

The images show the structure of some types of martensitic stainless steel at the quenched state (X4CrNiMo16-5-1).

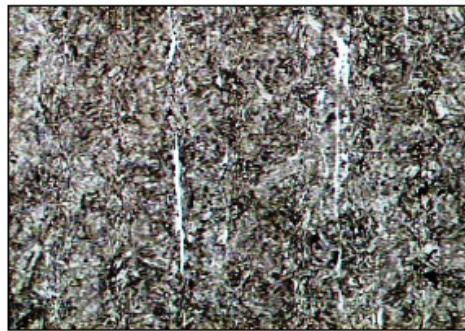
The presence of ferrite in a percentage above 1.5 decreases steel toughness and during drawing can cause cracks.

In a similar way, the considerable amount of ferrite within the welds decreases their resistance to corrosion and ductility.

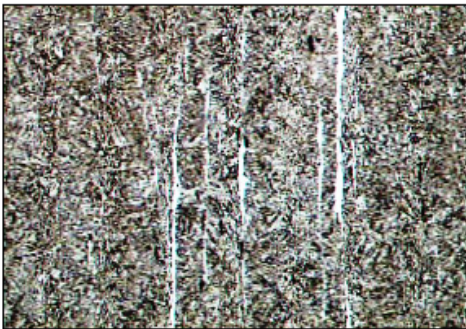
Lengthwise comparison of structures at 100 magnifications



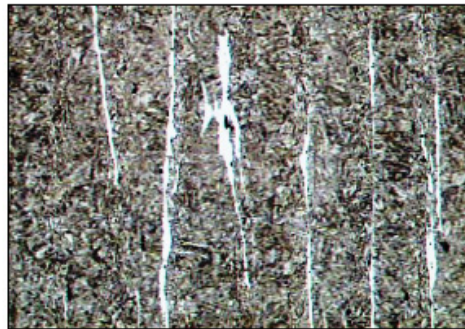
~ 0,5%



~ 1%



~ 2%



~ 4%

Images from Deutsche Edelstahlwerke

(I) Ferrite is the solid solution of very small quantities of carbon in α (alpha) iron which, unlike iron γ (gamma) and due to the shape of its atomic lattice, has little possibility of keeping carbon in solution.

Any solution of other elements in alpha iron and among these chrome is called ferrite.

(I) Biblioteca Tecnica Hoepli. Gli acciai inossidabili1. Gabriele Di Caprio.

The specific volume of ferrite is 11.789 cubic Amstrong

In austenitic steel, the addition of the chemical element Nitrogen (N) inhibits the formation of ferrite.

IMAGES OF THE SIGMA PHASE

The images can help assess the percentage of Sigma Phase into those types of Austenitic-Ferritic stainless steel commonly defined as Duplex, where the structure is 50% austenite and 50% ferrite.

The material under examination has undergone a solubilisation heat treatment (+AT).

The Sigma Phase has a colour leaning towards blue.

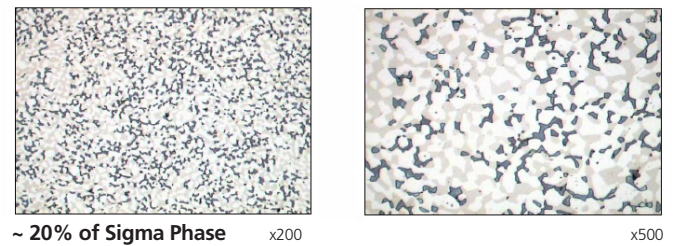
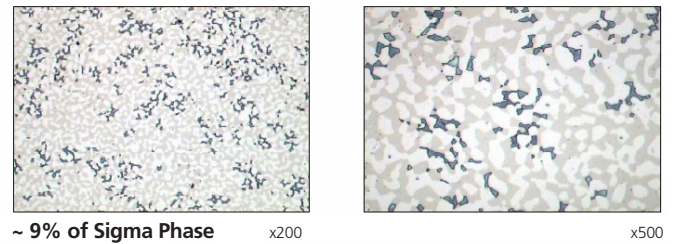
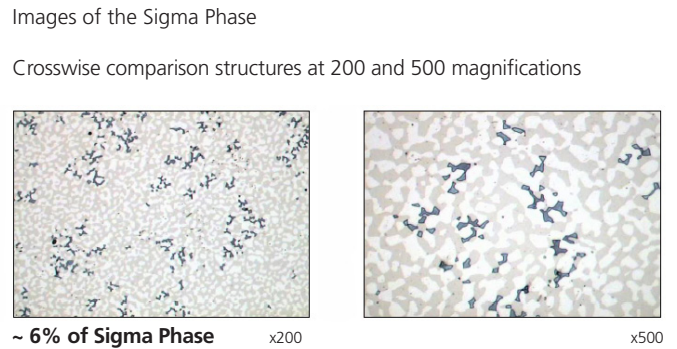
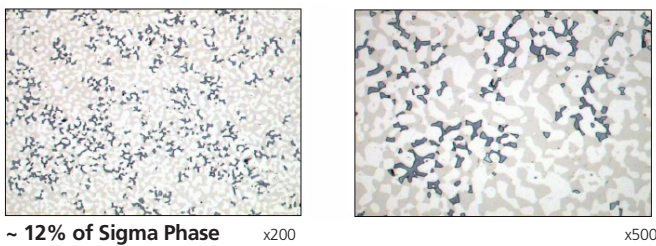
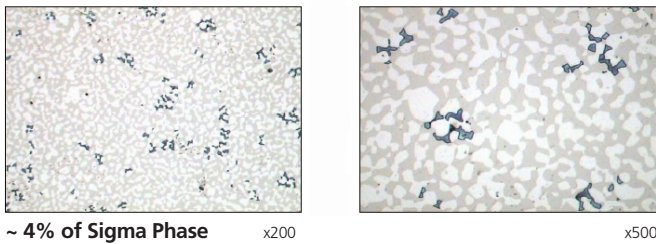
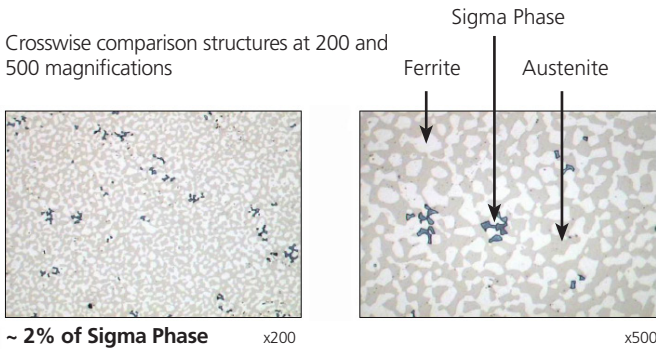
Austenite is white.

Ferrite has a light grey colouring.

As the percentage of Sigma Phase increases, impact resistance (toughness) decreases at low temperatures (cold) and at room temperature.

Furthermore, the tests carried out that this phase decreases corrosion resistance and creep resistance.

This structure can also arise in Duplex or ferritic stainless steel having more than 20% of chrome in their composition, when the material is exposed to a long stay at temperatures within 600 and 900 °C.



ASSESSMENT OF DELTA δ FERRITE PERCENTAGE

Delta ferrite is a residual structure of the solidification process, it is magnetic and brittle at low temperatures.

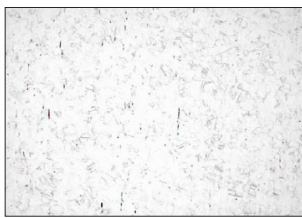
δ Ferrite is present in austenitic stainless steel and in Duplex stainless steel (austenitic - ferritic) at room temperature.

In austenitic steel δ ferrite can be found after welding.

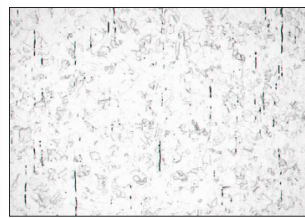
Ferrite in high percentage can cause problems such as the following:

- Transformation of ferrite, at low temperatures, into sigma phase, more brittle.
- Corrosion of ferrite in environments containing acid chlorides.
- Increase in the formation of martensite, in austenitic steel having a low Nickel content and following cold work, with a consequent reduction of ductility.
- Magnetic behaviour of austenitic steel, due to the ferromagnetic nature of ferrite.

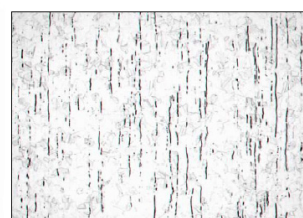
Lengthwise comparison structures at 100 magnifications



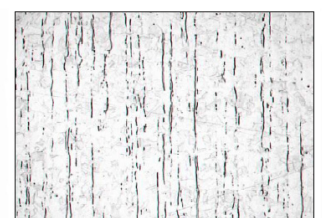
0,1%



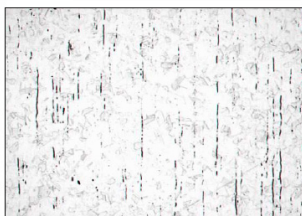
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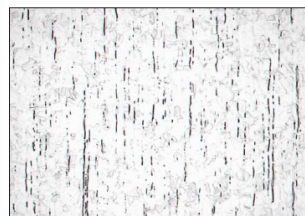
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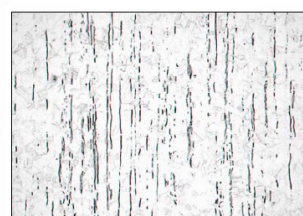
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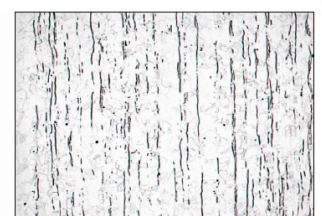
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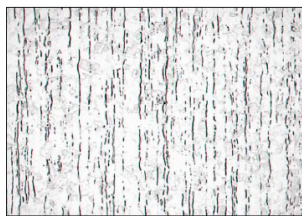
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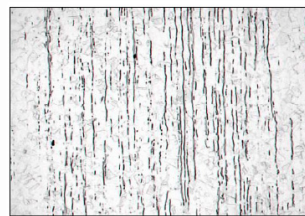
5%



6%



7%



8%

Delta ferrite percentage

Lengthwise comparison structures at $\times 400$ magnifications