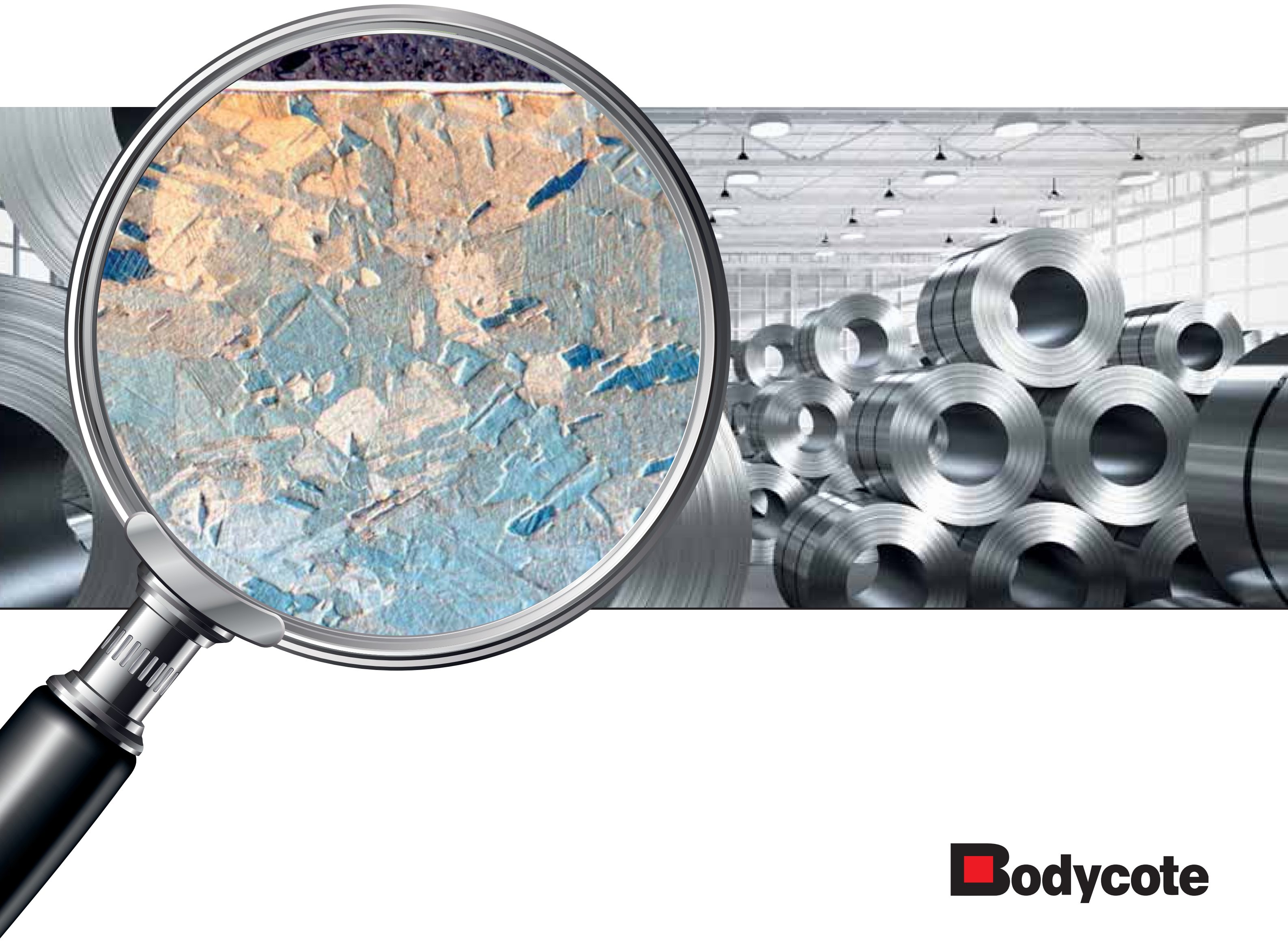
In the SPOTLIGHT

MATERIAL QUALITY OF STAINLESS STEELS IN S^3P TREATMENT

INFLUENCE OF ALLOYING ELEMENTS AND DISTRIBUTION

HOMOGENEOUS MICROSTRUCTURE

INCLUSIONS ARE WEAK SPOTS



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S³P increases surface hardness and wear resistance of austenitic, martensitic and duplex stainless steels. For low-temperature diffusion processes to be most successful, it is necessary to use quality materials that allow a uniformly hardened zone to be achieved. A number of factors relating to the quality of the material being treated can influence S³P treatment results.

Elements and distribution

The chemical composition of stainless steel alloys should include more than 12 wt% chromium to achieve a chemical inertness, and evenly distributed chromium within the microstructure ensures the formation of a uniform protective passive layer. In contrast, sulfur improves machinability, but considerably lowers the corrosion resistance (fig. 1 a-b). Finely dispersed sulfur below 0.005 wt% is recommended for achieving the best S³P results.

Material microstructure

Besides individual alloying elements, the microstructure of the alloy should be formed homogeneously, optimally without structural defects. When there is a noble surface region with high corrosion resistance next to an area with poor corrosion resistance, a "galvanic element" is created (fig. 2). This can cause galvanic corrosion and the region with poor corrosion resistance is sacrificially dissolved.

Microstructural weak spots:

- Inclusions, segregations and precipitations can be considered as impurities which weaken the passive film (fig. 3). The larger and more numerous these are, the lower the corrosion resistance will be.
- All types of inclusions with a different chemical composition than the base microstructure can form a galvanic element. Reduction in corrosion resistance can be caused by delta ferrite in an austenitic structure, but most critical are sulfide or carbide stringers.
- Deformation martensite can be formed during machining, leading to a changed material microstructure. The formation of precipitations in the near-surface material can lead to reduced corrosion resistance.

In many cases, it is recommended to apply homogenising or solution annealing, chemical pickling or electropolishing, to reduce microstructural defects before applying S³P processes to achieve the best results.

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S³P – Specialty Stainless Steel Processes
Material Quality of Stainless Steels

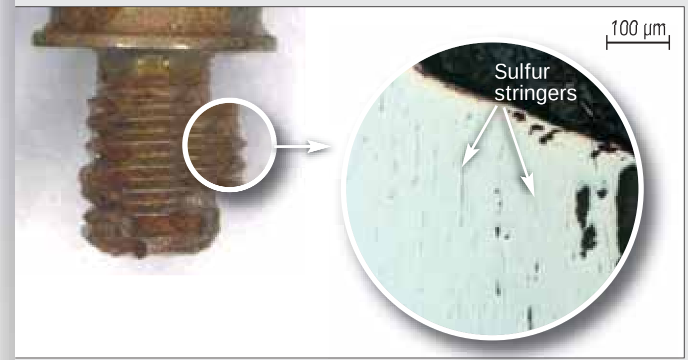

Fig. 1 a-b: Material, AISI 303 (1.4305); Left: Surface hardened bolt shows rust after usage in chloride-containing environment; Right: High amount of sulfur stringers in the material microstructure leads to a reduced corrosion resistance in aggressive media.

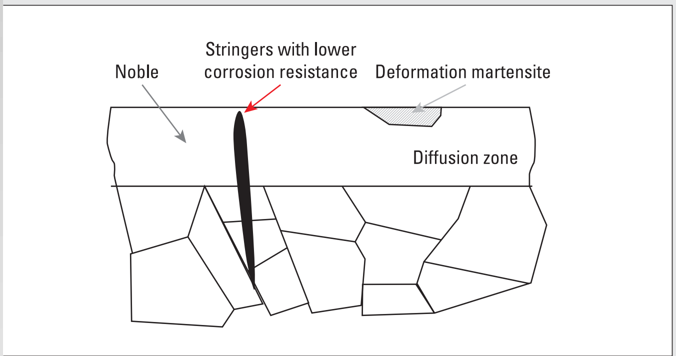

Fig. 2 Schematic crystal structure of S³P-treated austenitic stainless steel with noble diffusion zone; microstructural impurities (stringers) and deformation martensite, already present before surface hardening, can lower the corrosion resistance after Kolsterising®.

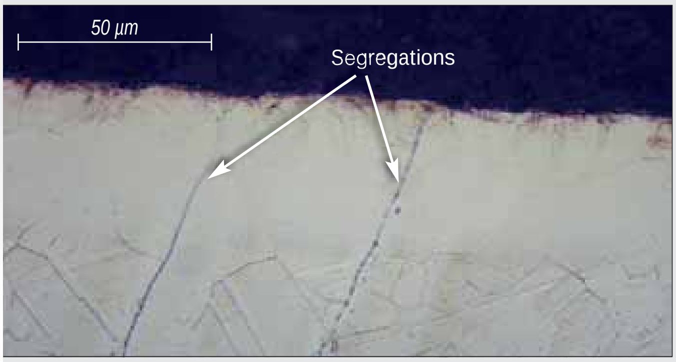

Fig. 3 Material, AISI 316L (1.4435); Manufacturing-related segregations can be considered as discontinuities in the material structure, comprising different, inestimable properties of the stainless steel component before and after S³P-treatment.

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www.bodycote.com
S3P@bodycote.com

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