EUROPE Allard

The Steel and Iron Foundry

Production of thick walled castings in duplex stainless steels using equilibrium phase calculations

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Contents of the presentation

- Short introduction on Allard-Europe
- Physical metallurgy of duplex
- Problems encountered during production of massive parts
- Why and how to use equilibrium phase calculations

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Allard-Europe

- Jobbing foundry specialised in the production of unique parts and small series.
- Located in Turnhout (Belgium)
- SME: 100 employees, turnover 17 MEuro
- Maximum casting weight: 30ton, Moulding box dimensions up to 5800x5800 mm
- Materials: steel (low and high alloyed), high Cr white cast iron, since 4 years production of heavy section duplex stainless steel
- In-house machining.

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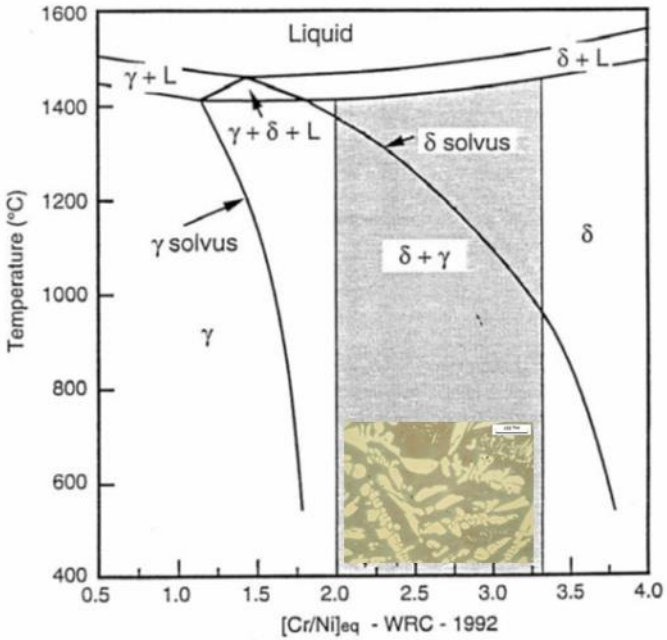
Physical metallurgy of DSS

- Structure: 50%Ferrite+50%Austenite
- High strength, toughness and corrosion resistance.



Solidification sequence:

L - F - F+A

Fast quench preserves the F+A structure.

- Massive castings: cooling rate limited by thickness and by moulding sand

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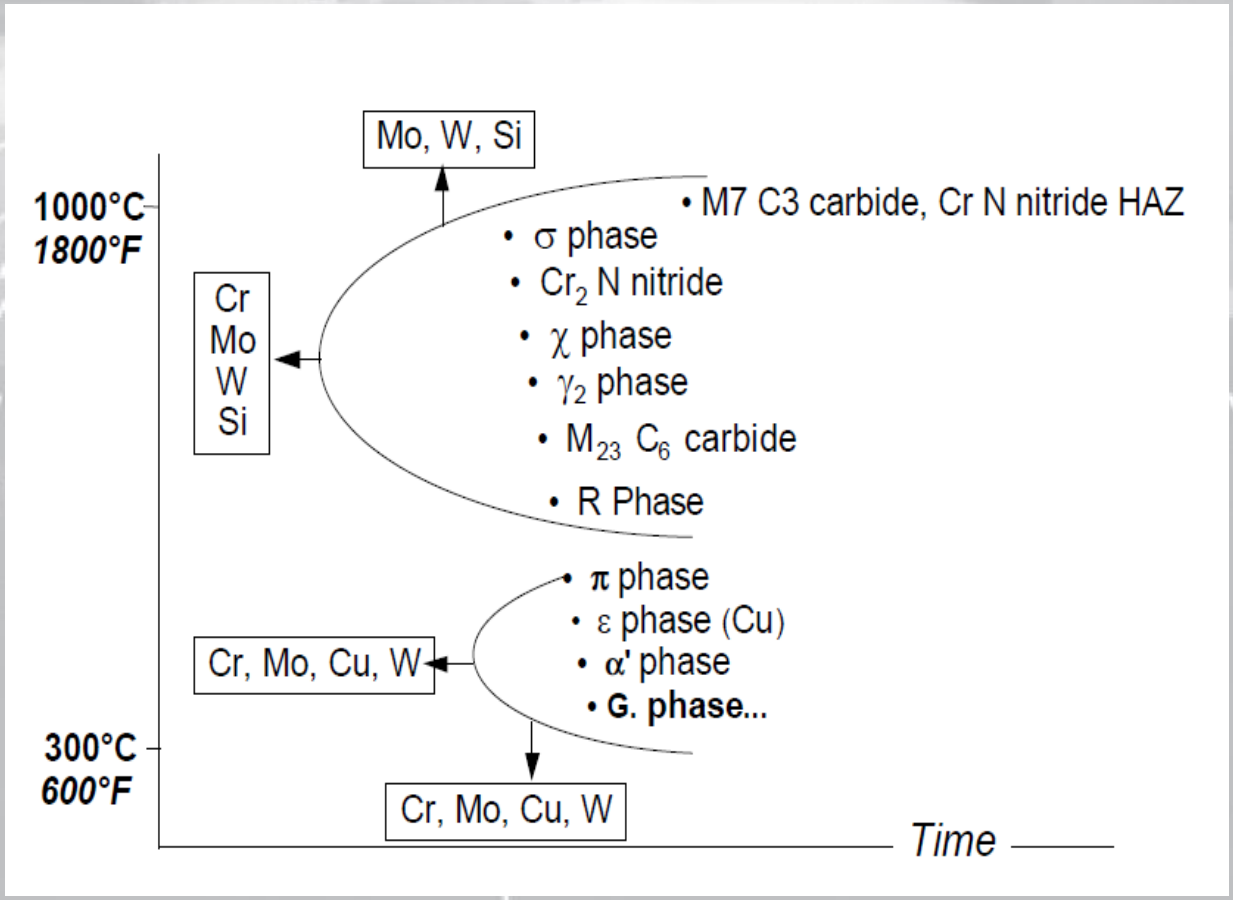
Unwanted precipitates in DSS



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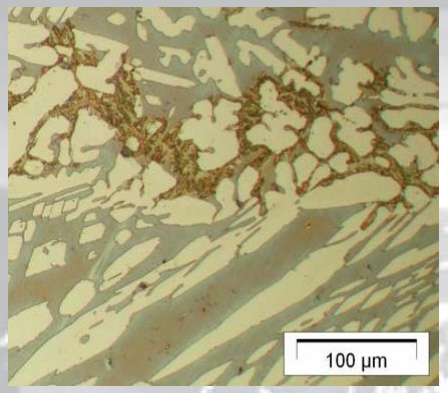
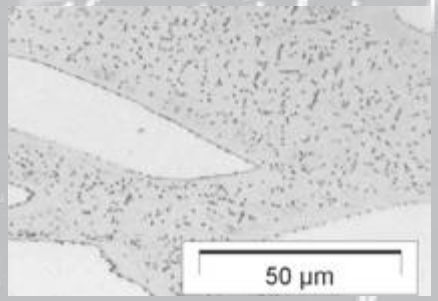
Problem phases: σ and Cr_2N



(as cast duplex)



(annealed and air cooled)

- σ
  - Hard and brittle
  - Tetragonal
  - Big lattice mismatch

=>POSSIBLE FRACTURE DURING PROCESS

- Cr_2N
  - Not a problem during process

BOTH σ AND Cr_2N MUST BE ELIMINATED FROM FINAL PRODUCT
=> APPROPRIATE ANNEAL AND QUENCH

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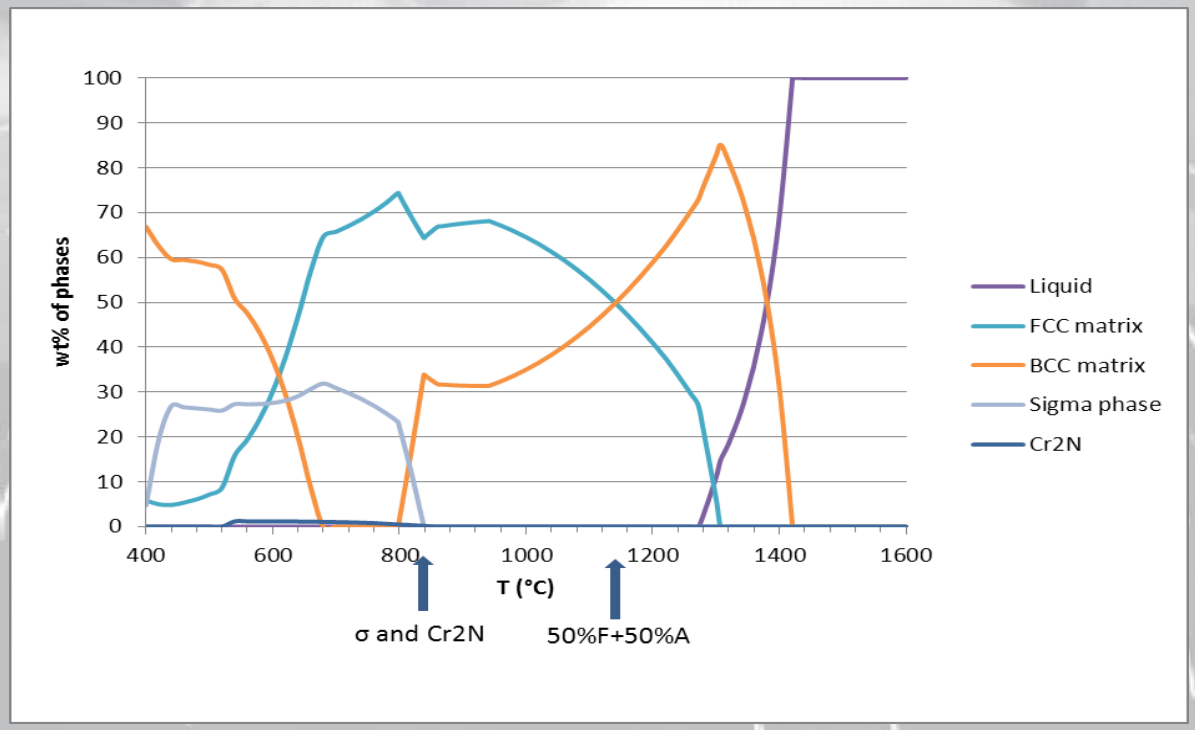
Heat treat successfully: use equilibrium phase calculations

- Phase fraction diagram:



- Annealing and quench temperature must lie:
  - Above σ and Cr_2N precipitation temperature
  - According to the F/A ratio

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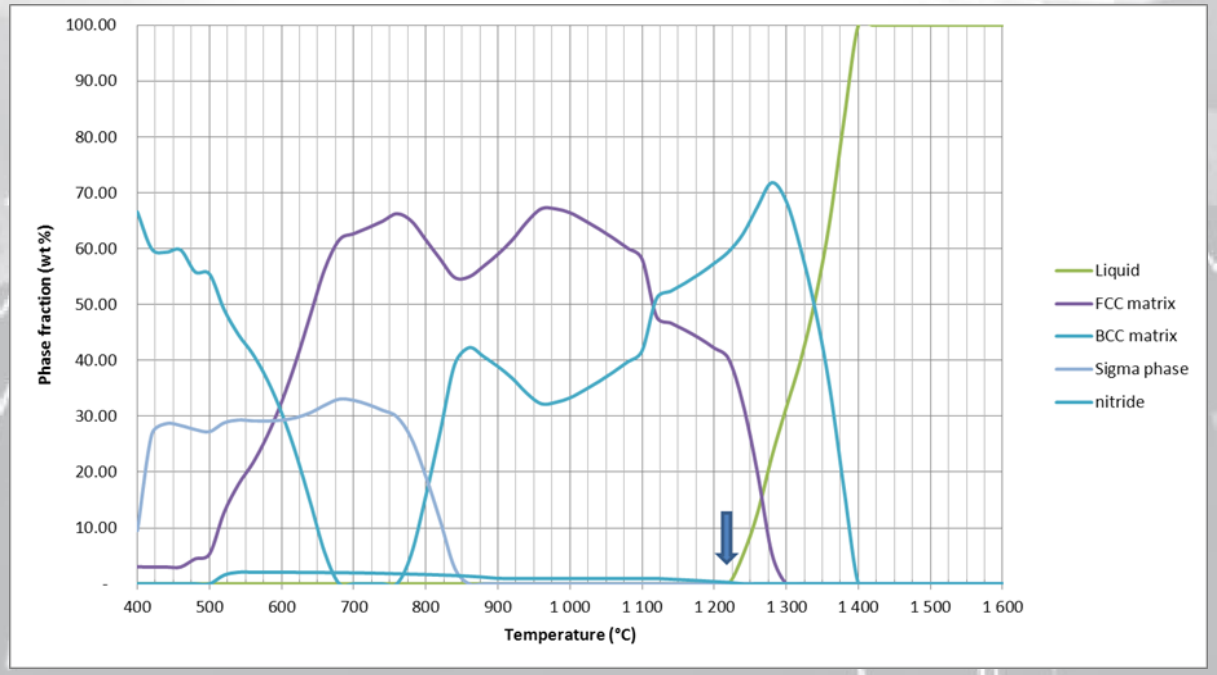
Equilibrium phase calculations

- Allow estimating the annealed and quenched structure of a given composition:



- Impossible to avoid nitride

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Equilibrium phase calculations

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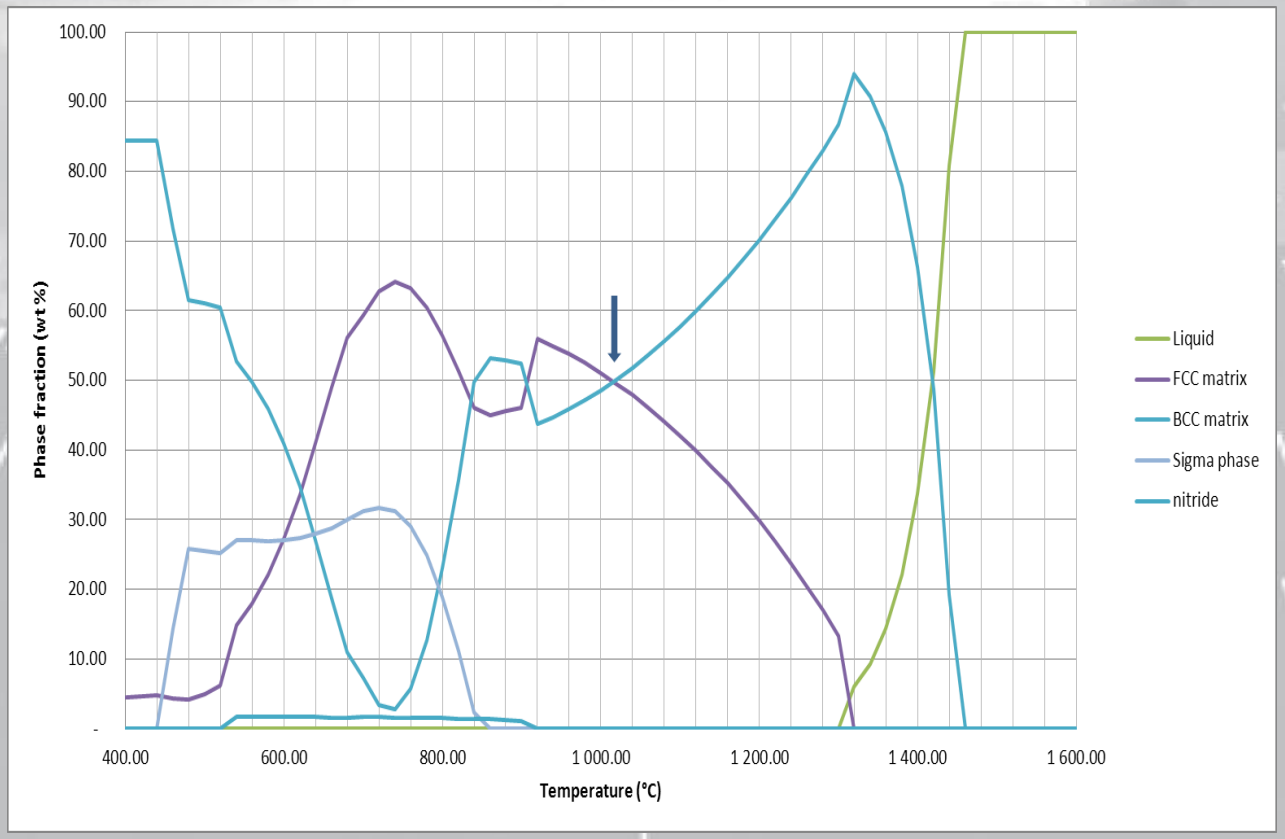

- %F>%A

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Equilibrium phase calculations

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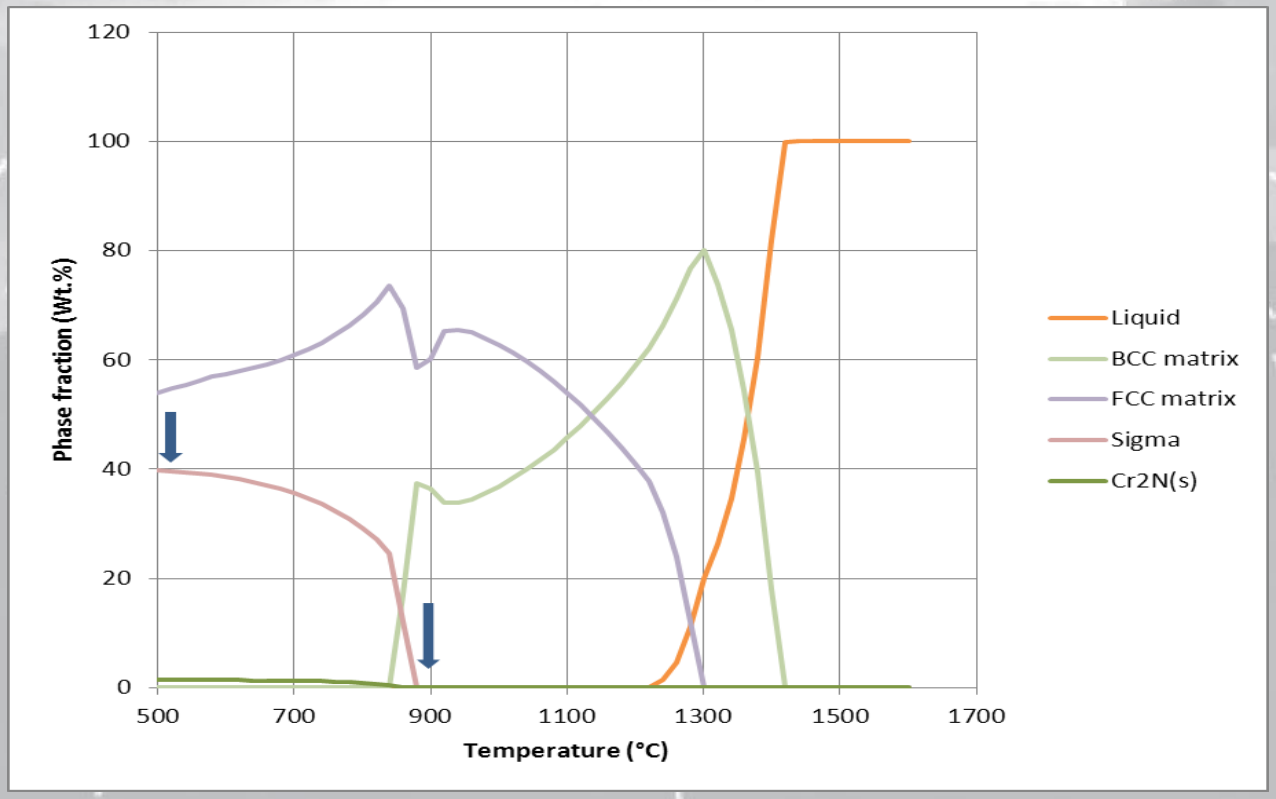

- Higher as cast σ fraction

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Conclusions

- Casting duplex stainless steel up to 300mm is possible
- Equilibrium phase calculations are essential:
  - to optimize the composition,
  - to choose the final annealing treatment.
- The final microstructure depends also on the precipitation kinetics during the quench.
- Besides, casting thick walled duplex requires:
  - Understanding the physical metallurgy of the material
  - Control of the casting practice due to risk of fracture
  - Adjusting the composition to the geometry and thickness of the part to be casted and to the end properties.

Photo Gallery

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Thanks for your attention

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