WHERE TO START?

Selecting the right material for your design can be daunting. You could choose the “best” possible material that far exceeds the needs of your design, but doing so will likely turn out to be costly. Alternatively, you could choose a material that is cost effective but cannot handle the requirements of the job, sending you back to the drawing board if your part breaks, bends, corrodes, or otherwise fails. This guide aims to assist in determining the most practical material for your specific design by examining the qualities of commonly available machinable materials.


The first step in selecting your material is to choose the two features that are most important to you. For example, if you are selecting material for an airplane part, strength and weight are very important, but it will be unrealistic to think a material that exhibits these qualities, such as titanium, will be inexpensive. Alternatively, such a part could be made out of aluminum, which would maintain the desired property of being lightweight while sacrificing some strength in exchange for cost-effectiveness.
What Attributes to Consider?

**Cost**
Cost is a major factor to consider in all but the rarest of circumstances. For this reason, it is imperative to understand the different variables contributing to the cost of your part. See our cost savings guides for clarification.

**Strength**
Understand the different types of strength materials can possess. Typically, when people think of strength, they tend to think of tensile strength. However, in addition to tensile strength, there is compressive strength, impact strength, shear strength, and bending/flexural strength.

**Stiffness**
Consider the stiffness and rigidity of your material. Be aware of the type of stress your part will undergo. Although a part may not snap if stressed, it can still deform enough to become unusable.

**Toughness**
Toughness encompasses multiple qualities in a material including different measurements of strength, stiffness, corrosion and/or heat resistance as well as its durability over time. Since toughness covers so many types of material attributes, it is often regarded as the most important aspect of a material’s performance.

**Machinability**
If you’ve read our General Cost Saving Machining Tips, then you already know why machinability contributes to cost. A hard material could be cheaper than a soft material for a given volume, but if it takes longer to machine, it will increase costs. Don’t fall into the trap of choosing an inexpensive but hard to machine material.

**Conductivity**
Conductivity may be important if you need electrical current or heat to pass through a part, or if you are trying to use your part to insulate something from electrical current or heat.

**Corrosion Resistance**
Consider if your part will be exposed to chemicals, moisture, or the elements for extended periods of time.

**Heat Resistance**
Metals typically have higher melting points than plastics but are usually more expensive. Knowing how much heat your part will be exposed to is significant to selecting the right material.
### Metals

#### Aluminum

- **Resistant to:** Solvents and most types of corrosion
- **Susceptible to:** Acids and bases

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- **Common Types:** 5052, 6061, 7072
- **Practical Uses:** Wheels, rivets, trim on cars, cans, bike frames, ladders, pots, pans, mailboxes, and staples.

#### Stainless Steel

- **Resistant to:** Extreme cold, abrasion, acids and many forms of corrosion
- **Susceptible to:** High salinity areas and poor air-circulated environments

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- **Common Types:** 304, 316
- **Practical Uses:** Marine equipment, chains, bowls, silverware, and wrenches.

#### Copper

- **Resistant to:** Moisture
- **Susceptible to:** Corrosion

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- **Common Types:** 101, 110
- **Practical Uses:** Roofs, lamps, rain gutters, pipes, tubing, doorknobs domes, spires, jewelry, and kitchenware.

#### Mild Steel

- **Resistant to:** Wearing down
- **Susceptible to:** Moisture

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- **Common Types:** A36, CRCQ, HRCQ
- **Practical Uses:** Aircraft engine mounts, forms, shafts, spindles, chef knives, pins, rods, and springs.
**Metal Properties**

### Brass
- **General Cost:** $$$$$
- **Machinability:** 
- **Electrical Conductivity:** 
- **Thermal Conductivity:** 
- **Thermal Resistance:** 
- **Common Types:** Grade 2, Grade 5, Grade 9
- **Practical Uses:** Valves, gears, nuts, locks, pipes, rivets, musical instruments, and hinges.

### Titanium
- **General Cost:** $$$$$
- **Machinability:** 
- **Electrical Conductivity:** 
- **Thermal Conductivity:** 
- **Thermal Resistance:** 
- **Common Types:** Grade 2, Grade 5, Grade 9
- **Practical Uses:** Tools, knives, fishing rods, armor plating, and golf clubs.

### Bronze
- **General Cost:** $$$$$
- **Machinability:** 
- **Electrical Conductivity:** 
- **Thermal Conductivity:** 
- **Thermal Resistance:** 
- **Common Types:** Aluminum-Bronze, Copper-Nickel, Phosphor-Bronze
- **Practical Uses:** Propellers, bearings, gears, springs, musical instruments, valves and pump parts.

### Other Metals
- There are other less common machinable metals. These metals include Cast Iron, Nickel, Tungsten, Carbon Steel, Lead, Tin, Zinc, Iridium, Platinum, Gold, Silver, and Magnesium among others.

These metals exhibit unique properties which can be useful in the right type situation.
### ABS

- **Properties:**
  - Strong, Flexible, Tough
  - Resistant to: Moisture and heat
  - Susceptible to: Wearing down and ultra violet degradation

- **General Cost:**
  - $ $ $ $ $

- **Machinability:**
  - 

- **Electrical Conductivity:**
  - 

- **Thermal Conductivity:**
  - 

- **Thermal Resistance:**
  - 

- **Common Types:**
  - General Purpose, High Impact

- **Practical Uses:**
  - Auto body parts, toys, liquid containers, and outdoor waste receptacles.

### Acetal

- **Properties:**
  - Strong, Stiff, Tough
  - Resistant to: Moisture, chemicals and heat
  - Susceptible to: Stress

- **General Cost:**
  - $ $ $ $ $

- **Machinability:**
  - 

- **Electrical Conductivity:**
  - 

- **Thermal Conductivity:**
  - 

- **Thermal Resistance:**
  - 

- **Common Types:**
  - Derlin, PTFE blend, Natural

- **Practical Uses:**
  - Ski bindings, bearings, toys, coffee spigots, zippers, safety locks, gears, hobby, R/C, and cams.

### Acrylic

- **Properties:**
  - Weak, Brittle, Soft
  - Resistant to: Abrasion, ultra violet degradation and shock
  - Susceptible to: Extreme heat

- **General Cost:**
  - $ $ $ $ $

- **Machinability:**
  - 

- **Electrical Conductivity:**
  - 

- **Thermal Conductivity:**
  - 

- **Thermal Resistance:**
  - 

- **Common Types:**
  - Cast, Extruded, AR2

- **Practical Uses:**
  - Lenses, doors, access panels, jewelry, lighting fixtures, signage, shelving, and prototypes.

### Nylon

- **Properties:**
  - Strong, Stiff, Tough
  - Resistant to: Moisture, chemicals, heat and abrasion
  - Susceptible to: Ultra violet degradation and mold

- **General Cost:**
  - $ $ $ $ $

- **Machinability:**
  - 

- **Electrical Conductivity:**
  - 

- **Thermal Conductivity:**
  - 

- **Thermal Resistance:**
  - 

- **Common Types:**
  - Cast, Extruded, 6/66

- **Practical Uses:**
  - Sheaves, wear pads, gears, bushings, handles, caps, beach items, and camping tents.
# Polycarbonate

**Resistant to:** Heat and impact  
**Susceptible to:** Ultra violet degradation

**Common Types:** Machine Grade, Hygrad, Textured

**Practical Uses:** Clear tubes for sports equipment, light pipes, bullet-proof windows, and machine guards.

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# Polystyrene

**Resistant to:** Moisture, acids and shock  
**Susceptible to:** Solvents

**Common Types:** GPPS, HIPS

**Practical Uses:** Office supplies, signs and displays, siding, car interiors, bushings, window profiles, and pipes.

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# Fluoropolymer

**Resistant to:** Moisture, solvents, chemicals, heat and bases  
**Susceptible to:** Melt-fracture

**Common Types:** PTFE, FPM, FKM, PFSA

**Practical Uses:** Manifolds, valve seats, automotive fuel hoses, glides, bearings, wear-strips, and gasketing.

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# PVC

**Resistant to:** Moisture, chemicals and heat  
**Susceptible to:** Differential-stress

**Common Types:** PVC, CPVC

**Practical Uses:** Tanks, electrical boxes, filters, vinyl siding, car interiors, bushings, window profiles, and pipes.

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**Polyethylene**

- **Strong**
- **Flexible**
- **Tough**

**Resistant to:** Moisture and chemicals

**Susceptible to:** N/A

**General Cost:** $

**Machinability:**

**Electrical Conductivity:**

**Thermal Conductivity:**

**Thermal Resistance:**

**Common Types:** HDPE, LDPE, Polypropylene

**Practical Uses:** Vapor barriers, cutting boards, cups, vials, caps, furniture, and containers.
**CARBON FIBER**

- **Strong**: Strong
- **Brittle**: Brittle
- **Tough**: Tough

**Resistant to**: Moisture and chemicals

**Susceptible to**: Ultra violet degradation

**General Cost**: $$$$$

**Machinability**: 

**Electrical Conductivity**: 

**Thermal Conductivity**: 

**Thermal Resistance**: 

**Common Types**: N/A:

**Practical Uses**: Sports equipment, car hoods, protective casings, bicycles, hobby, R/C, and aviation parts.

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**FIBERGLASS**

- **Strong**: Strong
- **Brittle**: Brittle
- **Tough**: Tough

**Resistant to**: Moisture, acid and ozone

**Susceptible to**: Hydrofluoric acid and phosphoric acid

**General Cost**: $$$$$

**Machinability**: 

**Electrical Conductivity**: 

**Thermal Conductivity**: 

**Thermal Resistance**: 

**Common Types**: G10, Polester

**Practical Uses**: Housing insulation, outdoor equipment, automotive and aviation applications.
# Rubber

## Polyurethane

**Strong** | **Flexible** | **Soft**
--- | --- | ---

Resistant to: Abrasion and vibration  
**Susceptible to:** Moisture and ozone

|---|---|---|---|---|---|---|

## Buna-N

**Strong** | **Flexible** | **Tough**
--- | --- | ---

Resistant to: Chemicals, oil, and fuel.  
**Susceptible to:** Corrosion from exposure to ozone

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| $ $ $ $ | ![ Lightning Electric ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Lightning Electric ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Fire Fire Fire Fire ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Fire Fire Fire Fire ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | Nitrile, NBR, Acrylonitrile Butadiene | Keypads, footwear, sponges, expanded foams, floor mats, hoses, and seals.

## Neoprene

**Weak** | **Flexible** | **Tough**
--- | --- | ---

Resistant to: Moisture and heat  
**Susceptible to:** Chemicals

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| $ $ $ $ | ![ Lightning Electric ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Lightning Electric ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Fire Fire Fire Fire ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Fire Fire Fire Fire ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | Polychloroprene | Gaskets, hoses, laptop housing, remote controls, mouse pads, face masks and fan belts.

## Silicone

**Strong** | **Flexible** | **Tough**
--- | --- | ---

Resistant to: Moisture, chemicals and heat  
**Susceptible to:** Corrosion from ozone, heat, and ultra violet degradation

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| $ $ $ $ | ![ Lightning Electric ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Lightning Electric ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Fire Fire Fire Fire ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | ![ Fire Fire Fire Fire ](https://media.licdn.com/dms/image/C4E0BAQH4c2zychZC9A) | N/A | O-rings, cake pans, muffin molds, gaskets, and baking mats.

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**eMachineShop**
Launched in 2003, eMachineShop uses CNC technology and secondary processes to fabricate quality custom-machined parts for businesses, engineers, inventors and hobbyists.

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Try our fast online quote. We offer machining, sheet metal fabrication and injection molding. We now accept CAD files, hand drawings, photos and written descriptions.

Request a Quote

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