Customer Value Proposition:
PREMIER™ is the world's first commercially available conductive thermoplastic for real world EMI shielding solutions. It is a blend of PC/ABS thermoplastic polymer alloys and conductive fillers engineered for stable electrical, mechanical, and physical performance.

The conductive filler technology utilizes nickel plated carbon (Ni-C) fibers as the base filler. In the case of higher shielding versions, Nickel-Graphite (Ni-C) powder is blended with the fiber base to deliver enhanced performance.

Combined with standard injection molding processes, PREMIER technology delivers evenly dispersed filler throughout a part’s geometry (Figure 1). PREMIER parts have no resin rich areas prone to EMI leaks, and no brittle, resin poor areas that can break under mechanical stress. PREMIER provides world class shielding effectiveness, requires no machining, plating, painting, vacuum coating, or other added processing steps.

The elimination of secondary operations can reduce costs by up to 50% compared to die castings, bent formed metal, machined extrusions and plated plastic parts.

Product Features:

**SHIELDING**
- Greater than 85 dB shielding effectiveness
- Low through resistance down to 30 mΩ
- Highly conductive
- High permeability (6.5) increases shielding effectiveness

**MECHANICAL / PHYSICAL**
- High tensile strength and modulus
- High flexural strength and modulus
- Low density provides weight reduction up to 75%
- UL 94 flammability rating of V-0

**ENVIRONMENTAL**
- Recyclable – conforms to WEEE EoVL TCO
- Compliance – RoHS, Halogen-free, EPA
- Up to 105°C Relative Temperature Index (RTI)
- Corrosion-free for long field life

**ECONOMICS**
- Lower total cost of ownership through elimination of secondary operations
- Six sigma processing
- Waste elimination
- Global supply available for rapid delivery

Typical Applications:
- Patient monitoring medical applications
- Man portable military handhelds
- In cabin controls in aircraft
- Industrial controls
- Medical diagnostic devices
- Critical care applications
- Military displays

Contact Information:
Parker Hannifin Corporation
Chomerics Division
77 Dragon Court
Woburn, MA 01801
phone 781 935 4850
fax 781 933 4318
chomailbox@parker.com
www.parker.com/chomerics
PREMIER™ EMI shielding performance is based upon proprietary filler technology which optimizes materials, dispersion and morphology. The filler matrix within PREMIER starts with a nickel plated carbon (Ni-C) fiber. Electrolytic plating with nickel establishes excellent adhesion to the flexible carbon core, preventing stripping off of the nickel during the injection molding process. Enhanced shielding performance and part fill is achieved by the addition of nickel plated graphite powder. By optimizing particle shape, size distribution and particle-to-fiber ratio, up to 95 dB of shielding effectiveness is obtained. The powder is integrated into the fiber matrix securing more points of electrical contact both on the part surface and inter-fiber. PREMIER’s uniquely engineered filler system delivers ≤ 6 sigma molding performance at various costperformance break points. Unlike stainless steel fiber fillers, the carbon core will bend and flow around and into cavity details without breaking or clogging. The inherent material properties of both nickel and carbon make Premier a highly lossy [dissipates energy] material that is paramagnetic.

To ensure even dispersion, the Ni-C fibers are treated with a unique, proprietary dispersion technology. The dispersion agent when combined with the low shear mechanical action experienced in the injection molding process delivers a randomly oriented, evenly dispersed and interlocked fiber matrix within the polymer. Only Chomerics has a dispersion agent that effectively promotes an even matrix throughout complex part geometry. Only PREMIER eliminates the gate clogging typically found with EMI shielding plastics. When dispersed, the engineered fiber matrix provides the optimum filler morphology for performance. The foundation of PREMIER’s EMI shielding performance is the high aspect ratio Ni-C fiber. The long pathways of uninterrupted electrical conductivity provide low bulk conductivity. A minimum level of fiber is needed to provide effective EMI shielding and all grades of PREMIER have this level. To increase performance, particulate nickel graphite powder is added to the base fiber matrix to create higher shielding grades. The inclusion of powder to augment the fiber matrix is indicated by “HF” in the material grade designation (Figure 2).

PREMIER is a single component pellet system. The polymer is cross head extruded on top of the dispersion agent treated Ni-C fiber tow. The “HF” grade has nickel graphite powder that is compounded into the polymer. The polymer-filler system is chopped into pellets ready for injection molding.

The pellet length optimizes the conductive fiber aspect ratio to maximize shielding. The single component system eliminates mixing or weighing at the press, fiber nesting and clogged extruder throats.

PREMIER parts provide shielding effectiveness greater than 95 dB to meet global commercial EMC requirements. PREMIER provides the electrical conductivity, EMI absorption, and mechanical durability to replace aluminum and plastic housings that have been metalized or conductively coated. The shielding effectiveness of PREMIER is far greater than that of carbon-filled ESD (electrostatic discharge) plastics.

PREMIER™ Provides Maximum Performance at Lower Costs

PREMIER can reduce costs by up to 65% and provide a lower total cost of ownership with a shorter time to market. PREMIER EMI shielding thermoplastics eliminate most secondary operations to save money and time (Figure 3). Supply chains can be reduced to as little as one step — injection molding.

Unlike metal die castings there is no need for machining to obtain needed dimensional tolerances or flatness. Plating to control corrosion and sporadic yield losses due to porosity (often exposed in the pre-plating etching process) are eliminated. Also gone are the inspection costs and uncertainty of problem containment. Shipping costs and time in transit to specialized platers no longer inflates cost, increases work in process (WIP) and prolongs lead time.

Unlike metal parts fabricated from aluminum extrusions, cutting-to-length and machining features such as throughholes are not required with Premier. The injection molding process provides all part features with 6 sigma reliability. Often part elements cannot be incorporated into the extrusion cross section and require secondary assembly. An example is PCB mounting bosses on a blade front panel. The freedom to design bosses and other features into an injection molded part reduces assembly needs, costs and yield losses.

Unlike parts injection molded with non-EMI shielding plastic, PREMIER parts do not require the secondary operation of plating or painting for EMI shielding. PREMIER thermoplastic parts that come out of the tool have shielding effectiveness engineered in as a base property. PREMIER eliminates the direct cost of secondary EMI shielding and 6-6% yield losses due to:

- Overspray on selectively plated parts
- Delamination of metallized coatings due to contamination or humidity
- Inability to reliably reach part area with line-of-sight coating technologies due to part geometry shading areas
- Solvent-based conductive paints crazing plastic surfaces
- Additional handling and transportation

PREMIER™ Reduces Typical Manufacturing Complexity

PREMIER™ METALIZED CONDUCTIVE PAINTED PLASTIC DIE CASTING METAL EXTRUSION

<table>
<thead>
<tr>
<th>Step</th>
<th>PREMIER™</th>
<th>METAL EXTRUSION</th>
<th>DIE CASTING</th>
<th>PAINTED PLASTIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ship To Customer</td>
<td>Ship To Customer</td>
<td>Ship To Customer</td>
<td>Ship To Customer</td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td>Package</td>
<td>Package</td>
<td>Package</td>
<td></td>
</tr>
<tr>
<td>Assembly</td>
<td>Assembly</td>
<td>Assembly</td>
<td>Assembly</td>
<td></td>
</tr>
<tr>
<td>Injection Mold</td>
<td>Unpack</td>
<td>Ship To Supply Chain Leader</td>
<td>Ship To Supply Chain Leader</td>
<td></td>
</tr>
<tr>
<td>Ship To Supply Chain Leader</td>
<td>Package</td>
<td>Package</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apply Conductive Coating</td>
<td>Plate</td>
<td>Plate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unpack</td>
<td>Ship To Plater</td>
<td>Ship To Plater</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ship To Coater</td>
<td>Package</td>
<td>Package</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Package</td>
<td>Machine</td>
<td>Machine</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injection Mold</td>
<td>Deburr</td>
<td>Cut To Length</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Cost</td>
<td>Cost</td>
<td>Cost</td>
<td></td>
</tr>
</tbody>
</table>

Figure 2: Polymer construction “HF” material grade designation

Figure 3: PREMIER thermoplastic reduces complexity and process steps

Costly sorting and rework efforts can be eliminated using PREMIER. Since standard injection molding equipment and processes are used with PREMIER, quality is built into the process, and not inspected in after manufacture. PREMIER shortens the supply chain, saving packaging and shipment costs to specialized coaters. The production process is lean and responsive to customer demands.

PREMIER reduces tooling layers, start-up costs and accelerates time to market. Premier tooling consists of a thermoplastic injection mold that can be sourced anywhere in the world. There are no masks, hanging racks, machining jigs or unnecessary assembly fixtures. This single tooling layer means fewer processes to develop and approve, saving time and money. New production part approval can be obtained with one stop.

Since PREMIER is not abrasive to tooling surfaces, the injection molding tool may last up to 1,000,000 shots/cavity. This far outlasts die casting tooling, paint masks, and machining jigs. Tooling replacement and repair needs are a fraction of other processes. Ongoing engineering support on major programs is virtually eliminated, resulting in an uninterrupted supply of parts.

If all features cannot be designed into the injection molding process, any secondary assembly of components onto a PREMIER part can occur right on the injection molding tool. Use of standard ultrasonics or vibration welding, heat staking or mechanical assembly techniques all work with PREMIER. Self-forming screws are commonly used. By using insert molding or two shot molding, many assembly needs can be engineered into the injection molding cycle. These processes remove the human factor to deliver high reliability with virtually no added processing costs. The need for aluminum heat sinks and areas of non-conductivity are commonly satisfied with these techniques.
PREMIER™ is Environmentally Friendly

PREMIER complies with worldwide directives for ecological compatibility, such as the European Union Restriction of Hazardous Substances [EU-RoHS], TCO (Swedish Confederation of Professional Employees), and U.S. Environmental Protection Agency standards, by containing no halogenated or banned compounds. PREMIER allows for compliance with EoC. Product-related Environmental Declarations by containing no substances listed as hazardous for plastic components. If a device’s function includes prolonged skin contact.

PREMIER materials comply with EN1811 for Ni extraction, allowing for use on hand-held devices. The specification developed by CEN (Comité Européen de Normalisation, European Committee for Standardization) in response to dermatological reaction to nickel plated jewelry sets a threshold limit of 0.50 μg/cm²/week of nickel leaching when the item comes in contact with perspiration. PREMIER performance is well under the limit. At the end of product life, PREMIER parts can be recycled by regrinding using a nibble granulator to comply with stringent disposal regulations. Unlike painting or plating, no costly stripping is required, eliminating end-of-life issues. Scrap may occur in normal production from runners, startups, shutdowns or other sources can be re-ground and re-used eliminating waste during the production cycle.

Re-ground PREMIER parts may be used up to 15% by weight without affecting performance. PREMIER allows for cost-effective compliance with end-of-life vehicle [EoL], TCO and the EU Waste in Electrical and Electronic Equipment [WEEE] directives.

NEBS Compliance

- FR versions of PREMIER comply with stringent flammability needs specified by Network Equipment Building Standards (NEBS). When tested in accordance with Underwriters Laboratory (UL) Standard 94, -FR grades are rated V0 and 5V. They also have oxygen index ratings greater than 28% and pass needle point flame testing. Flame retardant PREMIER (-FR) can be used with confidence in network equipment.

Price and Performance Material Choices

PREMIER™ plastics are provided in three PC/ABS based families: HT, for 85°C RTI applications; ST, for 105°C RTI applications, and FR, for 70°C RTI applications where UL 94 V-0 flammability grade material is required (the flame retardant is non-halogenated). Each PREMIER family offers three standard material grades based on the level of conductive filler. Increasing filler loading increases EMI shielding performance. Multiple levels of fiber loading allow a cost-effective match of the desired amount of EMI shielding with the lowest possible material cost. Fill levels are identified as follows: A220 = Low, A230 = Medium, A240 = High. The resin family is specified in the part number by the two letter identifier after the filler loading level number (e.g., A220-FR for low filler level 70°C flame retardant material). If the resin is available with a blend of fiber and powder, HF is added after the resin identifier; filler blends are not available at the A220 level. See the typical property table [Table 2] for all commonly used grades. Premier grades at medium and high filler are also available in all fiber forms. Contact Chemours for information on these grades.

Premier EMI Shielding Solutions

Chemours can make PREMIER your EMI shielding solution through the supply of molded parts or raw pellets into your supply chain. Chemours has extensive in-house capabilities to design, prototype, and manufacture PREMIER parts with optimum mechanical and electrical characteristics. As the leading provider of quality shielding solutions, hundreds of millions of Chemours parts and materials are employed in telecommunications, consumer, military, automotive and industrial electronics around the globe. To verify your product’s EMC performance, Chemours has in-house test services that are globally certified to FCC, EC, VCCI, IEC 1000, EN/IEC 1069, CISP, Aústeel and EU regulations. Chemours also performs certified product testing.

PREMIER and Your Supply Chain

Our unique EMI shielding design experience is a true asset to your supply chain team. We leverage our knowledge in the tool design and molding processes to ensure excellent performance of your design in production. Your parts are optimized for EMI shielding, and affecting performance. PREMIER allows for cost-effective compliance with end-of-life vehicle [EoL], TCO and the EU Waste in Electrical and Electronic Equipment [WEEE] directives.

Direct Part Supply from Chemours

Our customers routinely enjoy cost effective savings and convenience using Chemours as a single point of contact. PREMIER molded parts can be produced worldwide at Parker locations in the Americas, Asia and Europe.

Bulk PREMIER Pellets

Chemours works with global injection molders to make the availability of PREMIER conductive plastic shielding solutions as convenient as possible. We support each step of the sales and production process to assure the highest quality parts for your shielding customers.

Bulk PREMIER pellets are provided in the HT, ST, and FR series. Each pellet contains a measured Ni-C fiber bundle treated with Chemours’ dispersion technology set within a polymer jacket. Pellets are ready to use without weighing or dry blending. They can be ordered in a 55 pound (25 kg) box or 1,000 pound (454 kg) bale.

Part numbers for PREMIER pellets are built from WW-A2XX-YYZZ where XX is the filler level descriptor and YY is the family descriptor:

<table>
<thead>
<tr>
<th>WW</th>
<th>A2XX</th>
<th>YY</th>
<th>ZZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREMIER Pellet Unit of Measure</td>
<td>CK = Kilograms</td>
<td>CP = Pounds</td>
<td></td>
</tr>
<tr>
<td>Filler Level</td>
<td>A220 = Low</td>
<td>A230 = Medium</td>
<td>A240 = High</td>
</tr>
<tr>
<td>Family Descriptor</td>
<td>HT = General Temperature 85°C</td>
<td>ST = Temperature 105°C</td>
<td>FR = Flammability Rated, UL94 V-0</td>
</tr>
<tr>
<td>Filler Blend Descriptor</td>
<td>All Fiber = Blank</td>
<td>Fiber Powder Blend = HF</td>
<td></td>
</tr>
</tbody>
</table>

Shielding Effectiveness

PREMIER thermoplastic is both electrically conductive and paramagnetic, which provides levels of EMI shielding beyond the indicated performance of surface conductivity tests. A surface conductivity test of a PREMIER part underrepresents its total shielding performance.

The total amount of shielding effectiveness of any EMI shield is equal to the reflective and absorptive losses. The greater the conductivity, permeability, thickness and frequency, the greater the attenuation due to absorption. The greater the conductivity and the lower the frequency, the greater the reflective losses. PREMIER has permeability significantly greater than most commonly used EMI shielding materials as shown in Table 1.

Compared to surface coatings such as vacuum deposited Al, Ni/Cu plating or conductive paints, higher conductivity and permeability can be achieved in conductivity, providing comparable reflective losses. All grades of PREMIER provide significantly higher shielding absorption due to the permeability and thickness. PREMIER is used as the structural element with thicknesses at least an order of magnitude greater than the coating. Shielding from absorption is directly proportional to thickness, allowing PREMIER to outperform surface coatings.

Figure 4: Shielding Effectiveness

Compared to metals, such as aluminum and magnesium alloys, shield based upon their conductivity with little to no permeability. EMI shielding is achieved primarily by reflection (especially below 10 GHz) and absorption due to skin depths. PREMIER’s permeability provides incremental shielding effectiveness above the reflective losses by way of enhanced absorption at all frequencies. The added absorptive shielding outperforms lower reflective losses, thus making PREMIER a viable alternative in such applications.

Table 1 - Shielding Effectiveness Parameters

<table>
<thead>
<tr>
<th>Material</th>
<th>Surface Resistance (/square)</th>
<th>Permeability (μ)</th>
<th>Typical Shield Thickness (mil)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PREMIER</td>
<td>0.030 to 4.5</td>
<td>6.5</td>
<td>0.8 to 3.0</td>
</tr>
<tr>
<td>Acrylic paint</td>
<td>Ag/Cu filled</td>
<td>0.01 to 0.1</td>
<td>&lt;&lt;&lt;&lt;1</td>
</tr>
<tr>
<td>Nicalon Deposited Al</td>
<td>0.01 to 0.2</td>
<td>1</td>
<td>0.0025</td>
</tr>
<tr>
<td>Nickel over Copper Plating</td>
<td>0.011 to 0.10</td>
<td>=50</td>
<td>0.0001</td>
</tr>
<tr>
<td>Aluminum Alloys</td>
<td>0.005 to 0.005</td>
<td>1</td>
<td>1.5 to 3.0</td>
</tr>
</tbody>
</table>

Figures 4, 7 and 8 present data on PREMIER performance. The graphs show shielding effectiveness per a far field antenna measurement and ASTM F953. All data show increased shielding as frequency increases as predicted by the absorptive properties of PREMIER. Each recognized procedure is designed for the frequency range reported and a test report can be supplied on request.
An application’s mechanical design is critical to optimizing the shielding performance of any material. An effective EMI shielding scheme features a conductive shielding medium, with 360 degrees peripheral ground and termination of the shield at mating flanges.

For applications that do not use an EMI shielding gasket at the seams, or with large openings, PREMIER will perform comparably to metal based designs. The seam or opening will provide less shielding than the housing material, making the seam or opening the determining component of the housing’s overall shielding performance. Generally, a non-gasketed seam with good incidental contact will deliver 40 to 70 dB (800 MHz to 12 GHz) shielding effectiveness in both PREMIER and aluminum. Typically, surface plated plastic housings will have 3 to 5 dB less shielding effectiveness than PREMIER. Copper-filled coatings will be 5 to 10 dB less.

To optimize performance, a tortuous path joint with a maximized surface area is suggested for seams instead of a simple butt joint. Five to fifteen dB of shielding performance can be added to a typical PREMIER housing using a fabric-over-foam gasket, such as Chomerics’ SOFT-SHIELD® 3500, 5000 or 4800 Series, a form-in-place conductive elastomer gasket, such as Chomerics Cho-Form® family of materials or a hollow/spliced conductive extrusion captured in a groove.

**Mechanical Properties**

Due to an even dispersion of long Ni-C fibers, PREMIER parts have exceptional tensile and flexural properties. Injection molded PREMIER parts provide excellent durability against mechanical shock and vibration similar to performance of composites used in the aircraft industry. This high performance allows PREMIER to be considered as a replacement for metal parts and still deliver the needed mechanical performance. A listing of typical properties appears in Table 2.

**Material Property Stability**

PREMIER materials retain their superior performance after rigorous life testing. Testing has included 1,000 hours at RTI and 85% relative humidity, 1,000 hours dry heat at RTI with mechanical, thermal cycling (IEC 68-2-14) and thermal shock testing (IEC 68-2-30). Results show greater than 95% retention of typical properties for electrical, shielding effectiveness and mechanical properties. For a test report contact Chomerics.

**Corrosion Resistance**

The corrosion resistance of Premier is exceptional, making it an excellent choice for outdoor applications in harsh environments. After 360 hours of salt fog exposure (35°C at 95% relative humidity of a 5% NaCl solution, ASTM B117) electrical and shielding effectiveness was virtually unchanged. This performance is the direct result of the intrinsic corrosion resistance of the highly stable nickel plated carbon fiber and nickel graphite powder used in Premier. Now EMI shielded housings no longer require costly painting or plating secondary operations to obtain stability in harsh environments.

**Thermal Management Capabilities**

Ni-C fibers act as thermal conductors, thus PREMIER plastics have inherent thermal conductivity properties as high as 0.70 W/m-K. (See Table 2). This allows PREMIER parts to be used within many thermal management systems.

Thermal conductivity results improve when an insert molded metal heat sink or spreader is used with a PREMIER part to maximize heat dissipation. Tests by Chomerics show that by embedding an aluminum heat spreader/heat sink into Ni-C filled PREMIER plastic, significant reductions in junction and skin temperatures result. Transistor power also increases when compared to results using a non-conductive PC/ABS plastic. The image in Figure 9 demonstrates effective thermal management of a 10W source. Heat spreaders and heat sinks can be used with PREMIER parts by attachment with Chomerics’ THERMAATTACH®, double-sided, thermally conductive adhesive tapes or THERMAGAP™, thermally conductive gap fillers.

**Weight Savings**

PREMIER parts can weigh up to four times less than commonly used metal parts. The density of Premier at 1.2 to 1.4 g/cc is one-half the density of aluminum (2.7 g/cc), and far less than other commonly used metals. PREMIER’s light weight, coupled with the ability to mold walls as thin as 1.0 mm or one-half as thick as Al die castings allow PREMIER parts to weigh 75% less. Although PREMIER must have thicker walls than a stamped-bent metal stainless steel part due to the large reduction in density, PREMIER can weigh 50% less than the stainless steel part. For weight sensitive transportation or hand held device applications, PREMIER can help yield weight reduction and save cost.
Typical Properties - PREMIER EMI Shielding Plastics

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Filler Level</td>
<td></td>
<td>Low/Medium/High</td>
<td></td>
<td>Low/Medium/High</td>
<td>Low/Medium/High</td>
<td>Low/Medium/High</td>
<td>Low/Medium/High</td>
<td>Low/Medium/High</td>
<td>Low/Medium/High</td>
<td>Low/Medium/High</td>
<td>Low/Medium/High</td>
</tr>
<tr>
<td>Electrical Surface</td>
<td></td>
<td>Ohm/sq</td>
<td>4.50</td>
<td>0.60</td>
<td>0.25</td>
<td>4.50</td>
<td>0.60</td>
<td>0.25</td>
<td>4.50</td>
<td>0.50</td>
<td>0.20</td>
</tr>
<tr>
<td>Through Resistance</td>
<td></td>
<td>Ohm</td>
<td>0.800</td>
<td>0.006</td>
<td>0.030</td>
<td>0.800</td>
<td>0.006</td>
<td>0.030</td>
<td>0.800</td>
<td>0.060</td>
<td>0.030</td>
</tr>
<tr>
<td>Mechanical Tensile</td>
<td>ASTM D438</td>
<td>MPa/psi</td>
<td>67.6</td>
<td>7.10</td>
<td>7.17</td>
<td>68.3</td>
<td>7.10</td>
<td>7.17</td>
<td>78.6</td>
<td>88.3</td>
<td>91.0</td>
</tr>
<tr>
<td>Elongation %</td>
<td>ASTM D438</td>
<td>%</td>
<td>1.00</td>
<td>1.20</td>
<td>0.50</td>
<td>1.00</td>
<td>1.20</td>
<td>0.50</td>
<td>1.65</td>
<td>1.02</td>
<td>0.50</td>
</tr>
<tr>
<td>Mechanical Modulus</td>
<td>ASTM D438</td>
<td>GPa/psi*10^3</td>
<td>5.8</td>
<td>6.7</td>
<td>7.7</td>
<td>6.7</td>
<td>7.7</td>
<td>6.0</td>
<td>11.1</td>
<td>15.6</td>
<td>21.7</td>
</tr>
<tr>
<td>Flexural Strength</td>
<td>ASTM D790</td>
<td>MPa/psi</td>
<td>110</td>
<td>100</td>
<td>110</td>
<td>109</td>
<td>95</td>
<td>100</td>
<td>121</td>
<td>131</td>
<td>152</td>
</tr>
<tr>
<td>Flexural Modulus</td>
<td>ASTM D790</td>
<td>GPa/psi*10^3</td>
<td>5.2</td>
<td>6.3</td>
<td>8.0</td>
<td>5.2</td>
<td>6.3</td>
<td>8.0</td>
<td>5.6</td>
<td>8.1</td>
<td>11.9</td>
</tr>
<tr>
<td>Izod Impact (Unnotched)</td>
<td>ASTM J/m</td>
<td>ft-lb/in</td>
<td>197</td>
<td>192</td>
<td>197</td>
<td>192</td>
<td>192</td>
<td>298</td>
<td>233</td>
<td>234</td>
<td></td>
</tr>
<tr>
<td>Izod Impact (Notched)</td>
<td>ASTM J/m</td>
<td>ft-lb/in</td>
<td>74.7</td>
<td>64</td>
<td>58</td>
<td>53.3</td>
<td>64</td>
<td>77</td>
<td>93</td>
<td>120</td>
<td></td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>ASTM D5470</td>
<td>W/m-K</td>
<td>0.56</td>
<td>0.59</td>
<td>0.70</td>
<td>0.56</td>
<td>0.59</td>
<td>0.70</td>
<td>0.56</td>
<td>0.59</td>
<td>0.70</td>
</tr>
<tr>
<td>HODL at 18.2 bar (264 psi)</td>
<td>ASTM D648</td>
<td>°C (°F)</td>
<td>122</td>
<td>118</td>
<td>118</td>
<td>70</td>
<td>80</td>
<td>85</td>
<td>128</td>
<td>123</td>
<td>119</td>
</tr>
<tr>
<td>CLTE</td>
<td>ASTM D196</td>
<td>m/100°C/10° (1x10^-6/°C)</td>
<td>0.26</td>
<td>0.30</td>
<td>0.38</td>
<td>0.28</td>
<td>0.20</td>
<td>0.18</td>
<td>0.29</td>
<td>0.15</td>
<td>0.13</td>
</tr>
<tr>
<td>Physical Specific Gravity</td>
<td>ASTM D3763</td>
<td>MPa</td>
<td>1.20</td>
<td>1.39</td>
<td>1.40</td>
<td>1.20</td>
<td>1.39</td>
<td>1.40</td>
<td>1.20</td>
<td>1.31</td>
<td>1.40</td>
</tr>
<tr>
<td>Flammability</td>
<td>UL 94</td>
<td>0.15 mm</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>V0</td>
<td>V0</td>
<td>V0</td>
<td>V0</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Molding with PREMIER

Parts can be molded with wall thicknesses down to 0.8 mm and localized areas can be 0.5 to 0.8 mm thick. Generally, larger parts require wall thicknesses greater than 0.8 mm to facilitate flow. As with any injection molded part, flow leaders or internal walls can be used to promote flow and minimize wall thicknesses. Part designs should take into account all standard practices to avoid sink marks and put radii in corners. Gates should be located to minimize any negative cosmetic effects of gate vestige with all fiber reinforced thermoplastic systems.

Equipment Requirements

- **PREMIER** does not require specialized injection molding equipment. However Chomerics uses a press with a large daylight clearance as possible to allow room for a hot runner system and a valve gate manifold, if needed.
- In order to control PREMIER processing parameters a closed loop control system for injection speed, injection pressure, feed throat control and back pressure is strongly recommended. A process variable recording system tied to inspection data is a very helpful tool for trouble shooting production.
- Shot size should be 30 to 80% of barrel size and a variety of screw diameters should be available to ensure compliance. A hardend general purpose screw with a diameter greater than 22 mm and compression ratio of 2.30:1 to 2.50:1 is recommended. For example, an Engel press screw with a 280 mm feed zone/225 mm transition zone/140 mm feed zone with a 25 mm nominal screw diameter and 2:35:1 compression ratio works well. The injection molding equipment should have a free flow check ring. Do not use magnet in feedthrough hopper.

Injection Molding Tooling

- **PREMIER** works well with injection molding tooling made in accordance with SPE/SPi Class 101 tooling standards. For production tooling, a prehardened steel should be used [57 or H13] and depending on part specifications 1,000,000 shots per cavity may be expected. Experience to date shows no excessive tool wear. For prototyping of less than 1,000 pieces, a mild tool steel is preferred or aluminium tooling may be used.
- **PREMIER** is not highly abrasive to tooling, and a minimum of one million shots is achievable as molds perform similarly to those made from tool steel (A220-HT, A230-FRH, & A240-ST). Molding with PREMIER materials (A220-HT, A230-FRH, & A240-ST).

### Table 3 - Shrink Rate

<table>
<thead>
<tr>
<th>Product</th>
<th>Shrink %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A220-FR</td>
<td>0.25</td>
</tr>
<tr>
<td>A230-FRH</td>
<td>0.25</td>
</tr>
<tr>
<td>A240-FRF</td>
<td>0.25</td>
</tr>
<tr>
<td>A240-HT</td>
<td>0.25</td>
</tr>
<tr>
<td>A240-HTHF</td>
<td>0.25</td>
</tr>
<tr>
<td>A240-STF</td>
<td>0.25</td>
</tr>
<tr>
<td>A240-ST</td>
<td>0.15</td>
</tr>
<tr>
<td>A240-ST</td>
<td>0.10</td>
</tr>
</tbody>
</table>

**Legend:**

- **CLTE** = Coefficient of Linear Thermal Expansion
- **HODL** = Heat Distortion Temperature Under Load
- **RTI** = Relative Temperature Index
Typical Processing Parameters - Injection Molding Processing

<table>
<thead>
<tr>
<th>Units</th>
<th>A2XX-HT</th>
<th>A2XX-HTHF</th>
<th>A2XX-ST</th>
<th>A220-FR</th>
<th>A2XX-FRHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drying Temperature</td>
<td>°C</td>
<td>82 to 87</td>
<td>87 to 95</td>
<td>95 to 100</td>
<td>65 to 70</td>
</tr>
<tr>
<td></td>
<td>(°F)</td>
<td>(180 to 190)</td>
<td>(190 to 200)</td>
<td>(200 to 210)</td>
<td>(150 to 160)</td>
</tr>
<tr>
<td>Drying Time, Typical</td>
<td>hours</td>
<td>3 to 4</td>
<td>3 to 4</td>
<td>3 to 4</td>
<td>4 to 5</td>
</tr>
<tr>
<td>Drying Time, Maximum</td>
<td>hours</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Suggested Maximum Moisture</td>
<td>%</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Rear Temperature</td>
<td>°C</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
</tr>
<tr>
<td></td>
<td>(°F)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
</tr>
<tr>
<td>Middle Temperature</td>
<td>°C</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
</tr>
<tr>
<td></td>
<td>(°F)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
</tr>
<tr>
<td>Front Temperature</td>
<td>°C</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
</tr>
<tr>
<td></td>
<td>(°F)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
</tr>
<tr>
<td>Nozzle Temperature</td>
<td>°C</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
</tr>
<tr>
<td></td>
<td>(°F)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
</tr>
<tr>
<td>Processing (Melt) Temperature</td>
<td>°C</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
<td>255 to 270</td>
</tr>
<tr>
<td></td>
<td>(°F)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
<td>(475 to 490)</td>
</tr>
<tr>
<td>Mold Temperature</td>
<td>°C</td>
<td>41 to 49</td>
<td>41 to 49</td>
<td>41 to 49</td>
<td>41 to 49</td>
</tr>
<tr>
<td></td>
<td>(°F)</td>
<td>(105 to 120)</td>
<td>(105 to 120)</td>
<td>(105 to 120)</td>
<td>(105 to 120)</td>
</tr>
<tr>
<td>Back Pressure</td>
<td>bar</td>
<td>&gt; 20</td>
<td>&gt; 20</td>
<td>&gt; 20</td>
<td>&gt; 20</td>
</tr>
<tr>
<td></td>
<td>(psig)</td>
<td>(&gt; 300)</td>
<td>(&gt; 300)</td>
<td>(&gt; 300)</td>
<td>(&gt; 300)</td>
</tr>
<tr>
<td>Clamping Pressure</td>
<td>MPa/cm²</td>
<td>40 to 70</td>
<td>40 to 70</td>
<td>40 to 70</td>
<td>40 to 70</td>
</tr>
<tr>
<td></td>
<td>(tons/in²)</td>
<td>(3 to 5)</td>
<td>(3 to 5)</td>
<td>(3 to 5)</td>
<td>(3 to 5)</td>
</tr>
<tr>
<td>Screw Speed for 25 mm (1 in) diameter at 95 to 130 rpm</td>
<td>cm/min</td>
<td>760 to 1,000</td>
<td>760 to 1,000</td>
<td>760 to 1,000</td>
<td>760 to 1,000</td>
</tr>
<tr>
<td></td>
<td>(in/min)</td>
<td>(300 to 400)</td>
<td>(300 to 400)</td>
<td>(300 to 400)</td>
<td>(300 to 400)</td>
</tr>
</tbody>
</table>

Insert and Two-Shot Molding

Insert molding is an excellent choice to eliminate post molding assembly of non-PREMIER components onto or into the unit. Heat sinks, honeycomb vents, fasteners and inserts can all be incorporated without the added cost of a secondary operation.

Two-shot molding to provide areas of non-conductive material in a PREMIER part or vice versa can be accomplished using standard two-shot molding equipment and tooling. In this manner selective application of PREMIER can take place to provide selective electrical isolation, cosmetic surface, or color matching. Often two or more parts can be combined, reducing assembly complexity, inventory, and costs.

Post-Molding Operations

Once molded, PREMIER™ parts can be further processed like any thermoplastic material.

Painting can provide a cosmetic finish. As with any long fiber, filled polymer system the only method to reach a highly cosmetic finish or to color match to a standard through the application of a surface coating. The choice of coatings that are compatible with PREMIER is limitless; cross-linked urethane coating is a recommended choice. Contact Chomerics for assistance in material choice.

Labeling using ink screening, pad printing or decal application are all possible and do not affect the performance of PREMIER. Standard materials and application techniques for traditional thermoplastics can also be used with PREMIER. As with all thermoplastics, part identification or other labeling can be accomplished by cavity marking either negative or positive.

Sonic or vibration welding for assembly of PREMIER to itself, and other like thermoplastics is an excellent attachment method. Tailing indicates a 77° energy director butt joint design gives a tensile strength equivalent to base material. Lap joints and double shear joints can be used effectively with tensile strength within 10% of base material. Specific designs will vary based upon part configuration — contact Chomerics for assistance.

Heat staking of threaded inserts can be done per standard procedures. Chomerics has worked with Emhart Technologies Dodge® Ultrasert II threaded inserts successfully and recommends their use. Blank hole sizes as recommended by Dodge should be used and can be obtained for all insert sizes from Dodge. It is believed any insert designed for use with a filled thermoplastic will work with Premier. For design assistance contact Chomerics or Dodge directly.

Thread forming screws can also be used to reduce cost for applications that do not require many openings and closings, eliminating the need for threaded inserts. Many commercially available screws can be used. Chomerics has performed testing with and recommends Delta PT grade screws. Hole diameters for the thread form should be 85% of the thread maximum diameter.

Contact Chomerics for assistance.
ENGINEERING YOUR SUCCESS.

or an authorized distributor ("Seller") verbally or in writing, shall when communicated to Parker Hannifin Corporation, its subsidiary and Conditions. Buyer’s order for any item described in its document, and its authorized distributors. This offer and its acceptance by any Offer Of Sale
distributors. This offer and its acceptance by the components or systems.

WHATSOEVER ON ITEMS BUILT OR ACQUIRED, WHOLLY OR

 conditions which might be encountered.

Consequences beyond the reasonable control of Seller (hereinafter ‘Events of Force Majeure’). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes, labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller’s control.

Premier’ Conductive Plastics: Premier’ conductive plastics are sold under license solely for use in the following applications: [i] EM/RFI shielding, electromagnetic and/or radio frequency interference shielding or compatibility and surface grounding therefore; [ii] earth grounding, corona shielding, and anti-static and/or electrostatic discharge protection. Premier’ conductive plastics may only be used in an end-user application for which the application provider, different or end-user, has no liability for infringement of any patents, trademarks, copyrights, and trade secrets (hereinafter ‘Intellectual Property Rights’). If any item sold hereunder infringes any such Intellectual Property Rights of a third party, Seller shall have no liability for infringement of any patents, trademarks, copyrights, and trade secrets (hereinafter ‘Intellectual Property Rights’). If any item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its
copyrights, and trade secrets (hereinafter ‘Intellectual Property Rights’) constituting Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole

because of any accident or act of God or any similar right.

whether this contract infringes the Intellectual Property Rights of a third party, Buyer shall have no liability for infringement of any patents, trademarks, copyrights, and trade secrets (hereinafter ‘Intellectual Property Rights’) constituting Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole
constitute Seller’s sole and exclusive liability and Buyer’s sole

shielded vents and windows.

ENGINEERING YOUR SUCCESS.
Parker Chomerics Capabilities

Thermal Management
Thermally Conductive Gels
Highly conformable, high performance fully cured single-component dispansible gap filler ideal for high volume automated dispense processes. Typical Applications: Telematics, ECU's, EPAS, batteries.

Thermal Insulators
Available in several forms, these materials are designed for use where the highest possible thermal, dielectric and mechanical properties are required. Typical Applications: Power train, lighting, braking, sensors, ECU's.

Thermal Gap Fillers
Low modulus thermally conductive gap pads offer ease of use, excellent thermal properties and highest conformability for low to moderate clamping force applications. Typical Applications: AV systems, ACC, braking, battery ECU's.

Integrated Display Solutions
CHO-TOUCH Touchscreen LCDs
Parker Chomerics has designed these touchscreen LCDs for harsh environments such as military, medical, avionics, and general industrial. Typical Applications: Military, Medical, Aerospace.

EMI Shielding & Grounding
Fabric over Foam Gaskets
SOFT-SHIELD® EMI gasketing products bring new flexibility to shielding decisions. They offer material choices, performance levels, configurations and attachment methods. Typical Applications: Telematics, ITE, Medical and Commercial.

Laminates and Grounding Products
Mechanical, electrical and processing properties plus economy for commercial applications. Typical Applications: EMI Shields, ground planes, ground straps and ESD shields.

EMI Shielded Touchscreens and Windows
EMI Shielded touchscreens for rugged performance meeting critical EMC needs. Glass and polycarbonate windows for EMI shielding and mechanical protection. Typical Applications: Military, Medical, Aerospace.

Integrated Display Solutions
CHO-TOUCH Touchscreen LCDs
Parker Chomerics has designed these touchscreen LCDs for harsh environments such as military, medical, avionics, and general industrial. Typical Applications: Military, Medical, Aerospace.

EMI Shielded Touchscreens and Windows
EMI Shielded touchscreens for rugged performance meeting critical EMC needs. Glass and polycarbonate windows for EMI shielding and mechanical protection. Typical Applications: Military, Medical, Aerospace.

Conductive Plastics
Conductive Plastics
Blend of thermoplastic and conductive fillers that provides world class shielding effectiveness and requires no machining, plating, painting or other added processing steps. Typical Applications: ACC, sensors, battery.

Conductive Compounds
Conductive Compounds
Specialty Materials
Offering a wide variety of adhesives, caulks, sealants and coatings. Typical Applications: EMI/RFI Shielding, Component and module caulking and sealing, ITE and Medical.

Wire & Expanded Metal Gasketing
Metal-based gaskets solutions for Electromagnetic Interference (EMI) and Electromagnetic Pulse (EMP) shielding as well as lightning strike protection. Typical Applications: Connector, Cabinet and Military.

Beryllium Copper and Stainless Steel Gaskets
Beryllium-copper (BrCu) and stainless steel EMI gaskets [SPRING-LINE®] combine high levels of shielding effectiveness with a broad deflection range and low closure force properties. Typical Applications: Cabinet, Enclosures, Commercial and Military.

EMI Shielding & Grounding
Fabric over Foam Gaskets
SOFT-SHIELD® EMI gasketing products bring new flexibility to shielding decisions. They offer material choices, performance levels, configurations and attachment methods. Typical Applications: Telematics, ITE, Medical and Commercial.

Laminates and Grounding Products
Mechanical, electrical and processing properties plus economy for commercial applications. Typical Applications: EMI Shields, ground planes, ground straps and ESD shields.

Conductive Plastics
Conductive Plastics
Blend of thermoplastic and conductive fillers that provides world class shielding effectiveness and requires no machining, plating, painting or other added processing steps. Typical Applications: ACC, sensors, battery.

Conductive Compounds
Conductive Compounds
Specialty Materials
Offering a wide variety of adhesives, caulks, sealants and coatings. Typical Applications: EMI/RFI Shielding, Component and module caulking and sealing, ITE and Medical.