# In the SPOTLIGHT:

## S³P – SULFUR IN CORROSION RESISTANT STEELS

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.

Bodycote

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S³P – Specialty Stainless Steel Processes

# Sulfur

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.

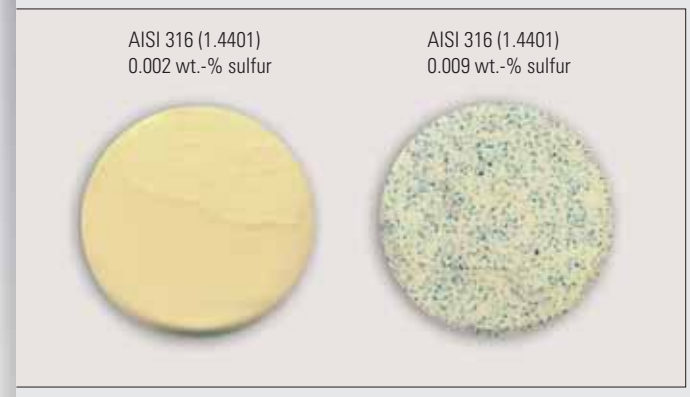


*Fig. 1 Material, AISI 316 (1.4401); Passive layer tested by KorroPad (BAM); left: sulfur content 0.002 wt %; stable and uniform passive layer; right: sulfur content 0.009 wt %; finely distributed manganese sulfides form weak points in the passive layer; by J. Lehmann, A. Burkert; Federal Institute for Materials Research and testing; 17136 N / 1 GfKORR; 2014.*

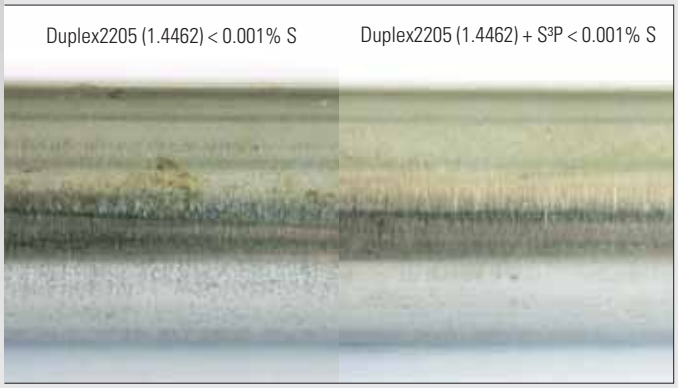


*Fig. 2 Material 1.4462; after 672 h salt spray test; left: solution-annealed at 1050 °C / 1 h; right: solution-annealed at 1050 °C / 1 h + S³P-treated; investigation conducted by UGITECH-CRU.*

## 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



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