Living in the Material World

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Molding prototype components enables the medical device designer to get a “preview” of a finished part before going into full production. However, to get the full benefit of this, material selection should be just about completed, including any additives that are to be used. This article looks at the considerations for medical device developers when planning molded prototype components.

Resin choice can be an important part of the process and the resulting product

Prototypes let an engineer test a material to determine whether a plastic part provides the required functionality. A prototype lets a designers see how a part looks, whether it can handle heat or stand up to corrosive materials, how dimensionally stable it is, and how it wears. If there are problems, it offers the opportunity to redesign or choose another material before committing to the cost of full-scale manufacturing or, worse yet, taking a less-than-optimal product to market.

In some cases, a part’s function is simple and the choice of material is less-than-critical. In such cases, ordinary, affordable, easy-to-mold ABS or polypropylene may be perfectly adequate. But the demands on many plastic parts today are far greater, particularly in medical applications in which life, health, and regulatory compliance are of concern. In some cases, requirements are so specific that none of the thousands of standard resins meet the need and custom blending becomes necessary. But even when requirements are less stringent, material choice can be critical.

Engineers can design a part and then go shopping in the vast “resin supermarket” for a suitable material. There are, however, good reasons to choose a resin, or at

least narrow the choices, as early in the process as possible. Designing with the resin in mind can speed development, cut costs, simplify choices along the way, and reduce the need for rework in later stages of the process. For example, if the resin selected is expensive, the focus may need to be on eliminating unnecessary material in the design. If the strength of a resin that does not flow well in a mold is required—glass-filled nylon, for example—the designer will have to be particularly aware of thin areas that can lead to voids or knit lines. If the part will serve as a bearing and requires the lubricity of an acetal resin, like Delrin, it is important for the designer to know that this resin is very sensitive to excess wall thickness.

In medical applications, functionality and agency ratings will be major factors in resin choice, but factors like moldability should be considered as well. Some medical applications will require “medical grade” materials; others will not. A part that will come in direct contact with tissue, in surgery or in an implant, will have entirely different requirements from the housing on a piece of electronic diagnostic equipment.

In medical applications, relevant resin characteristics may include strength, durability, hardness, flexibility, lubricity, resistance to autoclave temperatures or ethylene oxide, UV resistance, color, transparency, and cost. Moldability factors can include ease of flow, tendency to flash, ease of ejection, and likelihood of warp or sink. Obviously, not all of these characteristics will apply to any one part, but it does make sense to carefully review the requirements, determine which ones apply, and then rank them in terms of importance. Such a checklist can then be used to narrow the list of usable resins as early as possible in the design process.

In complex designs, however, even the best-informed initial resin choice may change over the course of development. Prototyping can help confirm a resin choice or suggest the need for change. Molded or machined prototypes can be made in multiple materials for testing and evaluation at various stages of development. If necessary, this can allow initial resin choices to be modified when the change will have the least impact on the process.

Protomold Resin Guide

		Mechanical Properties			Moldability Characteristics		
Resin Generic Name	**Some brand names**	**Strength**	**Impact Resistance**	**High Temp. Strength**	**Warp and Dimen-sional Accuracy, Molded**	**Fills Small features**	**Voids in thick sections**
Acetal	Delrin, Celcon	Medium	Medium	Medium-Low	Fair	Fair	Poor
Nylon 6/6	Zytel	Medium	High	Low	Fair	Excellent	Good
Nylon 6/6, glass filled	Zytel	High	Medium	High	Poor	Good	Excellent
Polypropylene	Maxxam, Profax	Low	High	Low	Fair	Excellent	Poor
High Density Polyethylene (HDPE)	Dow HDPE, Chevron HDPE	Low	High	Low	Fair	Excellent	Unknown
Polycarbonate	Lexan, Makrolon	Medium	High	Medium High	Good	Fair	Fair to Good
Acrylonitrile Butadiene Styrene (ABS)	Lustran, Cycolac	Medium-Low	High	Low	Good	Fair	Good
Polycarbonate / ABS Alloy	Cycoloy, Bayblend	Medium	High	Medium	Good-Excellent	Fair	Good

Our online Protomold Resin Guide lists a sampling of resins, along with their mechanical properties, moldability characteristics, and some brand names.

Choice of resin can impact design in many ways. For example:

- Polystyrene is hard, clear, and inexpensive, but brittle, limiting its application or requiring that steps be taken to toughen the resin.
- ABS is affordable and impact resistant, but susceptible to sink, requiring that thick areas be avoided.
- LCP is strong and fills thin features well, but it forms weak knit lines, affecting both part geometry and gate placement.
- Nylon is affordable and strong, but absorbs water, leading to dimensional and property change. This limits the medical applications in which it can be used.

Decisions don’t necessarily end with choice of a base resin. For specialized requirements, additives can extend or expand the capabilities of the base material.

- Short glass fibers can strengthen a resin and help prevent high-temperature creep. They can, however, make a resin more brittle and increase the tendency to warp as a part cools.
- Long glass fibers provide greater strength and creep resistance, but can impede resin flow, particularly through thin areas.
- Aramid (Kevlar) fibers add strength and are less abrasive than glass though not quite as strong.
- Carbon fiber can strengthen and stiffen a resin and aid in static dissipation, but is costly and can lead to warp.
- Stainless steel fibers are used in electrical housings to reduce electromagnetic and radio frequency interference.
- Mineral fillers—talc or clay—can increase hardness and reduce both cost and warp. More brittle than fiber filled materials.
- Glass beads and mica flakes add stiffness and heat deflection while reducing warp and shrinkage, but don't offer the same compressive strength and stiffness that fibers offer.
- PTFE (Teflon) and molybdenum disulfide, dry lubricants that function like graphite, can make plastic parts self-lubricating.

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