Design Guidelines for Makrolon® Thermally Conductive (TC) Polycarbonate Grades

Best practices for designing parts with Makrolon polycarbonate are readily available in the Covestro Part and Mold Design Brochure. While most of the principles in this design brochure apply to Makrolon TC polycarbonate, the electrically-conductive grades (≥ 8 W/mK) require additional considerations, as described below. This handout highlights those areas and provides suggestions tailored to Makrolon TC grades.

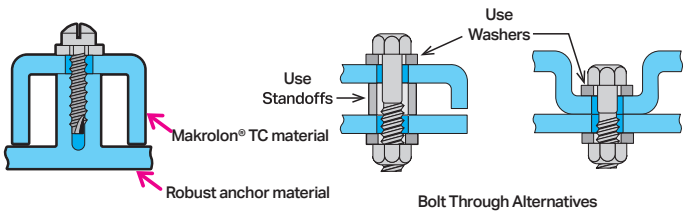
Design Considerations:

Wall Thickness:

- Optimize wall thickness based on part size. The thermally conductiveadditives affect flow and minimum wall thickness.
- 2.5-4.0 mm nominal wall thickness is suggested for most parts. A1.5 mm minimum nominal thickness may be possible for parts withshort flow lengths.
- 1.5 mm minimum thickness at apex of draft.
- Rib feature to wall thickness ratios as high as 0.8 have been successfully molded. The high thermal conductivity and faster cooling of Makrolon TCmakes sink marks less likely compared to standard polycarbonate materials. However, standard guidelines should be followed for cosmetically critical parts.

Draft Angle:

- Experience with Makrolon TC grades indicates a minimum draft angle of2.0° per side is preferred to ensure adequate ejection.



Joining Techniques:

- Adhesive bonding is a reliable method for assembly of Makrolon TCcomponents.
- Two part polyurethane, epoxy and acrylic adhesives that normally workwell with polycarbonate materials should also work well with Makrolon TC grades.
- As with any adhesive, suitabilty in the specific application should beverified through testing in a representative environment.
- Threaded fasteners can also be used provided they pass through theMakrolon TC component and are secured by a nut or by anchoring in acomponent of a material suited for screw assembly.
- Alternatively a threaded metal insert may be used to secure the fastener.
- The insert should be heated prior to molding to reduce potentialshrinkage stresses.
- Thermal joining techniques such as ultrasonic or hot plate weldinggenerally do not provide an adequate bond with Makrolon TC materials.

Joining Technique	Acceptable
Adhesive Bonding	Yes
Threaded Fasteners	Yes*
Snap Fits	Yes**
Hot Plate Welding	No
Ultrasonic Welding	No

* Limited Torque
** Due to strain limits, the snap fit flexible member should not be TC polymer.

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Decoration:

- Makrolon TC grades can be painted without base coating using solvent-based or waterborne paint systems as well as low temperature powder coatings.
- While it is not possible to electroplate Makrolon TC grades, they can be metallized using a sputter coating system.
- A base coating will improve the surface finish, but the quality of the final part should be validated before production.

Rigid inserts:

- Rigid inserts have been successfully molded in Makrolon TC materials.
- Inserts should include mechanical interlocks such as holes or tabs to provide a solid bond between the insert and the Makrolon TC material.
- Inserts should be heated prior to molding to reduce shrinkage stress.

Gate and Runner Systems:

- Three plate molds, edge gates, sub-gates and direct drop hot manifolds work well with Makrolon TC grades. However, cashew gates should be avoided due their limited effective diameter.
- Three plate sprue tip orifice diameters should be 0.8-1.0 times the wall thickness, and sub-gates should be 3 mm minimum diameter. Edge gates should be a ratio of 0.8-1.0 times the wall thickness.
- Manifold and runner systems should follow standard design practice for polycarbonate materials.

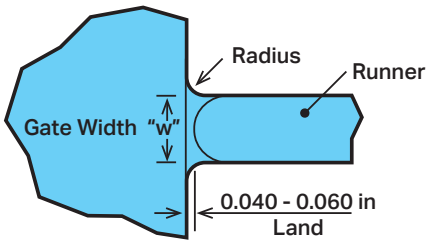
Ejection:

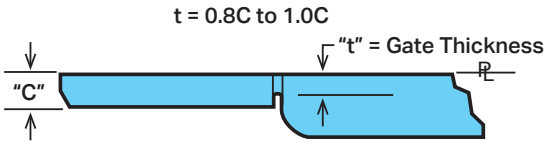
- A sufficient number of ejectors should be used to avoid twisting or tilting the part. Typically several ejectors should be located on the part perimeter and one or more per rib for a finned heat sink design.
- Sleeve, blade or stripper plates should be used when possible to provide a uniform ejection force.
- Tall or deep features should be located on the ejection side of the mold.
- Molds should be draw polished in the direction of ejection to improve release.
- Easy release coatings on the steel will also facilitate part removal.

Mold Cooling:

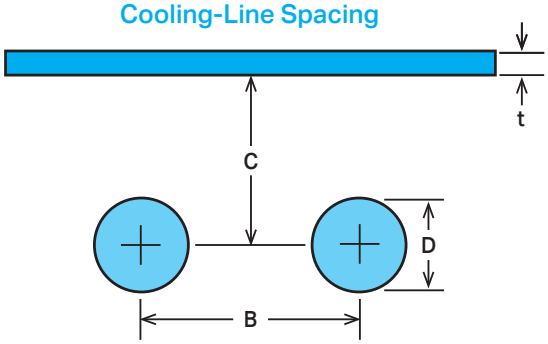
- Localized hot areas in the mold can cause Makrolon TC materials to stick, resulting in a build up of material on the surface.
- Cooling lines should be designed to control mold steel temperatures, typically 65-82°C (150-180°F) and to keep them as uniform as possible, to help avoid sticking and warpage.
- Inserts of highly conductive mold material such as beryllium copper are suggested for areas where sticking is likely such as ribs or deep cores.

Edge Gate for Makrolon TC Grades





Cooling-Line Spacing



B = 3D Maximum
C = 2.5D
D = 3/16 in - 5/16 in for t ≤ 1/16 in
D = 5/16 in - 7/16 in for t ≤ 1/8 in
D = 7/16 in - 5/8 in for t ≤ 1/4 in

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