

COLD TEMPERATURE IMPACT PC CASE STUDY

How Star Plastics Helps to Grow Weatherable Outdoor Technology

Situation: With the growing demand for cold temperature impact-resistant products, specifically driven by growth in the 5G market, Star Plastics saw the opportunity to deliver a certified product able to meet the needs of the application. Equipped with UL recognition and high-level formulating capabilities, Star was able to develop a UL certified, REACH and RoHS compliant, PC copolymer, designed specifically for outdoor applications.

Challenge: As markets in outdoor technology continue to grow, there is an increasing demand for products that deliver the same expected durable performance qualities in the most extreme conditions, as well as provide additional time reduction, cost savings and environmental benefits. Along with toughness, the evolving needs of the market are four-fold: reduction of secondary operations, weight reduction, sustainability, and custom coloring.

The traditional materials for this outdoor market, thermosets, failed to meet all the specifications required. Due to their inherently tough nature, thermosets require simple, basic molds with no mold complexity or thin walls. Any additional holes, latch mechanisms or coloring will occur as



a secondary operation after the part is made. Also, any scrap produced from these parts, as well as the parts' end-of-life, are not reusable or recyclable – in other words, it is destined for the landfill.

With elimination of secondary operations, a material with a better flow to fill complex parts is needed.

Reducing secondary operations saves time, reduces logistical costs and helps to balance the rising costs of additional materials (like metals) required. For example, parts should be able to be molded with holes rather than secondary operations for inserts. Additionally, removing secondary operations requires less transportation to and from the part assembler and supplier.



Lightweight parts, which require thinner walls in the molds, are also becoming more standard in the industry, stemming largely from the automotive

market. Lightweight parts also provide a logistical transportation advantage across all markets.

As the importance of sustainability grows across industries, more decisions are made based on how much environmental sense a product makes. A thermoplastic solution provides a more environmentally friendly choice because it is reusable and recyclable. In comparison, thermoset material and any scrap created



during molding are unable to be re-melted into a usable form. Finally, as more companies are looking for unique ways to incorporate their branding into molded parts, the desire for custom pre-colored material solutions emerges.

Cold temperature impact PC materials can be utilized in market applications such as:

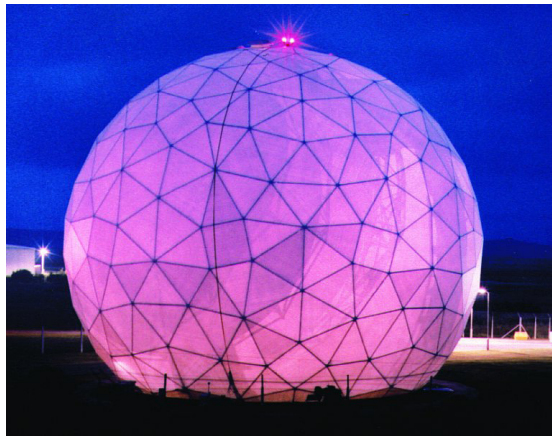
- 5G markets: Radome
 - a dome-like structure that covers antenna systems and other technological hardware/devices
- Outdoor enclosures and electrical housings
- Solar market technology: EV charging and weather monitoring stations.

Common outside applications including road markers, street light covers, fire alarm housings and equipment, plus instrument panels. Any outdoor applications with proximity to electricity.

As leaders in this market, one of the other challenges at the forefront was to find a way to make a product that not only withstands extreme temperatures but that can hold up against impact in extreme cold temperatures.

THE STAR PLASTICS SOLUTION

Embracing the opportunity to use our unique high-level formulation capabilities to develop a cold temperature impact PC, the Star Plastics team first looked at how they could improve what is currently being offered to this market. While thermosets are the



standard material solution for this market's applications, Star realized that, with the right formulation, a thermoplastic could provide the same strength and durability benefits of a thermoset while also offering better flow and custom coloring in a more environmentally friendly product.

From there, the Star Plastics team went to work formulating

a thermoplastic-based solution that can withstand cold temperatures, is impact resistant and features elevated RTIs for electrical applications without losing processability of the material. After going

through our process, our team developed a PC copolymer material solution. The addition of this copolymer produces a modified polycarbonate thermoplastic with both superior flow and high impact toughness. Our solution delivers a good flammability rating, is REACH/RoHS compliant and is UL certified for outdoor applications.

To verify our solution, we conducted Izod impact tests and performed melt and spiral flow analyses comparing the processability of the material.

Izod Impact

When compared to general purpose (GP) PC, Star Plastics' innovation delivers a better impact at lower temperatures. GP PC and PC copolymer have equal performance at higher temperatures, but as temperature decreases, the impact performance of the materials diverges. At

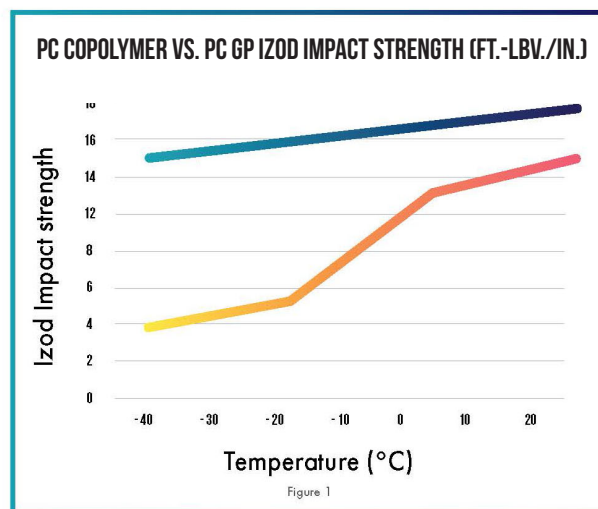


Figure 1

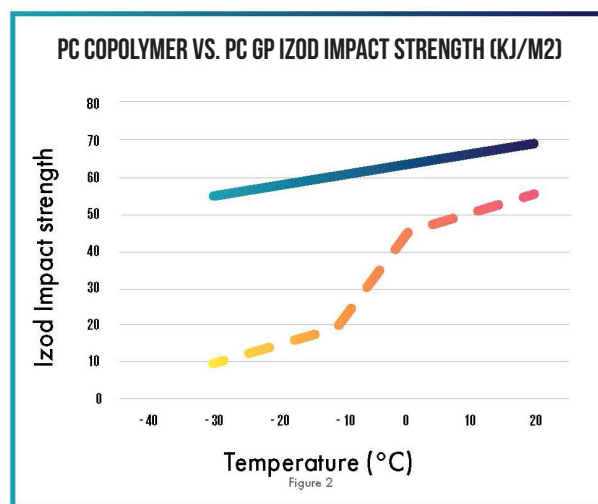


Figure 2

In Figure 1 and Figure 2, as temperature drops, general-purpose PC sees a noticeable decline in impact strength. Meanwhile, PC-SI maintains its strength, even as the temperature drops to extreme levels.

low temperatures, GP PC drops off in its impact strength, which demonstrates the material's transition from ductile mode into brittle mode. PC copolymer, however, remains strong and maintains its impact strength due to the copolymer and other additives.

Material Flow

When increasing the durability of a material, the flow and processability of the material tend to suffer. However, Star's solution features an improved flow during injection molding.

The improved flow characteristics of this material create a broader processing window, which allows you to support the complex part design that product developers want and the strength that they need. Previously, part complexity was not possible with the tough materials traditionally required of the applications in the outdoor market.

Thermosets' inherent rigidity, while necessary for impact strength, constrained part complexity due to poor flow.

Spiral flow tests were conducted to show improved processability of Star's Cold Temperature Impact (CTI) PC. This test measures the moldability of a material and the way it moves through a tool during the molding process. While the general-purpose PC and PC copolymer have similar melt flow results, when compared to using the spiral flow test, Star Plastics' CTI PC flows 20% further and fills 20% more of the tool than the general-purpose PC in the same amount of time.

The key benefit of the improved flow is the ability to more easily fill a part, which not only allows for larger and more complex parts but also reduces molded-in stress. This reduced stress results in the ability to produce thinner-walled parts that maintain strength, increased resistance to the effect of chemicals, and overall better part performance in high-impact areas like corners and joints.

RESULTS

Star Plastics was able to successfully formulate a

material to outperform standard general-purpose PC in terms of impact strength, especially in extreme temperatures, while also maintaining moldability through improved processing parameters.

The benefits of Star's innovative PC copolymer include:

- Increased strength in extremely cold temperatures
- Improved flow in injection molding
- Ability to mold larger, more complex and thinner-walled parts
- Re-usability of scrap and recyclability of parts at end-of-life
- Availability in custom pre-colored options
- Reduce the need for secondary operations



When increasing flow, many materials lose impact strength performance – but Star's CTI PC does not, as it contains a processing

aid that enhances flow while maintaining all your properties. The PC copolymer achieves ductility, flow and superior strength all at once.

This material's demonstrated benefits are backed up by UL certifications UL7446C (f1) and (f2) ratings, providing confidence that the amount of embrittlement that most plastics would experience due to UV exposure over extended periods would be limited. UL94 (flammability) and UL746B (relative thermal index rating) certifications also prove that the material is approved for enclosure applications of electrical current-carrying devices.



Ready to discover how you can reduce part failure and costs with Star Plastics' cold temperature impact PC? Star currently offers two grades from the Orion™ product line: extrusion grade and injection grade, and both are available in all colors. When you're ready to experience the Star Plastics advantage, give us a call at 304.273.0352 or visit StarPlastics.com.

