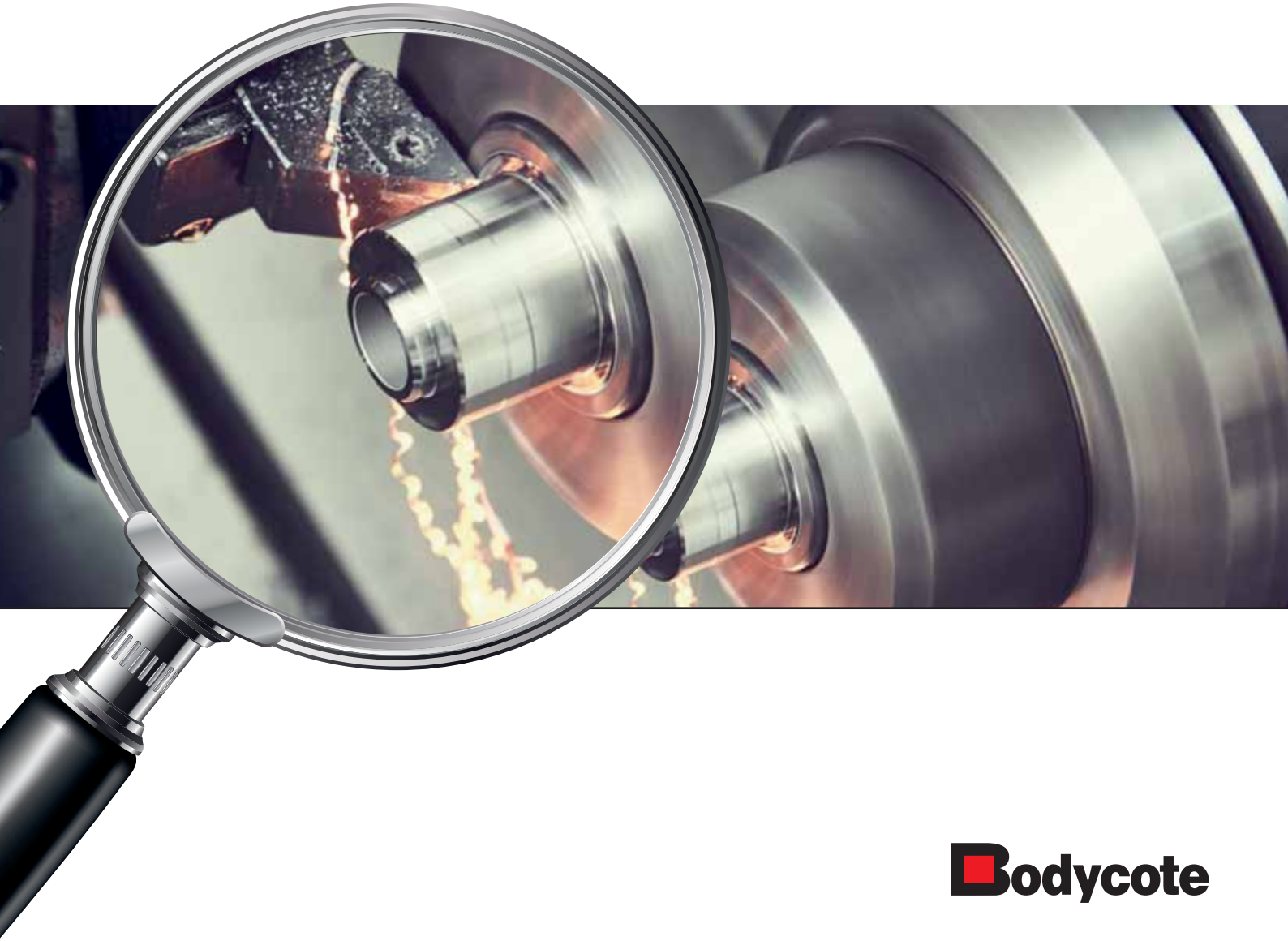
In the SPOTLIGHT

S^3P: CONSIDERATIONS REGARDING SULFUR IN CORROSION RESISTANT STEELS

- SIGNIFICANT REDUCTION IN CORROSION RESISTANCE
- DECREASED FATIGUE STRENGTH
- PROHIBITED FOR USE IN THE FOOD AND CONSTRUCTION INDUSTRIES
- NOT APPROVED FOR PRESSURE VESSELS



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S³P – Specialty Stainless Steel Processes
Sulfur

Sulfur content in stainless steel should be carefully considered

Sulfur is an element that is intrinsically and sometimes even deliberately present in 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 behaviour. Therefore, material grade and quality is critical to product performance, in particular when optical aspects and corrosion properties are important.

Low-sulfur stainless steels offer critical advantages

Where corrosion resistance is important, sulfur is generally undesirable in steel. 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 relatively 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 S³P treatments, such as Kolsterising® and S³P ADM, leads to a more rapid attack on manganese sulfides – thus reduced corrosion resistance.

Therefore, many steel manufacturers 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, excellent results can be observed. In Fig. 2, for example, the already very high corrosion resistance of duplex stainless steel in chloride-containing media was further increased.

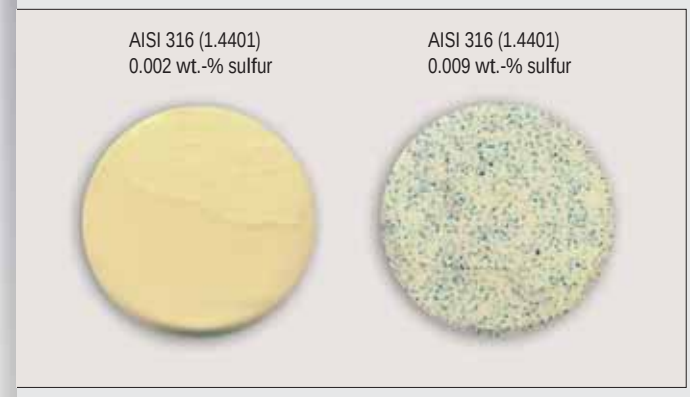

Fig. 1 Material, AISI 316 (1.4401); Passive layer tested by KorroPad (BAM); left: sulfur content 0.002 wt %; stable and uniform passive layer; right: sulfur content 0.009 wt %; finely distributed manganese sulfides form weak points in the passive layer; by J. Lehmann, A. Burkert; Federal Institute for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

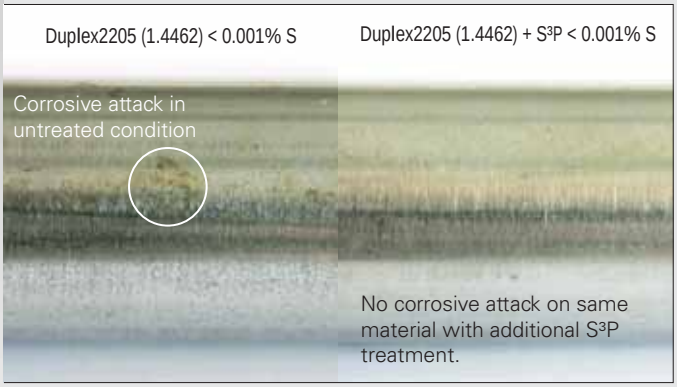

Fig. 2 Material 1.4462; after 672 h salt spray test;
Left: solution-annealed at 1 050 °C / 1 h; showing light corrosive attack
Right: solution-annealed at 1 050 °C / 1 h + S³P; without corrosive attack; investigation conducted by UGITECH-CRU.

Disadvantages of sulfur in steel

- Significant reduction in corrosion resistance
- Significant reduction in toughness
- Significant reduction in 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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10.2018/EN 422-1858