

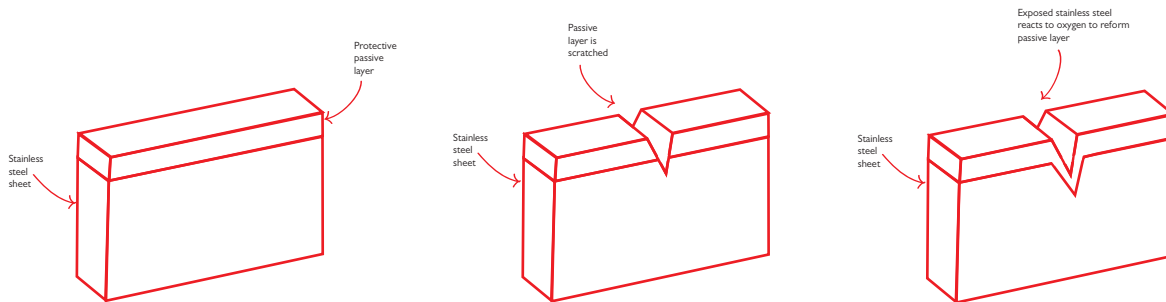
# Stainless Steel properties



## RSC TECHNICAL BULLETIN

Stainless Steel – a self healing metal - is highly resistant to corrosion. It is the high proportion of chromium in stainless steel (over 10.5%) that gives stainless steel this super power. The chromium reacts with oxygen to form a passive oxide layer over the stainless steel. If the protective layer is broken (by scratching for example) it will reform.

This strong resistance to corrosion is one of the key reasons stainless steel is so highly valued, particularly in situations where environmental conditions are extreme, such as coastal or highly polluted industrial areas.



The formation of the stainless steel protective layer (Reference: [www.worldstainless.org](http://www.worldstainless.org))

Other attractive reasons to use stainless steel include its light weight, its lack of maintenance required, and its long product life span.

Despite its superior self healing properties, stainless steel is not immune to corrosion, particularly when it is situated in tough conditions. The protective layer can be permanently damaged and it's usually caused by:

- ▶ chemicals
- ▶ temperature
- ▶ pH
- ▶ the finish of the surface
- ▶ the way the material is fabricated
- ▶ any maintenance undertaken on the surface

## THICKNESS

Stainless steel sheet comes in a range of thickness from 0.45mm to 3mm. Note, thickness should not be confused with gauge, which measures the weight of the sheet.



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### STAINLESS STEEL CLASSIFICATION

Stainless steel can be classified into five different categories – austenitic, ferritic, martensitic, duplex and precipitation hardened.

For our purposes, the majority of stainless steels we use falls into the austenitic category, so this technical bulletin with focus on this category, but we have included a brief summary of each type.

CATEGORY	QUALITIES
<p>Austenitic stainless steel</p> <p>This covers grades of stainless steel in the 200 and 300 series. The most commonly used stainless steel grades are 304 and 316. Both are austenitic stainless steel.</p>	<ul style="list-style-type: none"> <li>➤ Good ductility, strength and ability to resist corrosion</li> <li>➤ Contains between 17% to 25% chromium, 8% to 20% nickel, and may contain molybdenum</li> <li>➤ Not magnetic unless annealed</li> <li>➤ Can become slightly magnetic when cold worked</li> </ul>
<p>Ferritic stainless steel</p>	<ul style="list-style-type: none"> <li>➤ Contain low levels of carbon, little to no nickel and high amounts of chromium (11% to 27%)</li> <li>➤ Magnetic up to 650°C – 750°C</li> <li>➤ Higher thermal conductivity than austenitic stainless steel</li> <li>➤ High corrosion resistance (not as high as austenitic)</li> <li>➤ Better engineering properties than austenitic (ductility, formability)</li> <li>➤ Cannot be hardened by heat treatment but can be cold worked and annealed</li> </ul>
<p>Martensitic stainless steel</p> <p>This covers grades of stainless steel in the 400 series.</p>	<ul style="list-style-type: none"> <li>➤ Similar composition as ferritic stainless steel, but higher carbon content (up to 1.2%), and lower chromium (11% to 18%)</li> <li>➤ This makes it able to be hardened through heat treatment</li> </ul>
<p>Duplex</p>	<ul style="list-style-type: none"> <li>➤ Highly resistant to cracking caused by stress corrosion</li> <li>➤ Superior to austenitic and ferritic steels for tensile and yield strength</li> <li>➤ Can be welded and has good formability</li> </ul>
<p>Precipitation hardened stainless steel</p>	<ul style="list-style-type: none"> <li>➤ The process of precipitation hardening can be simplified into three major stages: solution heat treatment, quenching, and ageing</li> <li>➤ Increases strength over time</li> </ul>

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### AUSTENITIC STAINLESS STEEL GRADES AND THEIR CHARACTERISTICS

CLASS	CHARACTERISTICS
304	<ul style="list-style-type: none"> <li>➤ Most commonly used grade of stainless steel</li> <li>➤ Good corrosion resistance</li> <li>➤ Made up of 18% chromium, 8% nickel</li> <li>➤ Does not contain molybdenum</li> <li>➤ Used in many applications</li> <li>➤ More economical</li> <li>➤ Easy to work with</li> <li>➤ Strong</li> <li>➤ Can be welded</li> <li>➤ Used for pressure applications up to 800°C</li> </ul>
304L	<ul style="list-style-type: none"> <li>➤ Similar properties to 304 but lower percentage of carbon</li> <li>➤ Use in temperatures up to 425°C</li> <li>➤ Resistant to nitric acid</li> <li>➤ Better choice when you are going to weld the material (4mm or greater) but not post weld annealed</li> </ul>
316 Marine Alloy	<ul style="list-style-type: none"> <li>➤ Similar strength as 304</li> <li>➤ Use in marine exposed environments</li> <li>➤ Greater corrosion resistance than 304 and is better option when pitting or crevice corrosion is a risk factor</li> <li>➤ Resistant to phosphoric acid (most concentrations) and sulfuric acid (concentration below 10%)</li> <li>➤ 18% chromium, 10% nickel</li> </ul>
316L	<ul style="list-style-type: none"> <li>➤ Similar properties to 316 but has a lower percentage of carbon</li> <li>➤ Use in temperatures up to 425°C</li> <li>➤ Better choice when you are going to weld the material (4mm or greater) but not post weld annealed</li> </ul>
303	<ul style="list-style-type: none"> <li>➤ Used when there is need for improved machinability of 304</li> <li>➤ Not recommended for welding</li> <li>➤ Not used very often</li> <li>➤ 18% chromium, 8% nickel</li> <li>➤ Addition of sulphur or selenium helps improve machinability, but this can reduce corrosion resistance</li> </ul>
253	<ul style="list-style-type: none"> <li>➤ For use in high temperatures</li> <li>➤ Easy to work with and can be welded</li> <li>➤ Temperature range 850-1100</li> <li>➤ Higher mechanical strength than 300 series</li> <li>➤ 22% chromium, 11% nickel, 0.09% carbon, -0.05% cerium (improves the protective oxide layer)</li> <li>➤ Addition of sulphur or selenium helps improve machinability, but this can reduce corrosion resistance</li> </ul>

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### STAINLESS STEEL FINISHES

In the table below we compare the characteristics of the most popular stainless steel finishes.

FINISH	DESCRIPTION
<b>No 2D</b>	<ul style="list-style-type: none"><li>▶ A cold rolled finish that is highly resistant to corrosion</li><li>▶ Low reflectivity and relatively smooth</li><li>▶ 2D is not commonly available in Australia</li><li>▶ Note - the finish is not uniform so may be an issue if trying to match with another surface</li></ul>
<b>No 2B</b>	<ul style="list-style-type: none"><li>▶ A cold rolled finish</li><li>▶ Most commonly used and most economical finish</li><li>▶ A smooth finish that is highly resistant to corrosion</li><li>▶ Note - the finish is not uniform so may be an issue if trying to match with another surface</li></ul>
<b>Bright Annealed (BA)</b>	<ul style="list-style-type: none"><li>▶ A cold rolled finish that has a smooth appearance, with a reflective, mirror like surface</li><li>▶ Most commonly used in household appliances</li><li>▶ It is highly corrosion resistant because it is very smooth and non abrasive</li><li>▶ Note - the finish is not uniform so may be an issue if trying to match with another surface</li></ul>
<b>No 4</b>	<ul style="list-style-type: none"><li>▶ A brushed polished surface that is a duller finish than 2B and BA</li><li>▶ Lower corrosion resistance than 2B and BA (this can be overcome by using a different grade of stainless (eg - 316))</li><li>▶ Can be more easily matched, but there can still be variability, although less so than 2B and BA.</li><li>▶ Roughness is consistent across a range of gauges</li></ul>
<b>No 8</b>	<ul style="list-style-type: none"><li>▶ Non directional, mirror finish with good image clarity</li><li>▶ Note - while the surface is polished to a gloss finish, there may be some variation of finishes produced by different suppliers</li></ul>