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2. Proxima® resins
3. Examples of market segment positioning
   • Oil & gas
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5. The Materia difference
Proxima® resins combine high temperature stability with high impact toughness.
PROXIMA® PROCESSING VALUE PROPOSITION HIGHLIGHTS

- Processable by a wide variety of methods
- Tunable process window from seconds to hours
- Lower viscosity enables efficient infusion and high filler levels
- Very low capital investment required
MATERIA AT A GLANCE

• A manufacturer of high performance thermoset resins with unique performance properties
• Founded in 1998
• Nobel-prize winning chemistry
• 90 US and 270 foreign patents
• World-class technical services and support
• Only resin system that utilizes Grubbs Catalyst® technology

We enable our global customer base to be more competitive in the market with...

• High Temperature Subsea Insulation and Buoyancy Products
• Tough, Downhole Tools for High Pressure and High Temperature
• High Speed and High Frequency Electronics
• Advanced Composites
CAPABILITIES AND LOCATIONS

Manufacturing – Huntsville, TX

• Resin production
• ISO 9001 certified
• Tolling services
• Located 65 miles north of Houston
• Resin molding
• Reaction injection molding
• Molded part CNC machining
• Molded part painting

Technical Center of Excellence – Pasadena, CA

• Resin system expertise
• Product development
• Application development & testing
• Prototyping
• Analytical
• Process optimization
• Molding consultation and sample production
• Molded part CNC machining
MARKETS SERVED

Proxima® resins offer superior performance in diverse applications. Materia customers include world class global industry leaders throughout the oil and gas value chain, and other industries.
PROXIMA® RESINS
PROXIMA® RESINS

NORBORNENE MONOMERS

GRUBBS CATALYST

PROXIMA® THERMOSET NORBORNENE POLYMER

- Two-part thermoset resin system
- Based on dicyclopentadiene (DCPD) and a family of co-monomers
- Ring Opening Metathesis Polymerization enabled by Materia’s proprietary Grubbs Catalyst® technology
- Leveraging a portfolio of 15+ monomers and 20+ metathesis catalysts

UNREINFORCED POLYMERS
SYNTACTIC FOAMS
CONTINUOUS FIBER COMPOSITES
Proxima® resins combine high temperature stability with superior resistance to damage.

- **Proxima® ACR** resins for GF and CF composites
- **Proxima® HTI** resins for high temp insulation
- **Proxima® STR** resins for syntactic foams
- **Proxima® HPR** high-performance resins

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**Product line definitions:**
- Proxima® ACR = advanced composite resins product line
- Proxima® HTI = high temperature insulation resins product line
- Proxima® STR = syntactic thermoset resins product line
- Proxima® HPR = high performance resins product line
Materia has expanded the potential of DCPD thermosets due to a larger family of monomers from which to select, and due to exclusive use of a more robust catalyst.
ADVANTAGES OF PROXIMA® RESINS OVER COMPETITIVE pDCPD RESINS

<table>
<thead>
<tr>
<th>Proxima® Resin Advantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproducible processing, compatible with additives, glass/carbon fiber composite formulations</td>
</tr>
<tr>
<td>Pot-life control from seconds to days</td>
</tr>
<tr>
<td>Controlled curing – no problems with thick parts and exotherms</td>
</tr>
<tr>
<td>Translucent properties for subsurface inspection significantly improves quality assurance and part reliability</td>
</tr>
</tbody>
</table>

Proxima® resins enable customer differentiation due to its high temperature stability with superior resistance to damage.

Competitive pDCPD resins can have molding defects that are very difficult to identify in thick parts.

Promixa’s translucency allows for subsurface inspection.
MARKET SEGMENT

OIL & GAS
Materia Focus Area: Thermal insulation products

Materia products: Proxima® HTI polymers

Competition: Silicone, neoprene rubber

Value proposition: Exceptional hot wet stability, easy processing for onshore and offshore operations, and excellent adhesion to other polymers
In record time Materia built the capacity to provide on-time delivery of Proxima® resin solutions for 40 miles of pipeline while delivering the highest quality product meeting all performance specifications.

**Shell Selects Materia’s Thermal Insulation System for Gulf of Mexico Project**

Materia, Inc., in conjunction with Aegion Corporation, has been selected by Shell Offshore, Inc., a wholly-owned subsidiary of Royal Dutch Shell plc, to supply pipeline insulation materials for the Appomattox development in the deepwater Gulf of Mexico.

Posted on April 7, 2016
PROXIMA® HTI 1400 WATER UPTAKE KINETIC STUDY

Extensive testing performed to successfully validate a 30 year service life.

**RESULTS**

- Very low equilibrium water content <1%
- Equilibrium is reached quickly

- Short duration study – Average of 3 cube sizes (1”, 1.5”, 1.75”). Cube size did not drastically alter uptake values.
- Long duration study – ASTM D638 Type I tensile specimens.
Focus Area: Subsea buoyancy

Materia products: Proxima® STR 3190

Competition: Epoxy

Value proposition: Lighter weight and faster processing
Proxima® syntactic foams give the processing ease of polyurethanes & better-than-epoxy performance.

- Single pour casting of large units (>60 gallons)
- 23-30% lower density than epoxy and polyurethane resins
- A portfolio of thermoset resin products available based on customer requirements.
**Focus Area:** Downhole tools, consumables, drillable components

**Materia products:** Proxima® HPR polymers

**Competition:** various

**Value proposition:** Tough/durable, abrasion resistant, light weight, and fast drill-out
CASE STUDY: CASING CENTRALIZERS

Proxima® centralizers provide reduced coefficient of friction and can withstand well conditions of >300 °F.

- A casing centralizer maintains pipe in the center of a wellbore to ensure well completion and integrity
- In horizontal wells, drag must be reduced to facilitate completion and enable longer horizontal well drilling
- Use HPR 2100, HPR 2112 or HPR 2124

Proxima® Thermoset vs. Metals

Lower Friction
Lighter Weight
Higher Ductility
Longer wells and faster completions;
Greater value in longer horizontal wells
Proxima® HPR 2029 is an example of a **low viscosity, filler-compatible** formulation designed for maximizing thermal and mechanical properties; enabling metal replacement and light-weighting.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>METHOD (ASTM)</th>
<th>UNIT</th>
<th>HPR 2029 pure polymer</th>
<th>HPR 2029 ceramic-filled</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>D792</td>
<td>g/mL</td>
<td>1.04</td>
<td>1.55</td>
</tr>
<tr>
<td>Moisture Absorption</td>
<td>D570</td>
<td>wt.%</td>
<td>&lt; 0.2</td>
<td>&lt; 0.2</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>D695</td>
<td>psi</td>
<td>13,600</td>
<td>27,000</td>
</tr>
<tr>
<td>Compressive Modulus</td>
<td>D695</td>
<td>psi</td>
<td>319,000</td>
<td>550,000</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>D638</td>
<td>psi</td>
<td>11,000</td>
<td>10,200</td>
</tr>
<tr>
<td>Tensile Modulus</td>
<td>D638</td>
<td>psi</td>
<td>372,000</td>
<td>820,000</td>
</tr>
<tr>
<td>Elongation at Break</td>
<td>D638</td>
<td>%</td>
<td>12</td>
<td>4%</td>
</tr>
<tr>
<td>Glass Transition Temp</td>
<td>DMA</td>
<td>°C</td>
<td>176</td>
<td>250</td>
</tr>
</tbody>
</table>
INTRODUCING PROXIMA® ACR 4350

You no longer have to sacrifice viscosity, toughness or light weight in order to get a high Tg composite.

When compared to 350 °F cure epoxies:

- Higher $K_{IC}$ and elongation equates to improved toughness and damage tolerance
- Lower density = lighter weight
- Lower water absorption and stable thermal performance under hot/wet aging
- Comparable Tg values in excess of 180 °C

<table>
<thead>
<tr>
<th>POLYMER PROPERTY</th>
<th>METHOD (ASTM)</th>
<th>UNIT</th>
<th>TYPICAL VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>D792</td>
<td>g/mL</td>
<td>1.05</td>
</tr>
<tr>
<td>Tg</td>
<td>DSC</td>
<td>°C</td>
<td>189</td>
</tr>
<tr>
<td>Compressive Strength</td>
<td>D695</td>
<td>MPa</td>
<td>100</td>
</tr>
<tr>
<td>Compressive Modulus</td>
<td>D695</td>
<td>MPa</td>
<td>2,360</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>D638</td>
<td>MPa</td>
<td>72</td>
</tr>
<tr>
<td>Tensile Modulus</td>
<td>D638</td>
<td>MPa</td>
<td>2,700</td>
</tr>
<tr>
<td>Elongation @ Break</td>
<td>D638</td>
<td>%</td>
<td>11</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>D790</td>
<td>MPa</td>
<td>108</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>D790</td>
<td>MPa</td>
<td>2,760</td>
</tr>
<tr>
<td>Fracture Toughness, $K_{IC}$</td>
<td>D5045</td>
<td>MPa·m$^{1/2}$</td>
<td>2.0</td>
</tr>
</tbody>
</table>
MARKET SEGMENT
CHEMICAL PROCESSING
Focus Area: Pipe and tank for corrosive fluid handling

Materia products: Proxima® HPR polymers

Competition: Vinyl ester / fiberglass

Value proposition: Longer service life, lighter weight
CASE STUDY: CORROSIVE FLUID HANDLING

- Customer needed a material with corrosion resistance to handle a process that converts sea water to \( \text{Cl}_2 \), \( \text{NaOH} \) and \( \text{H}_2 \) at 90 °C.
- Proxima® HPR polymer provides 6+ years service lifetimes in the caustic environment of chlor-alkali electrolysis.
- The cell tops are made in a single cast using ~800 lbs of resin and part thicknesses of 1 – 5”. 
ELECTRONICS

Focus Area: Printed circuit boards, IC packaging, Electronic adhesives

Materia products: Proxima® polymer resins

Competition: Polyphenylene ether, cyanate esters, AND polyimide

Value proposition: Superior dielectric properties and competitive pricing
Proxima® resins are in development for telecom, military, automotive, and oil & gas applications.

### ELECTRICAL PROPERTIES

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>STANDARD</th>
<th>UNIT</th>
<th>VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dielectric constant (@10 GHz)</td>
<td>ASTM D2520-13</td>
<td>-</td>
<td>2.45</td>
</tr>
<tr>
<td>Loss tangent (@10 GHz)</td>
<td>ASTM D2520-13</td>
<td>-</td>
<td>0.0012</td>
</tr>
<tr>
<td>Dielectric Strength</td>
<td>ASTM D149</td>
<td>V/mil</td>
<td>1800</td>
</tr>
<tr>
<td>Surface Resistivity</td>
<td>ASTM D257</td>
<td>Ohms</td>
<td>&gt; 9.7 x 10^{15}</td>
</tr>
<tr>
<td>Volume Resistivity</td>
<td>ASTM D257</td>
<td>Ohm-cm</td>
<td>&gt; 2.3 x 10^{16}</td>
</tr>
</tbody>
</table>

Current focus is B-stage resins for prepreg applications
MARKET SEGMENT

ALTERNATIVE ENERGY
Focus Area: Matrix thermoset resin for glass and carbon fiber wind blades

Materia products: Pre-commercial (targeting product launch in 2020)

Competition: Epoxy

Value proposition: Lighter weight, superior fracture toughness, longer design life, and faster processing
Proxima® resins are tougher than epoxy resins, one of the primary reasons customers select Proxima.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>METHOD (ASTM)</th>
<th>UNIT</th>
<th>ACR 4100</th>
<th>INFUSION EPOXY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture Toughness, $K_{IC}$</td>
<td>D5045</td>
<td>MPa·m$^{1/2}$</td>
<td>2.6</td>
<td>0.5</td>
</tr>
<tr>
<td>Interlaminar Fracture Toughness, $G_{IC}$</td>
<td>D5528$^{1,2}$</td>
<td>J/m$^2$</td>
<td>1,700</td>
<td>330</td>
</tr>
</tbody>
</table>

Proxima® ACR 4100 outperforms standard epoxies by 5x in crack propagation tests.

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>METHOD (ASTM)</th>
<th>UNIT</th>
<th>ACR 4100</th>
<th>INFUSION EPOXY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage after impact$^3$</td>
<td>D7136-07</td>
<td>mm$^2$</td>
<td>403</td>
<td>779</td>
</tr>
</tbody>
</table>

Damage zone of Proxima® laminate is 48% smaller than that of the epoxy laminate.

1. Data treatment per Reeder and Crews (NASA) for fracture toughness at crack initiation
2. Laminates prepared by VARTM of 1200 gsm unidirectional glass fabric and cured at 120 °C for 2h
3. Tested by Delsen Testing Laboratories
Proxima laminates absorb less water and retain properties better than market leading epoxy laminates.

**Salt Water Absorption Test: ~160 Days at 60 °C**

<table>
<thead>
<tr>
<th>T&lt;sub&gt;g&lt;/sub&gt; Stability</th>
<th>Day 0</th>
<th>Day 55</th>
<th>Day 82</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Epoxy laminate</strong></td>
<td>103</td>
<td>83</td>
<td>86</td>
</tr>
<tr>
<td><strong>Proxima laminate</strong></td>
<td>129</td>
<td>133</td>
<td>132</td>
</tr>
</tbody>
</table>

$2MM in funding from the Department of Energy to lower the cost of hydrogen storage vessels

<table>
<thead>
<tr>
<th>REDUCTION IN VOIDS / DEFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>New tank manufacturing process of vacuum pressure infusion of dry wound forms</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HIGH TOUGHNESS RESIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better fatigue properties and off-axis properties for improved performance after cycling</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>NEW WINDING PATTERNS</th>
</tr>
</thead>
<tbody>
<tr>
<td>New patterns supported by the dry-winding that may not be achievable with wet-winding</td>
</tr>
</tbody>
</table>
LOWER VOID CONTENT CONFIRMED

SEM images for void detection

Wet-wound epoxy tank with voids (3 to 9% across 7 different regions).

Infused tank with no detectable voids across 7 regions.

COPV with low void content (<0.5 vol.%) is achievable through infusion
PROXIMA® COMPOSITES FOR WEIGHT REDUCTION

Proxima® resins enable metal replacement and light-weighting in many industries.
PROXIMA® - HALF THE CARBON FOOTPRINT OF EPOXY

The production of Proxima generates ~ 50% less carbon than epoxy

Cradle-to-gate analysis by Sustainability A to Z
DEFENSE

Focus Area: Metal replacement for light-weighting, ballistic protection

Materia products: Proxima® HPR and ACR polymers

Competition: Steel, Aluminum, various others

Value proposition: Tough, light weight, and filler-compatible
NEAT RESINS SHOW SUPERIOR PROPERTIES TO EPOXIES

Proxima® resins are tougher than epoxy resins which is one of the key advantages for ballistics.

High speed camera images of the impact event at the V50 values

<table>
<thead>
<tr>
<th>RESIN</th>
<th>Tg</th>
<th>KE$_{50}$ (22 °C)</th>
<th>$K_{IC}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>pDCPD</td>
<td>142 °C</td>
<td>3.31</td>
<td>2.13</td>
</tr>
<tr>
<td>Epoxy 1</td>
<td>96 °C</td>
<td>1.42</td>
<td>0.76</td>
</tr>
<tr>
<td>Epoxy 2</td>
<td>164 °C</td>
<td>1.00</td>
<td>0.69</td>
</tr>
</tbody>
</table>


2 $KE_{50} = \frac{1}{2}m(V_{50})^2$, conducted with a 0.22 caliber gas gun.
## PROXIMA® COMPOSITE BALLISTIC TESTING

Proxima® resins are infusion friendly and the inherent toughness translates to composite parts.

<table>
<thead>
<tr>
<th>V50 Ballistic Limit Test</th>
<th>Shot Spacing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Size (in.)</strong></td>
<td>24 x 24 x 0.45</td>
</tr>
<tr>
<td><strong>Weight (lbs)</strong></td>
<td>10.61</td>
</tr>
<tr>
<td><strong>Areal Density (psf)</strong></td>
<td>4.72</td>
</tr>
<tr>
<td><strong>Thickness</strong></td>
<td>0.45</td>
</tr>
<tr>
<td><strong>Threat</strong></td>
<td>44 Mag 240 LSWC</td>
</tr>
</tbody>
</table>

1 Composite was tested by U.S. Test Labs under the MIL-STD-662F V₅₀ Test
PROXIMA® RESIN PROCESSING
Materia provides engineering support for a variety of Proxima® resin processing methods.

- Mold casting
- RIM / RTM
- VARTM
- Centrifugal casting

Vacuum-assisted resin transfer molding
Proxima® resins enable significant formulation flexibility with controlled curing, from seconds to hours; enabling customers to enhance their product portfolios.
Proxima® resins enable significant formulation flexibility with controlled curing, from seconds to hours; enabling customers to enhance their product portfolios.
THE MATERIA DIFFERENCE

• Materia goes beyond delivery of just a superior polymer but ensures excellence through formulation and applications engineering support

• Materia is nimble and can enhance your speed to market through immediate access to functional leaders

• Proxima resins can enhance your product portfolio and differentiate your offering in the marketplace

• We offer a total cost of ownership advantage: using Proxima® thermoset resins can lower your capital expenditures and enable higher throughput