



THE GUND COMPANY

MANUFACTURERS & FABRICATORS OF ENGINEERED MATERIAL SOLUTIONS

Thermoplastic Material Selection Guide

Amorphous and Semi-Crystalline

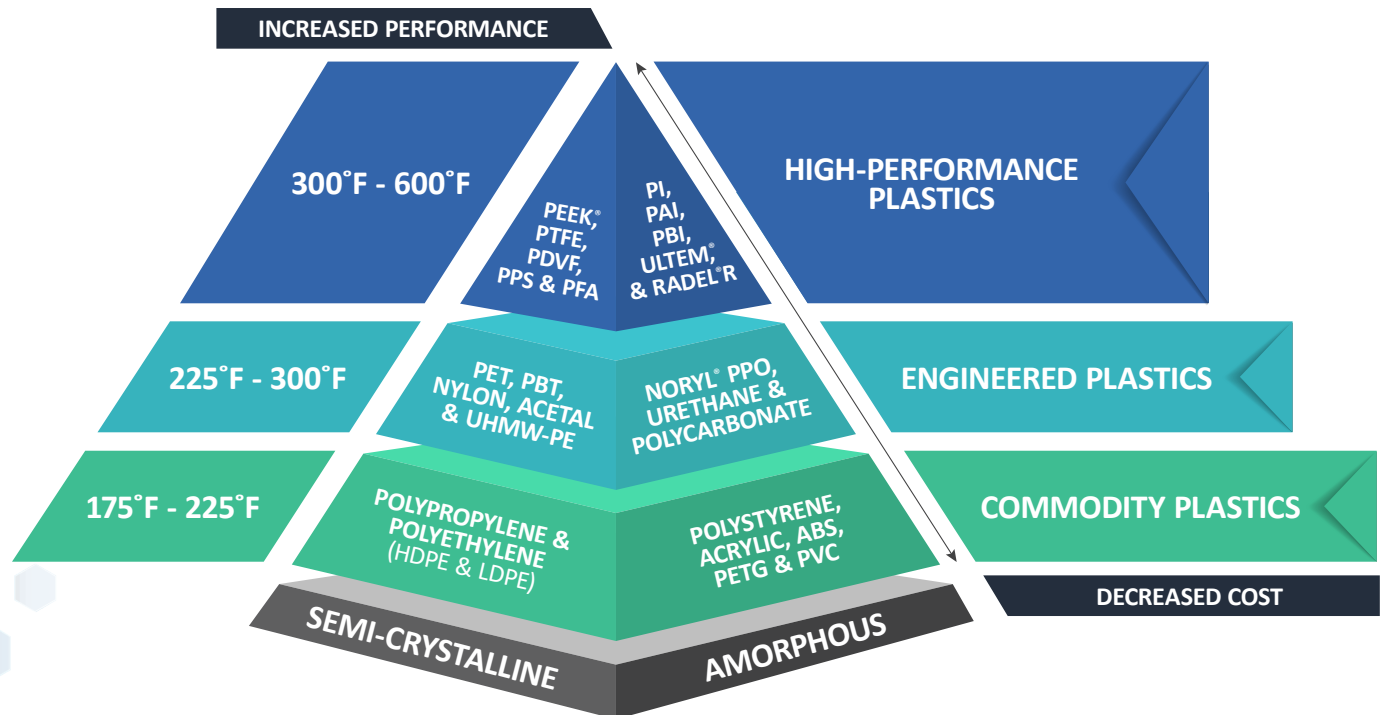
Thermoplastic materials are suitable for a wide range of applications across various industries, including aerospace, defense, medical, satellite communications, food service, and electronics. However, with so many options available, selecting the best thermoplastic based on price, performance, and manufacturability can be challenging.

PYRAMID OF PLASTICS

The pyramid of plastics (Figure 1) helps to narrow down material options by illustrating which materials are suitable for specific application requirements. It's essential to avoid using an expensive material when a more economical alternative could fulfill the needs of the application. Often, as operating temperatures and performance requirements increase, so does the cost.

Thermoplastics can be categorized into two groups based on their composition: **AMORPHOUS** and **SEMI-CRYSTALLINE** thermoplastics. In an amorphous polymer, the molecules are oriented randomly, while in a semi-crystalline polymer, the molecules are packed together in an organized manner.

FIGURE 1



FOR ADDITIONAL INFORMATION ON THERMOPLASTIC MATERIALS

thegundcompany.com/materials/thermoplastic-materials



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SEMI-CRYSTALLINE THERMOPLASTICS

Semi-crystalline thermoplastics are ideal for wear and structural applications. When compared to amorphous thermoplastics, these materials generally offer better chemical resistance, electrical properties, and a lower coefficient of friction. However, semi-crystalline plastics are challenging to thermoform, difficult to bond, have a sharp melting point, and exhibit lower impact strength.

SEMI-CRYSTALLINE PROPERTIES

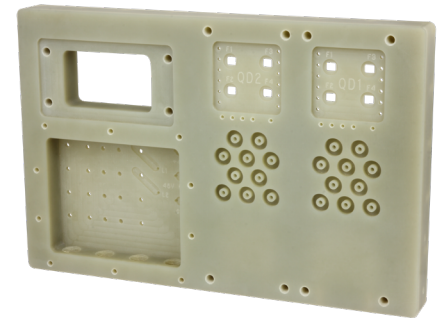
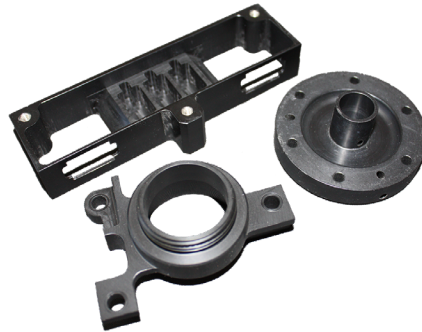
- Challenging to Thermoform
- Typically Opaque
- Sharp Melting Point
- Difficult to Bond
- Good for Structural Applications
- Good Fatigue Resistance
- Good for Wear & Bearing Applications
- Good Resistance to Cracking from Stress

AMORPHOUS THERMOPLASTICS

Amorphous thermoplastics are more conducive to thermoforming; they soften over a range of temperatures and have better bonding ability with adhesives. Compared to semi-crystalline thermoplastics of a similar grade, amorphous plastics typically exhibit better dimensional stability and impact resistance. However, they are more susceptible to fatigue and cracking due to stress.

AMORPHOUS PROPERTIES

- Easy to Thermoform
- Typically Translucent
- Softens Over a Range of Temperatures
- Bonds Well Using Adhesives
- Good for Structural Applications
- Poor Fatigue Resistance
- Not Ideal for Wear Applications
- Subject to Cracking Under Stress



TGC Composite Manufacturing & Fabrication Samples

SEMI-CRYSTALLINE MOLDING

- Good to High-Volume Production
- Efficient Material Use
- Fast Run Time
- Capable of Making Complex Parts
- High Tooling Costs
- Slow to Start Production
- Low Part Price

AMORPHOUS MACHINING

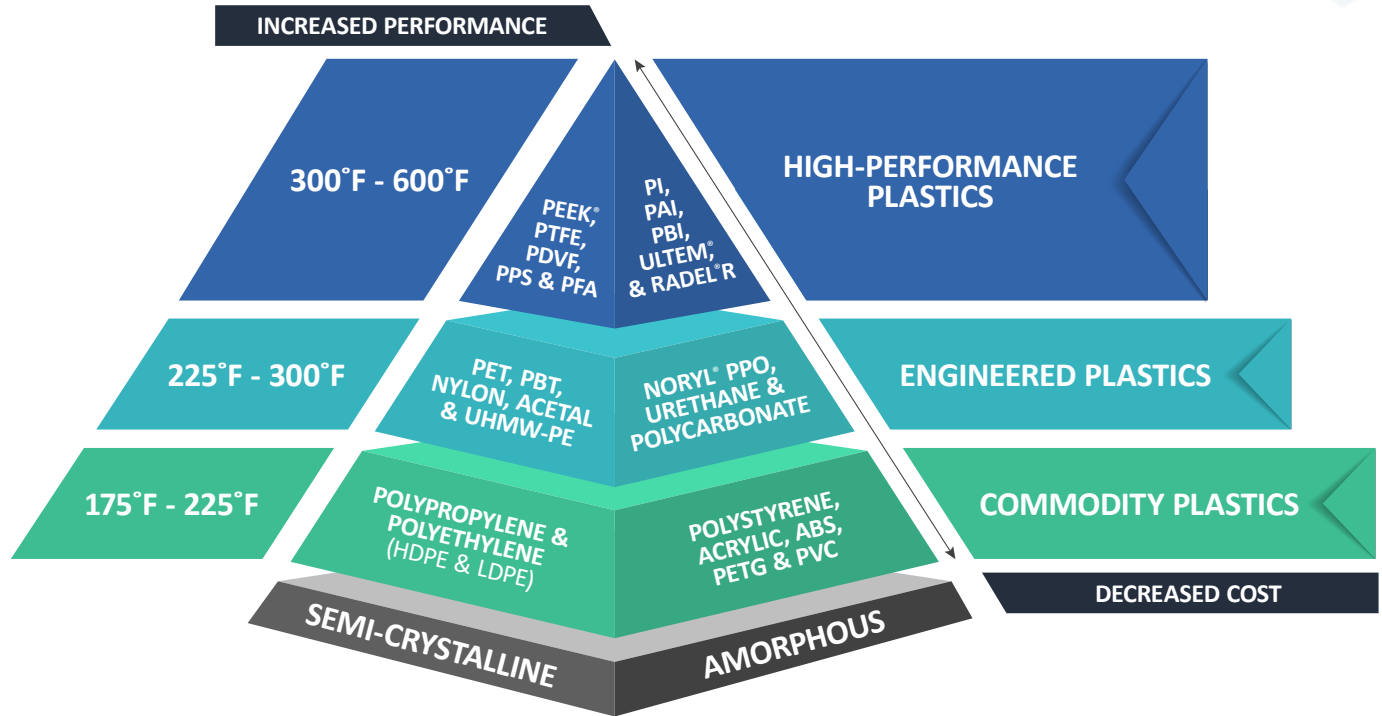
- Good for Short Runs
- More Material Availability
- Little to no Tooling Cost
- Quick to Start Production
- Slow Run Time
- High Part Price
- Limitations in Part Complexity



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PLASTIC FAMILIES

At the base of the pyramid, we find cost-effective commodity plastics like ABS, PVC, PET, PP, and PE polymers, available in both semi-crystalline and amorphous forms. While these materials typically have lower operating temperatures and strength compared to higher-performing plastics, they still provide good chemical resistance and machinability, although there can be variability among commodity plastics.

Moving up the pyramid, you'll encounter engineering plastics such as polycarbonate, nylon (PA), acetal (POM), and UHMW-PE. These materials generally offer higher temperature resistance and strength than commodity plastics. Engineering plastics are higher-performing and more expensive but still relatively low-cost compared to specialty materials. They are typically easy to machine, mold, or form and exhibit good electrical, mechanical, and physical properties for various applications. If one of these materials meets your requirements, it is often a better option than high-performance or imidized plastics.

For more demanding or specialized applications, high-performance plastics and imidized plastics may be necessary. High-performance plastics like PEEK, PTFE, and PSS can withstand very high temperatures and offer excellent chemical resistance. Imidized plastics, such as polyamide-imide (PAI), polybenzimidazole (PBI), and polyimide (PI), are often better suited for aerospace applications but can also be used for thermal insulators, high-performance bearings, and electrical connectors in extreme environments. These materials offer the highest temperature resistance and load-bearing capabilities, among other properties.

Switchgear



Electronics



Electric Vehicles



Military



Medical



Aerospace



A few of the Thermoplastic-Specific Markets TGC Currently Services



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Thermoplastic Material Selection Guide (cont.)

SELECTING A MATERIAL

Testing conducted at The Gund Company laboratory, as well as at independent and customer labs, has produced valuable data for four common magnetic laminate wedge materials.

1. UNDERSTAND THE APPLICATION'S OPERATING TEMPERATURE

Determining the operating temperature is crucial, as thermoplastic properties can change dramatically with heat. Mechanical properties such as elasticity and stiffness can significantly alter as a thermoplastic crosses the glass transition temperature (T_g). The pyramid is organized by operating temperature, making it easy to narrow material options to those that can operate at temperatures above the maximum application's operating temperature.

2. PERFORMANCE REQUIREMENTS

After establishing the operating temperature, other performance characteristics will guide material selection. Every application is unique and typically has one or two key performance criteria. Engineers should consider the following questions when narrowing down options:

- Are there any forces acting on the part? What are they?
- Will the part be used outdoors or exposed to UV light?
- Will the part come into contact with any chemicals? If so, which ones?
- What kind of electrical stresses will the part experience?

3. UNDERSTAND PRODUCT VOLUME

Each material can be manufactured or processed in various ways. Machining and molding are common methods for transforming thermoplastics into finished parts, but the required product volume is a significant factor in determining the most economical manufacturing method.

Machining parts from sheets or blocks is a good option for low-volume requirements. The tooling costs are minimal, the material is readily available, and lead times are typically shorter. However, machining tends to be slower than other operations, and there may be production limitations based on the complexity of the object.

Molding, on the other hand, is an excellent choice for high-volume parts. While tooling costs can be substantial depending on the part, the production speeds are considerably faster compared to machining. Additionally, material is utilized more efficiently, and the complexity of the part is less of a concern. That said, tooling lead times and material availability can be common drawbacks to molding, but these may represent a small expense for a long-term project. There are other options as well, such as 3D printing, thermoforming, die-cutting, and punching, each with its own pros and cons. Not all thermoplastics can be manufactured using every method, so it is crucial to understand the volume requirements to narrow down the materials to those that can be produced most economically.

4. ESTABLISH A BUDGET

With so many options available, establishing a budget can be challenging. However, understanding the application's operating temperature and production volumes can help set clear expectations. Once the first two steps are complete, it's best to select a material that meets all property requirements and can be manufactured as efficiently as possible.

Considering performance, manufacturing, and cost requirements can make it difficult to identify the right material among thousands of options. The Gund Company is here to help.

If you need assistance finding a solution, The Gund Company has material specialists and application engineers who are available by email, phone, or through our website to help you find the appropriate material for your application. We offer a wide selection at competitive prices and can produce your part using one of our many manufacturing and fabrication capabilities at any of our 12 locations worldwide.

FOR ADDITIONAL INFORMATION ON THERMOPLASTIC MATERIALS

[thegundcompany.com/materials/thermoplastic-materials](https://www.thegundcompany.com/materials/thermoplastic-materials)

or call: 314-492-4837



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Power Generators



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Transformers



Metals Processing



Electric Vehicles



Military/Aerospace



Oil & Gas



Medical



Space

OUR EXPERTISE IS YOUR COMPETITIVE ADVANTAGE

The Gund Company provides a wide range of material solutions from rigid, glass epoxy composites to high-temperature, silicone sponges.

We take a consultative approach to understanding your application by working with your engineers and buyers to find materials that fit the application. By understanding the most important material properties, we often find cost-reduction opportunities. Our Application Engineering Teams have decades of material experience and look forward to working with you on your upcoming project.

Material Families:

- Thermoset Rigid Laminates and Composites
- Flexible Laminates, Papers, Films, and Felts
- Thermoplastic Materials
- Elastomeric Materials

Our Manufacturing Capabilities Include:

- Compression Molding
- Pultrusion
- Filament & Convoluted Wound Tube
- Infusion & B-Stage Composites Lay-up and Molding
- Injection Molding
- Extrusion of Thermoplastics

Our Engineering Capabilities Include:

- Custom Material Development
- Resin Formulation
- Laboratory Testing
- Comparative Materials Evaluation



THE GUND COMPANY GLOBAL FOOTPRINT – LOCAL SERVICE

