Alternate Material Selection Report

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Background

Material selection for Part A, Part B and Part C was based on certain requirements and some recommendations from various suppliers. Ultem 1010F-701 Black Polyetherimide from GE Plastics was specified. At present the parts are molded from natural version of the same grade of Ultem. Some of the problems encountered were stress cracking, leak failures, sink marks, slight warpage, consistency, etc.

Some of these problems may have been attributed to molding practices, given the fact that Ultem is a very difficult material to mold and requires certain molding expertise and equipment in excellent condition. This concern has been addressed and it appears that the latest shipment of parts is consistent and free of earlier problems.

Ultem is an excellent engineering material and has lot to offer in terms of mechanical strength, toughness, flammability, high heat resistance, and many other desirable characteristics. Ultem is one of the top ten exotic specialty plastics and it is also one of the most expensive materials in the market. The use of Ultem in this application is over-engineered. The key reason for selecting Ultem in various applications is its ability to withstand high heat and is good for 338 °F continuous exposure to heat.

Alternate Material Selection project

The project to select alternate material for this application is two fold.

1. Lower the overall cost of the molded part.
2. Reduce processing related issues by selecting material with larger processing window.

Material selection criteria:

a. Midrange mechanical properties such as Tensile strength, Modulus and Impact strength
b. UL 94 V0 rating
c. USP class VI preferred
d. Low Shrinkage material
e. Good Chemical resistance
f. Ease of processing

Material	**ULTEM**	**GF FR PP**	**Polyester (PBT)**	**PC/ABS**	**PC/Polyester**
Type	Natural	30% GF FR	30% GF FR	FR	FR
Grade	1010	105 CC FR SP	Valox 420 SEO	Bayblend FR 2000	Macroblend EL 700
Supplier	GE	RTP	GE	Bayer	Bayer
Specific Gravity	1.27	1.44	1.58	1.18	1.28
Shrinkage in/in	.005 -.007	.002 -.003	.002 - .003	.004 - .006	.004-.006
Tensile Strength @ Yield psi	16,000	9,500	17,000	8700	8400
Elongation @ yield %	60	5	5	50	120
Flex. Modulus psi	510,000	900,000	1,100,000	390,000	340,000
Notched Izod ft-lb/in	0.6	1.5	1.3	8	15
DTUL @ 66psi °F	405	300	415	n/a	n/a
Cont. Use Temp. (UL Temp. Index) °F	338	n/a	284	194	167
Flammability UL rating	94 V0	94 V0	94 V0	94 V0	94 V0
Cost/lb	8.8	?	1.55	1.64	2.0 ?

Polycarbonate/PBT

Characteristics

- High impact resistance
- Chemical resistance
- Dimensional stability
- UV stability

Limitations

- Greater shrinkage than for polycarbonate
- Shrinkage may vary with part thickness for large parts

Typical Applications

- Auto
  - Structural components for dashboards and instrument clusters
  - Seat components
  - Door handles
  - Bumpers (beams and fascia)
  - Body panels
  - Mirror housings
  - Wheel trim
  - Ignition components
- Power tool housings
- Lawn mower decks, snow blowers
- Electrical enclosures and housings
- Connector boxes
- Street lighting housings

Polycarbonate/ABS

Characteristics

- Ease of molding
- Low temperature impact
- Good indoor UV stability
- Flame resistance
- Excellent surface aesthetics

Limitations

- Chemical resistance to chlorinated solvents

Typical Applications

- Automotive
  - Instrument panels
  - Glovebox door lids
  - Parcel shelves
  - Wheel covers
  - Spoilers
  - Door handles
  - Grilles
  - Vents
- Office automation
  - Structural components and housing
- Communications
  - Telephone housings
  - Modems
  - Fax machine components
- TV housing components
- Appliances
  - Coffemakers
  - Laptop/notebook computer housings
  - Pager housings
  - PDA housings

Polyetherimide (PEI)

Characteristics

- High heat resistance
  (UL continuous use temp. listing 392ºF)
- Inherent flame resistance
- Low smoke evolution
- Excellent electrical properties
- Glass reinforced grades (up to 40%) available
- Transparent (amber color)

Limitations

- Notch sensitive, use care in part design
- High processing temperature;
  - Melt temperature: 660 -680°F
  - Mold temperature: 150 - 350°F

Typical Applications

- Electrical:
  - Connectors
  - IC chip carriers
  - Bobbins, coils and fuse blocks
  - PC Boards
  - Switches & controls
- Medical
  - Surgical instrument trays
  - Staplers
- Automotive
  - Engine condition sensors
  - Climate control modules
  - Forward lighting reflectors & bezels
  - Transmission components
- Aircraft seating & wall components
- Microwave oven components & ovenware
- Computer disc drive cartridges & cooling fans

Plastics Primer

Polypropylene

Characteristics

- Wide range of properties available through varying molecular weights, fillers and additives
- Light weight
- Heat resistance vs PE
- Strength
- Rigidity
- Flexibility; ie. Living hinge.

Limitations

- Low heat vs. engineering materials
- Difficulty of bonding adhesives, paints

Typical Applications

- Automotive
  - Front end systems
  - Bumper systems
  - Trim
  - Battery cases
  - Fender liners
  - Fan shrouds
- Laundry tub liners
- Bottles
- Material handling containers
- Appliance pumps
- Blower housings
- Cable covers

Polybutylene Terephthalate (PBT)

Characteristics

- Excellent electrical properties
- Good chemical resistance
- High heat capability
- Flame resistant formulations available
- Easy flowing material

Limitations

- Anisotropic shrinkage causing warpage
- High shrinkage of unreinforced grades
- Attacked by strong acids & bases
- Notch sensitive

Typical Applications

- Electrical connectors, sockets, sensors
- Electric motor housings
- Ignition bobbins
- Terminal blocks
- Switches
- Business machine components
  - Fan housings
  - Keys and keyboards
- Pump impellers and housings
- Gears, cams rollers, bearings
- Automotive
  - Door hardware modules
  - Fuel pumps
  - Oil and fuel filters
  - Ignition systems
  - Lighting components
  - Door handles
  - Mirror housings
  - Grille opening retainers

Recommendation and Next steps

All four alternate materials should be tried in existing molds. The slight difference in shrinkage with glass reinforced materials should be evaluated to see if there is a problem with mating parts. Extensive testing of molded parts is recommended. Mold flow analysis of each material should help mitigate any issues that may come up during molding trial.