

Selecting the best material for your sheet metal fabrication

The sheet metal used in fabrication includes a very broad list of possible materials. Making the best choice for your product includes decisions about the type of metal, its thickness, and a choice of form. What you choose should be based on your overall expectations, desired end product, and recommendations from your sheet metal fabricator.

Choice of metals

Sheet metal is made from a variety of metals that each have their own unique properties and offer unique benefits. A list of the most common sheet metals used for fabrication have been summarized in the table below.



HOT ROLLED STEEL (HRS)

Hot rolled steel is produced when steel is processed by a series of roll presses at temperatures over 1700°F. The process creates a steel that is easily formed or shaped into large pieces and is best used where tolerances aren't as important.

Q235 and Q345 are 16 Mn steel grade with good formability and weldability properties. It's commonly used for structural applications and parts for a variety of industries. Q345 offers better performance at low temperatures and offers better steel strength.



ADVANTAGES

- Good flexibility making it ideal for structural components
- Very malleable and doesn't require additional heating for other forming or shaping processes
- Less processing helps reduce costs
- Well suited to high production runs
- Suitable for a variety of shapes and forms
- Cooling process hardens and normalizes the material which prevents any internal stresses



DISADVANTAGES

- The steel shrinks as it cools making the final shape less predictable
- Surface needs to be descaled if appearance is important or painting is required
- Edges and corners often rounded because of shrinkage during cooling
- Square angles are not always precise
- Dimensional tolerances are generally 2-5% of the dimension

Commonly used for:

- Rail tracks, hopper cars, components
- Construction including i-beams, metal buildings, doors, shelving
- Vehicle frames, agricultural equipment
- Water heaters, pipes, tubes
- Cross-sections
- Sheet metal

COLD ROLLED STEEL (CRS)

Cold rolled steel (CRS) is essentially hot rolled steel that has gone through an additional rolling process at room temperature. This additional processing produces a steel with closer tolerances and a broader range of finishes. The result is an increase in strength by as much as 20% compared to hot rolled steel.

SPCC is commonly used for automotive parts and some construction applications. SPCC can be used for galvanized products, appliances, containers, and other products.

SAPH440 is commonly used for automotive frames, wheels, and other parts. It has very good tensile strength making it a good choice for load bearing or structural uses.



Advantages

- Harder and stronger than hot rolled steel
- Good for tight tolerances, creating shapes that are square with true edges and corners
- Allows for precise dimensions
- High quality smooth surface and finish
- Easier to process than hot rolled steel



Disadvantages

- Additional processing results in higher costs
- Can see warping from internal stresses caused by processing
- Limited in the number of shapes possible. Best for basic shapes.
- The process doesn't reduce thickness as much as with hot rolled steel

Commonly used for:

- Machine and automotive parts
- Metal furniture, desks, cabinets
- Home appliances
- Lighting fixtures
- Construction products
- Steel drums, cabinetry, water heaters
- Strips, bars, and rods

SPRING STEEL

The category of spring steel includes several high yield strength steels including low-alloy manganese, medium-carbon steel, or high-carbon steel. They are primarily used to manufacture springs as the steel will return to its original shape after twisting or load bearing. A carbon steel can be used for small springs, but large springs are best when an alloy is used.

High carbon spring steel is a common choice, inexpensive, and easily processed. It is not suited to extreme temperatures or for shock/ impact loads.

Alloy spring steel are well suited to shock or impact loads or conditions with high stress.

Stainless spring steel can be used in some forms at extremely high temperatures (288°C) and are corrosion resistant.

65Mn is a high carbon with manganese to improve hardenability. It has good wear resistance and good workability.



Advantages

- High yield strength, resisting distortion when twisted or compressed
- Products can withstand continuous twisting, compression etc and return to original shape
- Good hardness, elasticity, and hardenability



Disadvantages

- Some metals can have issues when overheated including brittleness
- Requires tempering after heating and quenching to relieve material stresses
- Not all are well suited to welding
- Difficult to form in hardened and tempered state

Commonly used for:

- Valve springs
- Clutch springs, brake springs
- Grinder spindles
- Coil springs, leaf springs, and s-tines
- Piano wire, guitar strings, precision tool wires
- Washers
- Lock picks
- Antennas, scrapers
- Blades

ALUMINUM

Aluminum is a pure metal that is easily alloyed with small amounts of other materials like copper, manganese, silicone, or magnesium. It is not magnetic or combustible and is a good conductor of electricity. Aluminum offers good corrosion resistance and is generally easy to form and process. It comes in several different grades and is often used because of its weight. It weighs about 1/3 of other materials like iron, steel, copper, and brass. It conducts heat well and is non-toxic making it a good choice in a variety of applications.

AL1060 is a wrought alloy with high electrical conductivity, corrosion resistance, and workability but somewhat low mechanical strength. It's commonly used in electrical and chemical industries. AL6063 is most often used for architectural applications or trimming. It has high tensile properties and offers good finish options. It also offers high corrosion resistance and is a good option for anodized applications.

AL 6061 is the most flexible heat-treated alloy with excellent workability. It's well suited to most processes and has good corrosion resistance.

AL 5052 is the highest strength non-heat-treated aluminum alloy and offers very good fatigue resistance. Highly workable, AL 5052 can be formed into complex shapes and offers good saltwater corrosion resistance.



Advantages

- Corrosion resistant and generally offers a maintenance-free finish
- Much lighter weight than alternatives like iron, steel, copper, and brass
- Great heat conductivity
- Nontoxic so it's suitable for food exposure and other specialized applications
- Non-combustible and reflective so often used for lighting
- Good formability, workability, weldability and machineability



Disadvantages

- Requires additional processing to be weldable
- More expensive than steel
- Steel is a better option where strength is a primary concern and weight isn't an issue
- Some alloys are less corrosion resistant than a stainless steel option
- Can affect taste of food so it's less common for food or cooking applications

Commonly used for:

- Window frames
- Aircraft and automotive parts
- Kitchenware
- Food packaging
- Lighting
- Electrical products
- Machinery and equipment

STAINLESS STEEL

Stainless steel includes a variety of sheet metals which contain at least 10.5% chromium. There are many different grade available, offering corrosion resistant and a commercially familiar appearance.

Standard or austenitic stainless steel (300 series steels) is very common and does not require heat during the manufacturing process. They offer good corrosion resistance, formability, and weldability.

SS301 has high work hardening and is commonly used for trailer bodies and fasteners. SS304 has low carbon, is an economical grade but is not seawater resistant.

SS316 has higher molybdenum content that improves its resistance to seawater corrosion. A lower carbon version is available for better corrosion resistance after welding.



Advantages

- Chromium content creates a corrosion resistant finish
- Good combination of strength, hardness, and malleability
- Available in a variety of widths, thickness, and hardness levels
- Can be used for hot or cold treatments/processes
- Suitable for a variety of processing techniques including spinning, brazing, polishing, buffing
- Weldable and suitable for soldering or riveting processes
- Very machinable
- Recyclable



Disadvantages

- Can be difficult to weld
- Can have corrosion at thick welding points
- Possible chipping during processing
- Tends to be more expensive
- Shows dirt and smudges easily and sometimes difficult to clean
- May require polishing and finishing

Commonly used for:

- Construction products like roofing, cladding, building structures, doors and windows
- Food processing equipment, cookware, and appliances
- Cooking utensils, kitchen sinks
- Vehicles including subways, cars airplanes
- Fuel and chemical containers

COLD GALVANIZED STEEL

Cold galvanized steel has a zinc coating painted to the steel surface to protect it from corrosion. The coating will provide both a barrier protection and a galvanic protection to help extend the life of the product. It can be applied with brushes, rollers, sprayers, or through electrogalvanizing. The paint includes special binders so it will mechanically bond to the steel.

SGCC is a galvanized steel with good weldability and formability. It can have a pure zinc coating or have a Zn/Fe alloy coating.



Advantages

- Protection in corrosive environments with a barrier and potentially cathodic protection for the steel
- Surfaces are generally easy to clean
- Low maintenance and good life expectancy for finished product
- Cost effective, fast application process
- Better than hot-dipped galvanization for small parts and components
- Can topcoat without any additional preparation



Disadvantages

- Surface of the steel must be clean and dry before application. This requires an extra step but is less demanding than hot-dipped applications
- Doesn't offer as good durability, abrasion resistance, or cathodic protection as hot-dipped galvanizing
- Physical damage can compromise the coating and result in corrosion
- Surface can include spangles

Commonly used for:

- Nails, screws, nuts, bolts
- Roofing, shutters, and other covers
- Equipment bodies
- Frames

Factors to consider when choosing sheet metal material for fabrication

Each metal has its own unique characteristics. This section of our guide outlines some of the factors that you should consider when making your choice of materials.

	Surface finish						Yield	Tensile	Hardness	GB Standard
	Powder coating	E-coating	Zinc plating	Dacromet	Anodized	Passivation				
Cold Rolled Steel (CRS)										
SPCC	X	X	X	X			≥210 MPa	≥350 MPa	HB 65 - 85	JIS G3141-2009
SAPH440	X	X	X	X			≥305 MPa	≥440 MPa	HB 80 ±30	Q/BQB 310-2009
Hot Rolled Steel										
Q235	X	X	X	X			≥235 MPa	375~500 MPa	HB 120 ±40	GB/T 700-2006
Q345	X	X	X	X			≥345 MPa	490~675 MPa	HB 120 ±40	GB/T 1591-2008
Spring Steel										
65Mn	X	X					≥785 MPa	≥980 MPa	HB 190 - 340	GB/T 1222-2007
Aluminium										
AL 1060	X				X		≥35 MPa	≥75 MPa	HB 26 ±5	GB/T 3190-2008
AL6061 T6	X				X		≥276 MPa	≥260 MPa	HV 15 ~ 18	GB/T 3190-2008
AL6063 T5	X				X		≥170 MPa	≥250 MPa	HB 25 ±5	GB/T 3190-2008
AL5052 H32	X				X		≥70 MPa	210~260 MPa	HV 11 ±2	GB/T 3190-2008
Stainless										
SS301	X				X		≥205 MPa	≥520 MPa	HB 76 ~ 187	GB/T 8170-2008
SS304	X				X		≥205 MPa	≥520 MPa	HB 76 ~ 187	GB/T 24511-2009
SS316	X				X		≥205 MPa	≥520 MPa	HB 76 ~ 187	GB/T 24511-2009
Cold Galvanized Steel										
SGCC	X						≥200 MPa	≥380 MPa	HB 50 - 65	JIS-G3302

SURFACE FINISH OPTIONS

Different metals can accommodate different surface finishes. Some will require additional processing before a surface finish can be applied. Your choice of surface finishes can be for aesthetic or functional reasons – or both.

- **Powder coating** is a dry powder used in place of traditional liquid paint. Applied electrostatically and heat cured, it provides a harder and more durable finish than traditional paint. The coating is often thicker, creates a more uniform finish with no drips or running, and can allow for some unique finishing. The powder coating material has no solvents and a fast curing time. Powder coating is available for most metals including: hot rolled steel, cold rolled steel, aluminum, stainless steel, spring steel, and cold galvanized steel.

- **E-coating** (electrophoretic painting) coats the metal parts by way of a bath that includes paint, resins, or pigments in a water-based solution. The use of an electric current facilitates the deposit of particles on the metal surface. The electric voltage can be adjusted to increase the thickness of the coating. Heat is applied to cure the e-coating. E-coating can be applied as a primer for further finishing or on its own to help prevent corrosion. Its commonly used on hot rolled, cold rolled, and spring steel.
- **Zinc plating** uses electrolysis to apply zinc to the surface. The result is a fine coating appropriate for detailed surfaces but less suited to heavy-duty applications. The zinc plating protects the metal from corrosion in 2 ways: as a physical barrier and as a sacrificial anode because it will corrode instead of the steel its applied to. Zinc coating is used for hot rolled and cold rolled steel to produce a product with high strength, good formability and corrosion resistant.
- **Dacromet** is a brand of coating that uses zinc and aluminum flakes combined with a binder for cold-dipped or spray applications followed by the application of heat. It offers corrosion and barrier protection and is a form of passivation. The result is improved resistance to organic solvents, heat, and salt. The coating is also conductive. Dacromet is common for hot rolled and cold rolled steel.
- **Anodizing** is used to improve the corrosion and wear resistance of aluminum alloys. While aluminum itself is very corrosion resistant, not all metals used in aluminum alloys are. The anodizing processes submerges the material into an electrolytic, acid solution that forms an aluminum oxide layer on the surface of the metal. Anodizing is common for aluminum alloys used in marine or saltwater environments to prevent corrosion. It's also used to improve the hardness of aluminum as the harder aluminum oxide provides additional abrasion resistance.
- **Passivation** reduces the natural chemical reactivity of the metal's surface. In the case of stainless steel, an acid solution is applied to remove any free iron from the surface leaving behind elements that are more resistant to rust and corrosion. Surface damage to the metal can expose iron in the material resulting in corrosion. As a result, passivation many need to occur more than once throughout the lifecycle of a product.

YIELD STRENGTH

The yield strength of a metal is the point at which applied stress will cause it to deform and not return to its original shape. It provides an indication of a metal's elasticity and the maximum force you can apply to it before it will permanently deform, buckle, or even fail. Processes like annealing can impact the yield strength of some materials.

- High yield strength metals: spring steel, cold galvanized steel, cold rolled steel, hot rolled steel, titanium, stainless steel, aluminum alloys
- Low yield strength metals: copper, brass, some aluminum alloys

HARDNESS

Hardness refers to the metal's ability to resist deformation from an impact, abrasion, or load. You can measure hardness based on its resistance to scratches, indentations, or rebounds. Some issues with hardness can be overcome with a hardening process. Hardness is important for load bearing structures as hard metals are better able to withstand the application of load or abrasion.

- High hardness metals: spring steel, hot rolled steel, titanium, stainless steel, cast iron, bronze, brass
- Low hardness metals: aluminum, copper, lead

TENSILE STRENGTH

Tensile strength refers to ability of a metal to resist force. Higher tensile strength requires more force to snap it for example. If the product you're producing doesn't need to bear any load, then a metal with less tensile strength might be the best choice. Keep in mind that how you form the sheet metal can impact its strength and the load it can bear.

- High tensile strength metals: spring steel, hot rolled steel, cold rolled steel, cold galvanized steel, stainless steel, titanium
- Low tensile strength metals: aluminum

DUCTILITY OR FORMABILITY

The ductility of a metal offers insight into how pliable it is and how easy it is to form. When a metal is referred to as having high ductility, that means it easier to form and bend.

- High ductility metals: aluminum, high carbon steel, brass, copper
- Low ductility metals: stainless steel, low carbon steel, medium carbon steel (medium)

WELDABILITY

If your product requires welding, it's important to understand how easy or difficult a metal is to weld. Some metals require extensive preparation or advanced welding techniques which can impact both your budget and schedule.

- Easily weldable metals: cold-rolled steel, low carbon steel
- Less weldable metals: aluminum, copper, stainless steel (medium), high carbon steel

MACHINABILITY

A metal that has high machinability is one that can be more easily cut and cut at higher speeds. Hard machinability requires more power and time to cut the metal.

- Hard machinability metals: stainless steel
- Low/ medium machinability metals: steel, aluminum

CORROSION RESISTANCE

The material you choose should take into consideration the environment it will be exposed to. Some metals respond better than others to factors like water, oxidation, or other elements it will be exposed to. Some metals, like stainless steel, won't corrode but they can develop an oxide film. Also keep in mind that galvanic corrosion can occur when dissimilar metals are in contact with each other.

- Less corrosion resistant metals: cold-rolled carbon steel
- More corrosion resistant metals: copper, stainless steel, aluminum, nickel, titanium, tin

WEIGHT

Choosing a lighter weight material might be best for large objects or objects that need to move (like vehicles, trailers, etc). At the same time, you need to consider the strength of the material. In general, lighter metals have less strength than heavier ones – although that's not always the case.

- Lightweight metals: aluminum, titanium
- Heavier metals: copper, brass, steel, stainless steel

COST

Cost usually isn't the most important factor in choosing a sheet metal for fabrication. It's important to make the best choice based on the other factors we've listed. However, if there is an equally good alternative that has a lower cost, it's worth considering. Keep in mind however, sometimes lower cost materials require additional processing which may result in you not actually saving a lot had you used the higher cost material instead.

- High cost metals: stainless steel
- Low cost metals: low carbon steel, hot rolled steel, tin