Trinseo High Performance Plastics for Medical Applications

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xxx, 2017
## Performance Plastics Division

### Latex
- Styrene Butadiene Latex
- Styrene Acrylate Latex
- Starch-containing Emulsion Technology

### Synthetic Rubber
- Solution Styrene Butadiene Rubber (SSBR)
- Lithium Polybutadiene Rubber (Li-PBR)
- Emulsion Styrene Butadiene Rubber (ESBR)
- Nickel Polybutadiene Rubber (Ni-PBR)

### Brands
- LOMAX™ MaxCoat™ ENVERSA™
- FOUNDATIONS™ EVEREST™
- HPL™ MaxForte™ Modifier-A

- BUNA™ SPRINTAN™

### Performance Plastics
- **Automotive**
- **Consumer Essential Markets**

### End Uses
- Paper and Board Coatings
- Carpet and Artificial Turf Backings
- Performance Latex

- Standard and Performance Tires
- Polymer Modification
- Technical Goods

### Products
- **Automotive**
- **Consumer**
- **Electronics**
- **Medical**
- **Lighting**
- **Electrical**

**SPE ANTEC® Anaheim 2017 / 1853**
CEM = Consumer Essential Markets

- Electrical
- Consumer Electronics
- Lighting
- Medical Devices
Medical Offerings

- Global manufacturing to ensure supply reliability and product consistency
- Focused on providing high quality resins and quality management systems to support customer compliance
- Dedicated to providing product innovation and technical support

We offer a comprehensive Management of Change process that includes:

- Lot Traceability
- Formulation Lock
- Notification of Change
- Extended Record and Sample Retention
### Medical Grade Plastics

<table>
<thead>
<tr>
<th>Brand</th>
<th>Resin Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>CALIBRE™</td>
<td>Polycarbonate Resins</td>
</tr>
<tr>
<td>CALIBRE™ MEGARAD™</td>
<td>Polycarbonate Resins (Radiation stabilized)</td>
</tr>
<tr>
<td>MAGNUM™ MED</td>
<td>ABS Resins</td>
</tr>
<tr>
<td>EMERGE™</td>
<td>Advanced Resins (Alloys)</td>
</tr>
<tr>
<td>TYRIL™</td>
<td>SAN Resins</td>
</tr>
<tr>
<td>STYRON™</td>
<td>PS and HIPS Resins</td>
</tr>
</tbody>
</table>

*TM Registered Trademark*
Plastics for Housings and Enclosures

**Therapeutic Device**
- Drug Delivery
- External Defibrillator
- Oxygen
  - Concentrator
- Ventilator
- Conserver
- Diabetes/Insulin
- Nebulizer
- Inhaler
- Aspirator/Suction

**Patient Monitoring**
- Blood Pressure
- Pulse Oximetry
- Anesthesia
- Cardiovascular
- Diabetes Glucose
- Sleep Apnea

**Medical Imaging**
- Ultrasound
- MRI
- X-Ray
- Gamma Camera
- PET
- Computed Tomography

**Diagnostic Equipment**
- Clinical Diagnostics
- Clinical Chemistry
- Immunoassay
- Hematology
- Hemostasis
- Microbiology
- Urinalysis
- Blood Banking
- Point-of-Care
Plastics for Housings and Enclosures

**EMERGE™ PC/ABS**
7000 Series
Ignition-resistant PC/ABS Alloys

**EMERGE™ PC**
8000 Series
Ignition-resistant Polycarbonate

**EMERGE™ PC/PET**
9000CR Series
Ignition-resistant PC/PET Alloys

- No Bromine, No Chlorine
- Custom Colors Available
- Sample Stock Program
Hospital Acquired Infections (HAI) Continue to be a major concern

CDC has published Guidelines for Disinfection and Sterilization in Healthcare Facilities:

- medical equipment surfaces should be disinfected with an EPA-registered low- or intermediate-level disinfectant
  - Isopropyl alcohol
  - Bleach
  - Phenolic Germicidal
  - Quaternary Ammonium Compounds
1.7 MM HAI annually in U.S.\(^{(1, 2)}\)

Hospital stays for methicillin-resistant *Staphylococcus aureus* (MRSA) infection have more than tripled since 2000 \(^{(2)}\)

Up to 99,000 deaths per year\(^{(2, 3)}\)

$28 - 33$ Billion annual healthcare costs\(^{(1)}\)

$5.7 - 6.8$ Billion annual costs to U.S. hospitals\(^{(1)}\)
Non-critical medical equipment surfaces should be disinfected with an EPA-registered low- or intermediate-level disinfectant

- Isopropyl alcohol
- Bleach
- Phenolic Germicidal
- Quaternary Ammonium Compounds

Plastics for Housings and Enclosures

Rate of medical equipment housing failures has substantially increased:

– More rigorous cleaning procedures
– Increasing aggressiveness of chemicals
– Little change in materials or design
Factors Affecting Part Performance

- **Material**
  - Chemical Resistance

- **Design**
  - Sharp corners, knit lines, wall thickness
  - Assembly, screws, bosses, fit

- **Processing**
  - Molded-in stress, orientation

- **Service**
  - Time, Temperature, Impact

- **Disinfecting/Cleaning**
  - Chemical, Time, Frequency

Most failures occur due to multiple factors
EMERGE™ PC/PET Material Technology

EMERGE™ PC/PET 9000 series materials are designed using science and formulation technology to formulate robust chemical resistant products for medical enclosures.

Key strategies for the development:

- **Residual Stress Reduction** – crafting easy fill and easy flow material solutions that process without excessive stress
- **Impact Modification** – selective impact modification of the dispersed PET phase
- **Stable Morphology** – tuning of the blend components to have a morphology that is not shear sensitive
Residual Stress Reduction

- Crafting high flow and thus easy part fill material solutions
- Easy part fill performance results in lower injection and packing pressures
- Reduction of residual stresses in the part
- ESCR performance improved through low residual stresses

- Test performed on 2mm spiral flow tool
- Resins tested at their recommended processing temperatures
- EMERGE PC/PET 9500CR has similar flow to Polycarbonate
Impact Modification

- Selective impact modification of the dispersed PET phase
- Impact modifier can be sensitive to chemical attack
- Protect Impact modifier in the PET phase
- Long term material toughness and durability after frequent cleaning
- Rubber cavitation process not affected by location
Stable Morphology

- Tuning of the blend components to have minimal shear effect on morphology
- Impact modifier embedding further stabilizes the morphology
- Chemical resistance is less sensitive to process conditions or part design
Environmental Stress Crack Resistance (ESCR) Test Procedure

- Injection Molded ASTM D 638 Type I Tensile Bars
- Samples are placed in a stainless steel jig under 1.5% strain
- A cotton pad is placed over the center of the bar at the strain point
- Cotton pads are moistened with approximately 5 mL of cleaning solution and covered with plastic to minimize evaporation
- Cleaning solution is applied every 24 hours for 3 days
- A control, with no cleaning solution, is always run for comparison
Bars are removed and gently wiped clean
ASTM D638 Tensile testing is performed on the bars at a rate of 2 in/min
Average values are calculated for:
  – Ultimate Tensile Strength or Tensile Break Stress ($\sigma$)
  – Ultimate Tensile Elongation or Tensile Break Strain ($\varepsilon$)
### Chemicals Chosen for Screening

<table>
<thead>
<tr>
<th>North America</th>
<th>Europe</th>
</tr>
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<tbody>
<tr>
<td>IPA (70%)</td>
<td>surf'a'safe</td>
</tr>
<tr>
<td>Wex-cide 128</td>
<td>surfanios premium</td>
</tr>
<tr>
<td>Virex&lt;sup&gt;(1)&lt;/sup&gt; Il 256</td>
<td>meliseptol</td>
</tr>
<tr>
<td>CaviCide&lt;sup&gt;(2)&lt;/sup&gt;</td>
<td>kohrsolin</td>
</tr>
<tr>
<td>CIDEX PLUS&lt;sup&gt;(3)&lt;/sup&gt;</td>
<td>hexaquart</td>
</tr>
<tr>
<td>Bleach (50%)</td>
<td>Incides N</td>
</tr>
<tr>
<td>Sani-Cloth&lt;sup&gt;(4)&lt;/sup&gt; Plus</td>
<td>klercide</td>
</tr>
<tr>
<td>Sani-Cloth&lt;sup&gt;(4)&lt;/sup&gt; AF</td>
<td>aniospray 29MD</td>
</tr>
<tr>
<td>Clorox Healthcare&lt;sup&gt;(5)&lt;/sup&gt; Bleach Germicidal Wipe</td>
<td>Dismozon</td>
</tr>
<tr>
<td>Clorox Healthcare&lt;sup&gt;(5)&lt;/sup&gt; Hydrogen Peroxide Cleaner Disinfectant Wipe</td>
<td>Mikrobac Forte</td>
</tr>
<tr>
<td>Virex&lt;sup&gt;(1)&lt;/sup&gt; TB</td>
<td>LinkDesSpeed</td>
</tr>
<tr>
<td></td>
<td>LinkDesUltra FX</td>
</tr>
<tr>
<td></td>
<td>perform</td>
</tr>
<tr>
<td></td>
<td>Incidin Plus</td>
</tr>
<tr>
<td></td>
<td>mikrozid PAA</td>
</tr>
<tr>
<td></td>
<td>Mikro-Quat Classic</td>
</tr>
</tbody>
</table>

**Disinfectant Categories:**
- Alcohol
- Chlorine
- Hypochlorite
- Peroxide
- Quaternary Ammonium Germicide
- Gluteraldehyde Germicide
- Phenolic Germicide
- Formaldehyde Germicide

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<sup>(1)</sup> Trademark of Diversey, Inc.
<sup>(2)</sup> Trademark of Metrex Research Corporation.
<sup>(3)</sup> Trademark of Johnson & Johnson.
<sup>(4)</sup> Trademark of Professional Disposables International, Inc.
<sup>(5)</sup> Trademark of The Clorox Company.
% Retention of Tensile Strength

Retention of Tensile Elongation (%)
**EMERGE™ PC/PET 9500CR**

**Chemical Resistance Comparison**\(^{(1, 2)}\)

Tested at 1.0% Strain

<table>
<thead>
<tr>
<th>Cleaner/Disinfectant</th>
<th>Retention of Ultimate Tensile Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>EMERGE™ PC/PET 9500CR</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Competitive PC/ABS</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Competitive PBT</strong></td>
<td></td>
</tr>
<tr>
<td>Wex-Cide 128</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>Virex(^{(3)}) Il 256</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>CaviCide(^{(4)})</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>CIDEX PLUS(^{(5)})</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>50% Bleach</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>70% IPA</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>Sani-Cloth(^{(6)}) Plus</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>Sani-Cloth(^{(6)}) AF</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>Clorox Healthcare(^{(7)}) Bleach</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>Germicidal Wipe</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>Clorox Healthcare(^{(7)}) Hydrogen Peroxide Cleaner Disinfectant Wipe</td>
<td>♦♦♦</td>
</tr>
<tr>
<td>Virex(^{(3)}) TB</td>
<td>♦♦♦</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>Retention of Ultimate Tensile Elongation</th>
</tr>
</thead>
<tbody>
<tr>
<td>♦♦♦</td>
<td>Excellent</td>
</tr>
<tr>
<td>♦♦</td>
<td>Marginal</td>
</tr>
<tr>
<td>♦</td>
<td>Poor</td>
</tr>
</tbody>
</table>

- 64% or ≥140%
- 65 - 79%
- 80 - 139%

\(^{(1)}\) Trinseo testing. Complete protocols and results available upon request.

\(^{(2)}\) Tested after 3 days exposure to chemicals under 1% strain.

\(^{(3)}\) Trademark of Diversey, Inc.

\(^{(4)}\) Trademark of Metrex Research Corporation.

\(^{(5)}\) Trademark of Johnson & Johnson.

\(^{(6)}\) Trademark of Professional Disposables International, Inc.

\(^{(7)}\) Trademark of The Clorox Company.
Plastics for Housings and Enclosures

EMERGE™ PC/PET 9530CR

New Grade with Improved UV Resistance

ASTM D4459

- EMERGE PC/PET 9500CR Natural
- Competitive PC/ABS
- EMERGE PC/PET 9530CR Natural

Time (hrs)

Average DE

0 5 10 15 20 25 30 35

0 100 200 300 400 500 600 700 800 900 1000

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1. Februar 2017
Thank you

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