Martensitic Stainless Steel in the Manufacture of Screws

Symbiosis of Performance and Durability

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What is a Stainless Steel of Martensitic Type?

Contrary to austenitic stainless steels, e.g. A2 or A4, in which the basic microstructural element is an austenite (paramagnetic γ-phase with a cubical, face-centered elementary grid - ***Fig. 1***) the final microstructure of martensitic steels is created by a martensite (a ferromagnetic α-phase with a cubical spatially-centered elementary grid - ***Fig. 2***) which is a product of hardening.

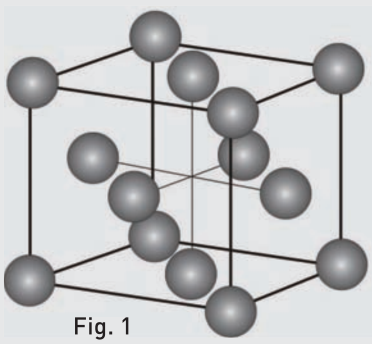

Fig. 1

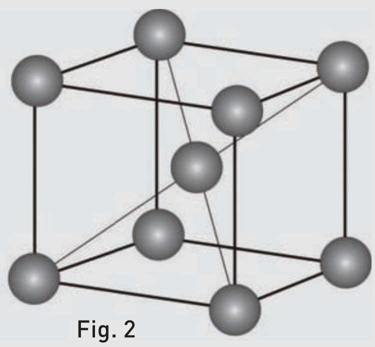

Fig. 2

The given alloying system provides not only strong resistance against corrosion comparable with A2 steels, but also an excellent combination of mechanical characteristics (***Fig. 3***).

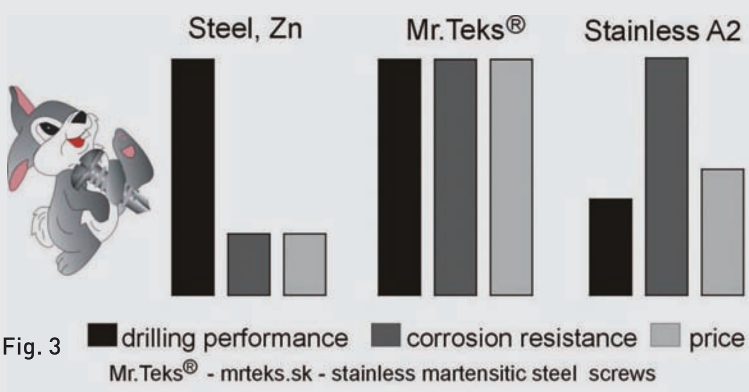

Fig. 3

It is impossible to harden the austenitic steels and therefore the characteristics at the level of hardenable steels cannot be reached. This is a general distinction between both types. They are equal only from the aspect of resistance against corrosion.

Specifically martensitic stainless steels are used to produce self-drilling screws (***Fig. 4***). They are applied mainly to the outer sheathing of the building (***Fig. 5***) and to the isolation of various industrial installations such as boilers, filters and others.

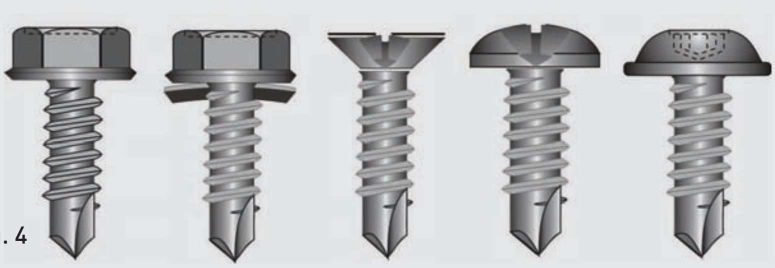

Fig. 4

Fig. 5

The Advantages:

- costs saving because of an inlet pre-drilling operation absence
- no problems with reseating the inlets
- nut-free, clearance-free bolted joint
- simple logistics and rational assembly
- strong resistance against corrosion

In the following text we will become more familiar with these screws.

Metallographic and Chemical Analysis

We tested the DIN 7504K bolts (d_1 = 4.2mm and d_1 = 5.5mm from two different manufacturers) (***Fig. 6*** and ***7***).

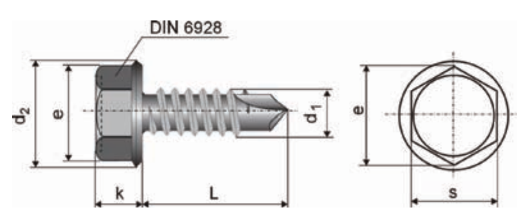

Fig. 6

Fig. 7

Hardness:

The hardness of the screws was measured according to the Vickers method HV1 along the unetched cut screws. The measurement results are shown in ***Figures 8*** (d_1=5.5mm) and ***Figures 9*** (d_1=4.2mm).

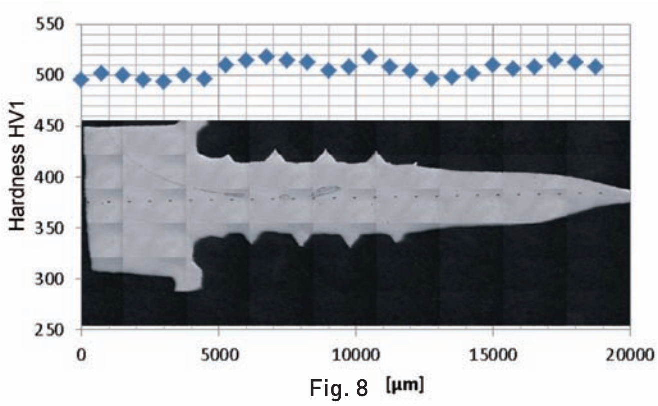

Fig. 8

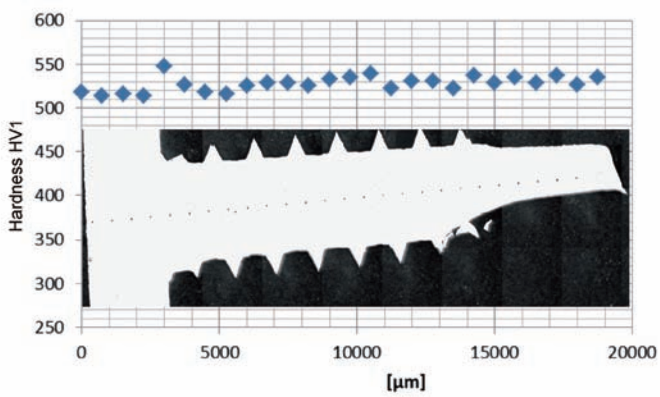

Fig. 9

Metallography:

On the unetched state the presence of microcracks was evaluated (***Fig. 10***). Microcracks occurred in specimen d_1= 4.2mm and were likely to have occurred during the rolling of the screws. The microstructure was induced by the solution Kallings 2. Both samples were martensitic (***Fig. 11***), which corresponds to a hardened condition.

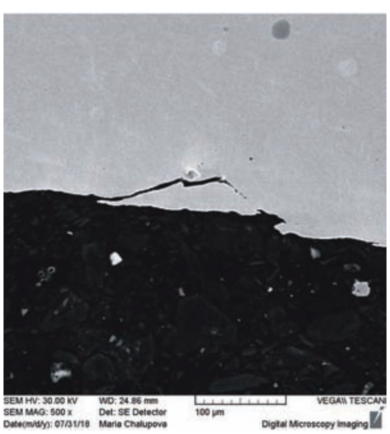

Fig. 10

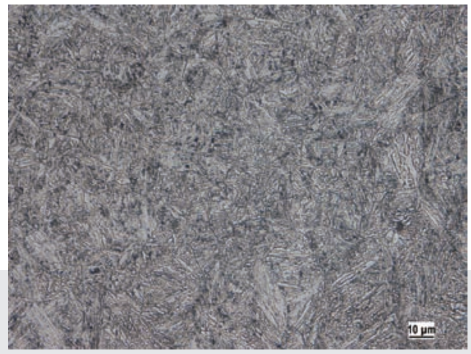

Fig. 11

Chemical Analysis:

The results of the chemical analysis determined by SPECTROMAXx spark emission spectrometer are shown in ***Table 1***. Both steels were identical and matched to stainless steel of martensitic type.

Table. 1

[%]	C	Si	Mn	Cr	Mo	Ni
d_1=4.2mm	0.319	0.312	0.228	13.91	2.08	0.926
d_1=5.5mm	0.236	0.412	0.329	12.97	2.29	1.05

Montage Test:

The assembly test was carried out on the steel profile "L" of the thickness 4.5mm. Under these conditions, there were no differences between the groups. Samples of a diameter of 4.2 mm had a lower head (***Fig. 7***).

Conclusion

In terms of chemical composition of steel, microstructure and hardness, there were no significant differences between the samples. In all cases, it is a hardened martensitic stainless steel. Also, during the assembly, the samples behaved identically. Microcracks on the screws (d_1 = 4.2mm) did not appear negative during the assembly test.