Sulfur is an element that is intrinsically and sometimes even deliberately present in a stainless steel. It is usually bonded in the form of manganese sulfides, which at low levels can have a significant influence on the properties of the workpiece. By design it improves machinability. However, the resulting sulfide proportion, type, and distribution can often cause a failure in the form of mechanical and/or corrosion resistance behavior. Therefore material grade and quality is critical with product performance in particular when optical aspects and corrosion properties is important.
Sulfur is generally undesirable in steel when corrosion resistance is important. The upper limits of corrosion-resistant alloys are comparatively high for sulfur for manufacturing reasons (e.g. 0.03 wt % for 1.4404 or AISI 316L). Unfortunately the negative impact is evident even at these low levels; see fig. 1.

In conjunction with the S³P processes, the negative influence of sulfur on corrosion resistance can be even greater. The more noble S-Phase formed by the S³P treatments leads to a more rapid attack on manganese sulfides – thus reduced corrosion resistance.

Many steel manufacturers, however, offer low-sulfur quality, which in addition to the lower sulfur content also has a finer and more homogeneous distribution in accordance with ASTM E45. Improved manufacturing methods such as electroslag remelting (ESR) allow sulfur contents below 0.001 wt %.

With finely dispersed sulfur content below 0.005 wt %, combined with the formation of the S-phase, Bodycote achieved very good results. Here, for example, the already very high corrosion resistance of duplex stainless steel in chloride-containing media could be further increased; see fig. 2.

Disadvantages of sulfur in steel
- Very strong reduction of corrosion resistance
- Strong reduction in toughness
- Strong reduction of the fatigue strength
- Must not be used below 0 °C
- Prohibited for use in the food and construction industries
- Not approved for pressure vessels
- Pickling increases surface roughness