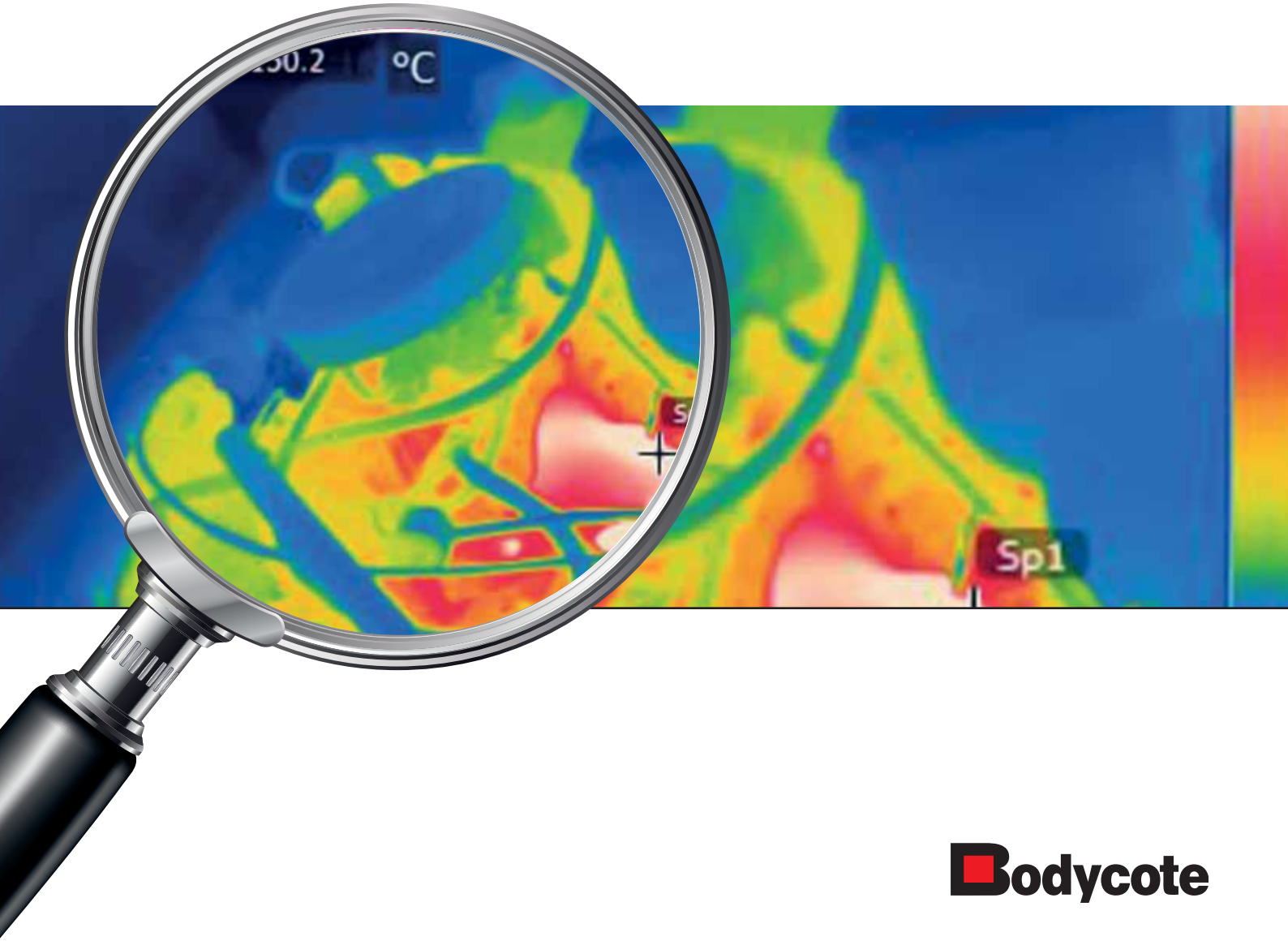
In the SPOTLIGHT

STABILITY OF S³P TREATED STAINLESS STEELS AT INCREASED TEMPERATURES

THERMAL STABILITY IN HARSH OPERATING CONDITIONS



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S³P – Specialty Stainless Steel Processes
Stability at Elevated Temperatures

Higher application temperatures possible with S³P compared to other solutions

At high operating temperatures the S-phase is destabilised. Hardness and corrosion resistance are reduced. The right material selection in conjunction with S³P will determine the behaviour at increased temperatures. If high operating temperatures are required the impact on such properties should be evaluated by laboratory or component testing. Presented below is the summary of an extensive research program carried out to identify the suitable surface treated material for an exhaust gas system.

Our research study

S³P-treated specimens of different stainless steel alloys were tested for changes of microstructure, case hardness and corrosion resistance after annealing at increased temperatures between 350 and 700 °C for up to 30 hours (see Tab.1).

The hardness was measured in $HV_{0.01}$. The corrosion resistance was measured for two different forms of corrosion: pitting and intercrystalline. A change in resistance against pitting was tested by comparing the non heat-treated pitting potential to the S³P-treated one. Intercrystalline corrosion was tested by means of a Strauss Test (according to DIN EN ISO 3651-2).

Our results

The change of microstructure and hardness after annealing at increased temperatures is shown descriptively in Fig. 1.

The diagram presented in Fig. 2 shows the relationship between annealing temperature / time and reduction of pitting resistance. As shown, annealing at increased temperatures leads to a reduction in pitting resistance. The tested material is the same S³P-treated stainless steel as seen in Fig. 1. An evaluation of hardness reduction, intercrystalline corrosion resistance and the change of microstructure was conducted in the same manner.

For an operation at elevated temperatures the S³P-treated austenitic stainless steel 1.4539 showed the most favourable properties. All other tested materials destabilise at lower temperatures and / or showed lower values of hardness and corrosion resistance (see Tab. 2).

Steel No.		Structure
1.4301	X5CrNi18-10	Austenitic
1.4404	X2CrNiMo17-12-2	Austenitic
1.4539	X1NiCrMoCu25-20-5	Austenitic
1.4462	X2CrNiMoN22-5-2	Duplex
1.4362	X2CrNiN23-4	Duplex
1.4162	X2CrMnNiN22-5-2	Duplex
1.4640	X6CrNiMnN19-7-2	Austenitic
1.4376	X8CrMnNi19-6-3	Manganese-Austenitic
1.4373	X12CrMnNiN18-9-5	Manganese-Austenitic

Tab. 1 Overview of tested materials.

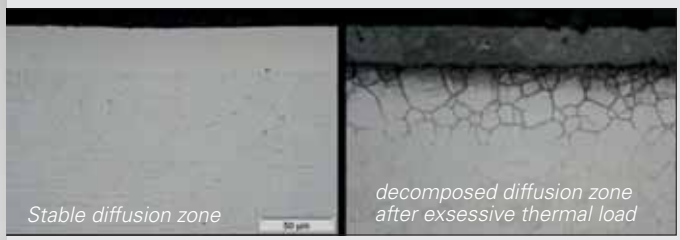

Fig. 1 Microstructure of 1.4539 after Kolsterising®. Left: not annealed (1 000 $HV_{0.01}$); right: after annealing for 4 h at 700 °C (250 $HV_{0.01}$). No loss of hardness up to an annealing temperature of 550 °C.

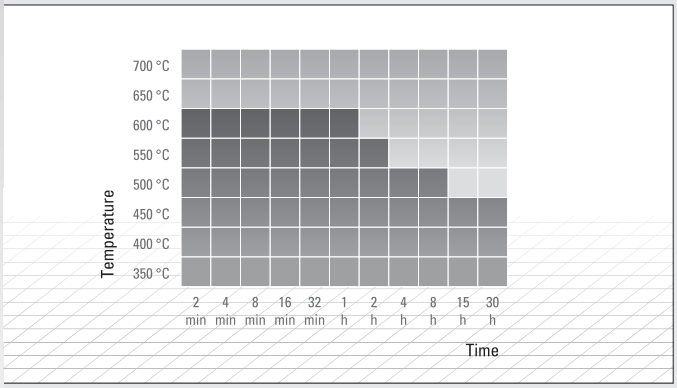

Fig. 2 Reduced pitting resistance after Kolsterising® 1.4539 (light grey areas).

Temperature limits of stability after annealing for 30 hours					
Steel No.	Structure	Hardness	Micro-structure	IC corrosion resistance	Pitting resistance
1.4539	Austenite	550 °C	500 °C	400 °C	450 °C
1.4301	Austenite	450 °C	500 °C	400 °C	450 °C
1.4462	Duplex	500 °C	450 °C	350 °C	400 °C
1.4373	Manganese-A.	500 °C	500 °C	400 °C	350 °C

Tab. 2 Temperature limits for the stability of tested properties after annealing for 30 hours.

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