- Large structural parts in ships

Wind Energy
- Blade shell, root end, ...
- Load carrying elements

Other industrial applications
- Automotive/transport: structural parts, booms
- Industrial machinery: carrier elements, robot arms

Leisure industry
- Sports equipment including paddles, fins, archery

4 Nomenclatures

Resin type
Resin content % in weight
Reinforcement Type and FAW
NCF: Longitudinal (L), Biax (BB), Transversal (T), Unidirectional (UD)
Fiber Type Carbon High Strength (CHS), Glass (G), Aramid (A)

Non-crimp fabrics (NCF) or Unidirectional (UD) prepregs

Resin type M79 / 38% / BB500 / G
Resin content
Reinforcement Type and FAW
NCF: Longitudinal (L), Biax (BB), Transversal (T), Unidirectional (UD)
Fiber Type Carbon High Strength (CHS), Glass (G), Aramid (A)

Fabric Prepregs

Resin type M79 / 42% / 200T2 / CHS
Resin content % in weight
Reinforcement Type and FAW
Plain (P), Twill (e.g. T2/T4), Satin (e.g. H4/H8)
Fiber Type Carbon High Strength (CHS), Glass (G), Aramid (A)

Combination Prepregs

Resin type M79 / 38% / UD600 + 2PES / CHS
Resin content % in weight
Reinforcement Type and FAW
NCF: Longitudinal (L), Biax (BB), Transversal (T), Unidirectional (UD)
Indication of additional reinforcement layer
Combination reinforcement type & FAW
Fleece (F), Polyester Grid (PES), Needlemat (FP)
Fiber Type Carbon High Strength (CHS), Glass (G), Aramid (A)
5. Product Range

HexPly® M79 prepregs are provided in an extensive selection of different reinforcements and fiber orientation. View the selector guide on our website for more detailed information: www.hexcel.com

5.1 Reinforcements

HexPly® M79 prepregs are available with glass, carbon, aramid and other fiber reinforcements in various cured ply thickness. See a selection of our wide range of M79 prepreg products below.

<table>
<thead>
<tr>
<th>Product Type</th>
<th>Reinforcement style</th>
<th>Item Description</th>
<th>Product Width</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>(mm)</td>
</tr>
<tr>
<td>Glass Prepreg</td>
<td>Multiaxial NCF</td>
<td>M79/55%/LB6(0/+80°)/G 1270MM</td>
<td>1270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/70%/BB200/G 1200MM</td>
<td>1260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/35%/BB600/G 1250MM</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/47%/BB1200(+/-80°)/G 1260MM</td>
<td>1260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/40%/BB600/G 1250MM</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/35%/BB600/G 1250MM</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/43%/LB1200/G 1260MM</td>
<td>1260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/50%/BB600/G 1250MM</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/50%/BB1200/G 1260MM</td>
<td>1260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/43%/LBB1200/G 1260MM</td>
<td>1260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/40%/LB600/G 1250MM</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/35%/UD600/G 1250MM</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/40%/LB1200+CV/G SE1500</td>
<td>960</td>
</tr>
<tr>
<td></td>
<td>Multiaxial NCF</td>
<td>M79/43%/LB1200+CV/G SE1500</td>
<td>960</td>
</tr>
<tr>
<td></td>
<td>Unidirectional</td>
<td>M79/32%/UD1200+CV/G</td>
<td>960</td>
</tr>
<tr>
<td>Carbon Prepreg</td>
<td></td>
<td>M79/32%/UD1200/G</td>
<td>1260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/LT/47%/BB1200(+/-80°)/G</td>
<td>1260</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/35%/BB800/G</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/LT/50%/BB600/G</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/42%/BB300/CHS</td>
<td>1270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/35%/UD600+2PES/CHS</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/42%/200T2/CHS-3k</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/42%/600T2/CHS-12K</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/34%/UD300/CHS</td>
<td>1300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/42%/285T2/CHS-12K</td>
<td>1250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/42%/LT400/CHS</td>
<td>1270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/42%/LT300/CHS</td>
<td>1270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/42%/BB400/CHS</td>
<td>1270</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/38%/UD150/CHS</td>
<td>650</td>
</tr>
<tr>
<td></td>
<td></td>
<td>M79/38%/175P/C</td>
<td>1000</td>
</tr>
</tbody>
</table>

*NCF= Non-crimp fabric
5.2 Delivery Forms

Hexcel primarily delivers prepreg materials in roll form with easy-to-peel release film (PE: 53μm-75μm/0.0021 in-0.00295 in) and an inner core diameter of 75 mm (2.95 in), 150mm (5.91 in) or 300 mm (11.8 in). Typical roll lengths are between 50 lm to 400 lm. Prepreg widths are available from 100 mm (3.94 in) up to 1300 mm (11.81 in) depending on reinforcement type. Roll weights also vary according to reinforcement type. Depending on its format and dimensions, the products can be delivered in cardboard or wooden boxes (with the product suspended in the center of the box) in metallic cradles or frames (with the product also suspended) or in pallets. Hexcel recommends keeping prepreg in its original packaging prior to use.

6 Physical Properties

HexPly® M79 is a formulated epoxy resin matrix, specially designed for prepreg applications allowing cure temperatures from 70 – 100°C (158-212°F).

The M79 resin matrix is highly tolerant of a wide variety of production techniques and process conditions and features low exothermic properties.

**Density**

1.1 – 1.2 g/cm³

**Viscosity**

Minimum viscosity 1.6Pas at 94°C (201°F) (heat up rate 2°C (35°F)/min)

**Recommended cure cycles**

The following isothermal cure times can be used and relate to a conversion of at least 95% of the resin.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Time</th>
<th>Tg cured</th>
</tr>
</thead>
<tbody>
<tr>
<td>70°C</td>
<td>158°F</td>
<td>480 min</td>
</tr>
<tr>
<td>80°C</td>
<td>176°F</td>
<td>240 min</td>
</tr>
<tr>
<td>90°C</td>
<td>194°F</td>
<td>130 min</td>
</tr>
<tr>
<td>100°C</td>
<td>212°F</td>
<td>75 min</td>
</tr>
</tbody>
</table>

Maximal TG cured 105°C (221°F) for HexPly® M79
Rheology
The cure behavior of the system is shown in the graph below (measured by rotary rheometer).

Reactivity
HexPly® M79 is a low-temperature and low-exothermic system. The enthalpy generated is low. This allows much thicker parts to be produced with this system and provides greater freedom in the cure cycle, for example eliminating the dwell time.

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Enthalpy (J/g)</th>
<th>Cold Tg (°C) / (°F)</th>
<th>Onset (°C)</th>
<th>Peak (°C) / (°F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M79</td>
<td>70.0</td>
<td>5.60 / 42.1</td>
<td>123.5</td>
<td>143.7 / 290.7</td>
</tr>
</tbody>
</table>

DSC Dynamic Test: temperature sweep from -40°C to 270°C at 10°C/min (-40°F to 518°F at 50°F/min), afterwards a second sweep is carried out.
7  Mechanical Properties

<table>
<thead>
<tr>
<th>Properties</th>
<th>Test Method</th>
<th>LBB1200+CV</th>
<th>300H8</th>
<th>600T2</th>
<th>200T2</th>
<th>UD150</th>
<th>UD600+2P (50k fiber)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0° Tensile Strength (MPa)</td>
<td>EN ISO 527</td>
<td>600</td>
<td>500</td>
<td>830</td>
<td>955</td>
<td>2880</td>
<td>2300</td>
</tr>
<tr>
<td>Modulus (GPa)</td>
<td></td>
<td>25</td>
<td>28</td>
<td>56</td>
<td>60</td>
<td>117</td>
<td>135</td>
</tr>
<tr>
<td>0° Compression Strength (MPa)</td>
<td>EN ISO 14126</td>
<td>520</td>
<td>-</td>
<td>570</td>
<td>750</td>
<td>1270</td>
<td>1400</td>
</tr>
<tr>
<td>Modulus (GPa)</td>
<td></td>
<td>27</td>
<td>-</td>
<td>54</td>
<td>57</td>
<td>128</td>
<td>123</td>
</tr>
<tr>
<td>0° Flexural Strength (MPa)</td>
<td>EN ISO 14125</td>
<td>-</td>
<td>650</td>
<td>700</td>
<td>840</td>
<td>1810</td>
<td>-</td>
</tr>
<tr>
<td>Modulus (GPa)</td>
<td></td>
<td>-</td>
<td>25</td>
<td>50</td>
<td>46</td>
<td>120</td>
<td>-</td>
</tr>
<tr>
<td>0° Interlaminar Shear Strength (MPa)</td>
<td>EN ISO 14130</td>
<td>40</td>
<td>60</td>
<td>56</td>
<td>63</td>
<td>68</td>
<td>70</td>
</tr>
</tbody>
</table>

Results for multiaxial prepregs are normalized to 50% fiber volume.
Results for unidirectional prepregs are normalized to 60% fiber volume.
Data is based on limited batches of production material.

8  Transport and Storage

Prepreg should be stored as it is received, preferably in a freezer (-18°C / -0,4°F) and must be kept sealed and out of the sunlight.

In unfrozen state prepreg rolls may deform due to own weight – ideally handle unfrozen rolls in hanging position.

### Shelf Life and Out Life

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>Values</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>-18°C</td>
<td>0°F</td>
<td>18 months</td>
</tr>
<tr>
<td>5°C</td>
<td>41°F</td>
<td>6 months</td>
</tr>
<tr>
<td>23°C</td>
<td>73°F</td>
<td>6 weeks</td>
</tr>
</tbody>
</table>
9 Process

**Conditioning before use**
After removal from the cold store, prepreg should be allowed to reach room temperature before opening the polyethylene bag, thus preventing condensation and avoiding water contamination. This tempering phase depends on the type of product, but it can take between 24 and 48 hours for a full packaged roll.

**Process parameter**
Temperature and humidity affect the resin tack and viscosity and can lead to different handling of the HexPly® M79 prepreg. Constant environmental conditions are required to assure consistent quality and handling properties. Moderated and controlled temperatures between 16°C (61°F) and 25°C (77°F) depending on the specific product are recommended.

There are different parameters that influence the quality of the final product and are important to acknowledge:

- **Temperature & Heat**: For thick parts the resin exotherm can be a leading factor
- **Pressure**: Could change substantially during the cure
- **Time**: Always related to the cure temperatures
- **Tooling materials**: Can act as a heat sink and affect degree of cure
- **Part Geometry and Design**: The more complex the geometry the more difficult it is to achieve uniform consolidation and avoid wrinkling
- **Vacuum Strategy**: Designing the air extraction shape, air tightness during the process

10 Health and Safety

The usual precautions when handling uncured synthetic resins and fine fibrous materials should be observed. The use of clean disposable inert gloves provides protection for the operator and prevents contamination of material and components. Please refer to product MSDS for further and up-to-date information specific to this product.
List of Abbreviations

GPa: GigaPascal, equivalent to 10⁹ N/mm²

gsm: grams per square meter

Min: Minutes

MPa: MegaPascal, equivalent to 10⁶ N/mm²

P: Pressure

s: Second

T: Temperature in Celsius (°C) unless expressly otherwise indicated

t: Time

The following common terms relating to prepreg technology (in alphabetical order):

- **Anisotropy**: The tendency of a material to exhibit differently along the directions parallel to the length or width of the lamination planes; or parallel to the thickness into the planes perpendicular to the lamination.

- **Autoclave**: A closed vessel that permits at the same time and independently the application of pressure, vacuum and heat used for processing composite materials.

- **Compression Molding**: A technique for molding thermoset plastics in which a part is shaped by placing the fiber and resin into an open mold cavity, closing the mold, and applying heat and pressure until the material has cured or achieved its final form.

- **Degree of Cure**: part of the potential total reaction that has been achieved at a certain point

- **Cure Cycle**: This is the time duration and temperature needed for the resin in the prepreg to harden.

- **DEA (Dielectric Analysis)**: A materials characterization technique used for investigating the viscosity and curing behavior of resin systems.

- **Debulking**: The application of vacuum pressure at specific points in the lay-up sequence to ensure full consolidation of the prepreg plies.

- **DSC (Differential Scanning Calorimetry)**: A thermo-analytical technique that is used to measure heat driven processes in a sample by measuring the amount of energy absorbed or released by the sample when it is heated or cooled.

- **Elongation**: Defined as the length at breaking point expressed as a percentage of its original length.

- **Exothermic Process**: Process or reaction that releases energy, usually in the form of heat, from the system to its surroundings.

- **Fiber Volume Fraction (FVF)**: Percentage of fiber in a material (by volume). Also known as Fiber Volume Content.

- **Flow**: The ability of the resin to move under pressure and/or heat allowing it to saturate all parts of a laminate.

- **Fiber Areal Weight (FAW)**: The weight of fabric used in a prepreg and measured per areal unit (gsm).

- **Glass Transition Temperature (Tg)**: Temperature at which a phase change occurs in the matrix, which gives an indication of the maximum service temperature.

- **Cure Cycle**: The number of plies and their orientation needed to produce a given part.

- **Out Life**: The maximum period of time that a prepreg remains usable at workshop temperature between removal from the freezer and cure.

- **Multiaxial**: Referred to a fabric which has several fiber orientations.

- **Peel Ply**: Layer of material applied to a prepreg layup surface that is removed from the cured laminate prior to bonding operations and leaves a clean resin-rich surface ready for bonding.

- **Ply**: A layer of prepreg.

- **Resin Weight (%RW)**: Percentage of resin in the prepreg (by weight).

- **Shelf Life**: The maximum storage life for prepreg when stored under specified conditions and remains usable.

- **Tack**: Measurement of the capability of an uncured prepreg to adhere to itself or to the tool.

- **Tack Life**: Period of time at a given temperature that the prepreg has sufficient tack for its application.

- **Uniaxial**: Referred to a fabric with a single fiber orientation (same as unidirectional).

- **Vacuum Bagging Technique**: This refers to the arrangement of vacuum bagging materials used when molding a part via vacuum or autoclave processing.

- **Viscosity**: Resistance of a fluid or viscoelastic solid to gradual deformation by shear stress or tensile stress.
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Hexcel is a leading worldwide supplier of composite materials to aerospace and industrial markets. Our comprehensive range includes:

- HexTow® carbon fibers
- HexForce® reinforcements
- HiMax™ multiaxial reinforcements
- HexPly® prepregs
- HexMC® molding compounds
- Polyspeed® laminates
- Modipur® polyurethanes
- HexFlow® RTM resins
- Redux® adhesives
- HexTool® tooling materials
- HexWeb® honeycomb
- Acousti-Cap® sound attenuating honeycomb
- Engineered core
- Engineered products