# Laser marking

## Martensitic stainless steels

**Laser marking How?**

By forming black oxidized dots on the metal surface. These dots are all enveloped by a HAZ (Heat Affected Zone). On the surface, it can be observed as colored halos encircling the marked dots. These local heated zones affect the microstructure, the mechanical properties and the corrosion resistance of the marked material. The extent of these HAZ zones depends on the power of the laser beam, as well as from the characteristics of the marked steel. The Table below shows some of the corrosion dangers associated with the laser marking technique.

**Potential corrosion sites**

Martensitic stainless steels with a low Cr content are more sensitive than steels with a higher Cr content. Generally speaking, all too strongly contrasted marking dots can be understood as potential corrosion sites.

**Influences oft he laser marking on martensitic stainless steels**

| HAZ (Heat Affected Zone) | Visual appearance | Negative influences | | |
|---|---|---|---|---|
| Black dot marking according to the "Sub-melting point" technique | | Time limits for the corrosion to develop in 5% NaCl-solution and saturated water steam (i.e. sterilization | | |
| | | short term | middle term | long term |
| Correct black oxidation oft he marked dots. No bubbling | Correct oxidize black dots on a smooth surface. Possible coloration of the HAZ. | No corrosion can be observed with naked eye. | Possible formation of light corrosion stains. Visible by naked eye. | Probable formation of numerous corrosion stains- all clearly visible by naked eye. |
| Too strong annealing (black oxidation) with partial melting and evaporation of the marked dots. | Strong contrasted oxidation (annealing) and formation of bubble in the marked dots. Light coloration of the surface HAZ. | Possible formation of corrosion stains in the middle of the marked dots. | Probable formation of corrosion stains in the center of the marked dots and the HAZ. | Definitive formation of corrosion sites at he marked dots and HAZ. |
| Too strong annealing with general melting and evaporation of the marked dots. | Strong contrasted annealing with bubbling of the marked dots. Strong oxidation of the HAZ, possible. | Numerous corrosion stains on the marked dots. Possible corrosion of the HAZ. | Generalized formation of corrosion sites on the marked dots. Probable corrosion of the HAZ. | Generalized corrosion of the marked dots and HAZ. |



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**Influence of the design of the markings**

The sensitization of the microstructure by the heat of the laser marking can also be influenced by the design of the markings. Hot zones and heat sinks can be created at acute angles, line crossings, and other design features. The acute angles of the letters A, M, X, V form heat sinks, as do close parallel lines of dots, or more generally, two dots close to each other or covering partially or totally each other.

**Influence trough the thermal oxidation**

By principle the laser marking forms black oxidized dots. All marked dots are encircled by a colored oxidation halo formed above 450-500°C. Light contrasted 0.15 mm diameter dots have already an halo 0.03 mm wide encircling them. Depending on the steel being marked, and according to the desired contrast, the laser marking can sensitize the microstructure and render it more or less prone to corrosion.

**Thermal influences on the mechanical properties**

All black dots made by the „Laser annealing“ technique are enveloped by an HAZ or Heat Affected Zone. These thermally sensitized zones have not only have an increased corrosion propensity, but also do influence the mechanical properties below them by modifying locally the microstructure. Such microstructural discontinuities can in turn negatively affect the mechanical properties, i.e. the fatigue properties.

**Pickling oft he colored oxidations**

The pickling away of the colored oxidations does only erase their optical appearances. It cannot eliminate the microstructural modifications in the depth of the HAZ itself. Consequently, the sensitization of the corrosion resistance and the negative influences on the mechanical properties, are definitively not modified.

**Case of the Laser welding**

Laser marking is generally made with a laser beam power < 50 W. Generally, laser welding is done at power > 50-100 W. Therefore, the weld-HAZ are significantly larger and intense than those of laser marked dots. Consequently the corrosion sensitivity of laser welds is more affected than by marking alone, as shown in the Table page 1.





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