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Università degli Studi di Padova – Dipartimento di Ingegneria Industriale

Corso di Laurea in Ingegneria meccanica

Relazione per la prova finale «Ghise per applicazioni ad alta temperatura»

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Heat resistant cast iron

Heat resistant cast iron plays an important role in extreme environments such as high temperature, high pressure and high corrosion.

With the continuous advancement of industrial technology, the range of applications of these cast irons is becoming wider and wider, influencing the development of all sectors.

OBJECTIVES

01

Preparation technologies

Cast iron production: from casting to heat treatments

02

Features

Chemical composition and mechanical properties

03

Applications

Main components in cast iron and future developments

HOW TO PRODUCT

1

Grounding

The material is cast inside molds made from foundry sand. Once the casting solidifies the mold is broken to extract the finished object.

2

Shell casting

It is done by pouring cast iron inside metal molds, which unlike "in the ground" molds are reusable and do not require breaking.

3

Continuous casting

Molten metal is solidified inside special cylindrical molds, into billet, bloom, or slab for subsequent rolling in the finishing mills.

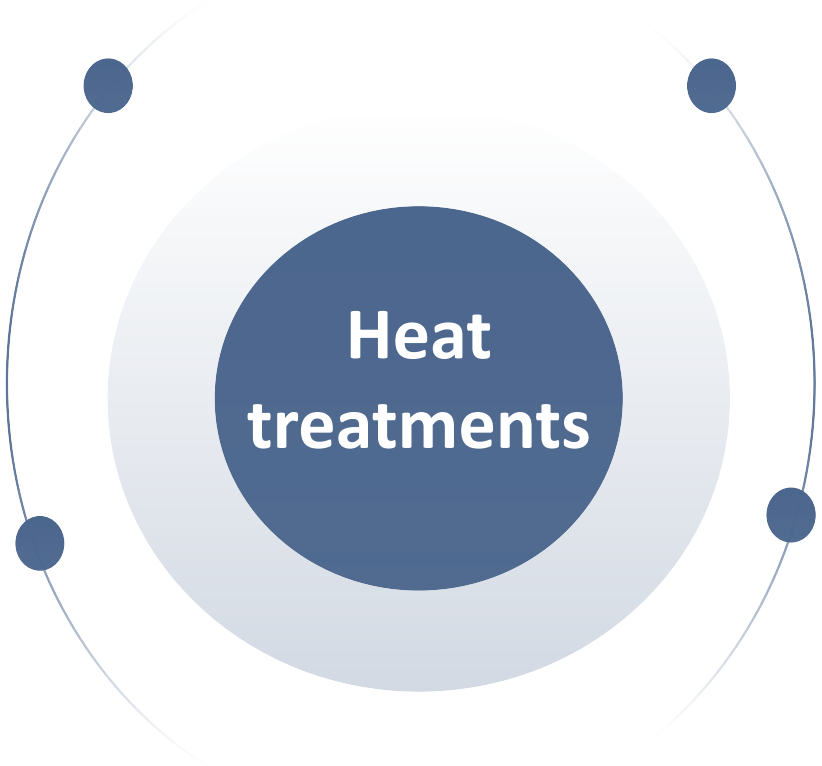
HOW TO PRODUCT

Lightening annealing

- heated to 500-550°C
- cooled in a furnace (gray cast iron) or by air (ductile iron)
- to remove 90-95% of the internal stresses.

Annealing with graphitization

- heated to 650-950°C
- furnace cooling at 500°C and then air cooling
- to remove iron carbides.



Reclamation of ductile iron

- heated 30-50°C above A1
- Quenching + tempering
- to improve the mechanical properties.

Surface treatments

- Surface hardening
- thermochemical treatment
- to improve surface hardness and wear/fatigue resistance.

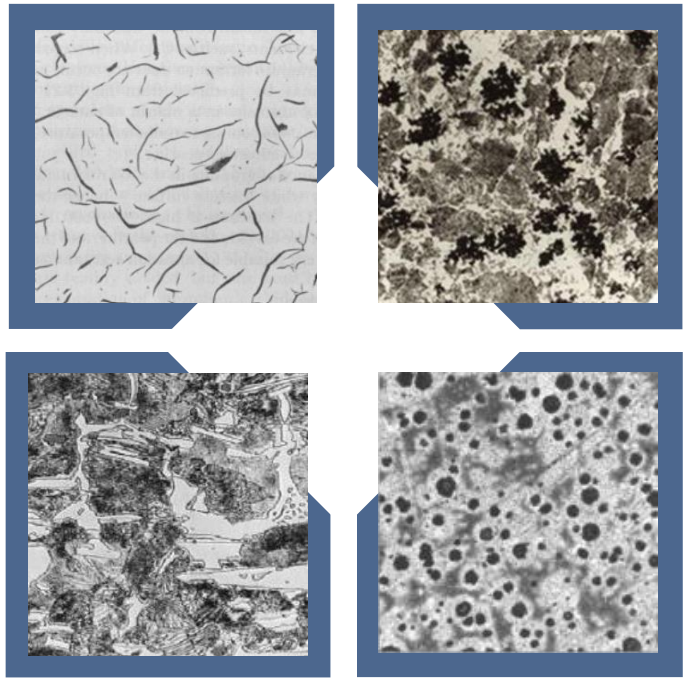
CAST IRON

Gray cast iron

the most commonly used, good strength but low toughness

Malleable iron

a metastable carbide in a pearlitic matrix, excellent mechanical properties



White iron

the presence of cementite increases the hardness but too brittle

Ductile iron

graphite in spherical form, much more impact and fatigue resistance

HEAT RESISTANT CAST IRON

Si

Silicon-based cast iron

- Good castability
- Low production costs
- High resistance to corrosion

Cr

Chrome-based cast iron

- Very high working temperature
- good wear resistance
- HCCI with hard carbides

Al

Aluminum-based cast iron

- Lighter components
- Oxide layer increases resistance to oxidation
- High strength

Ni

Nichel-based cast iron

- Good resistance to thermal shock
- Austenitic matrix even at low temperatures

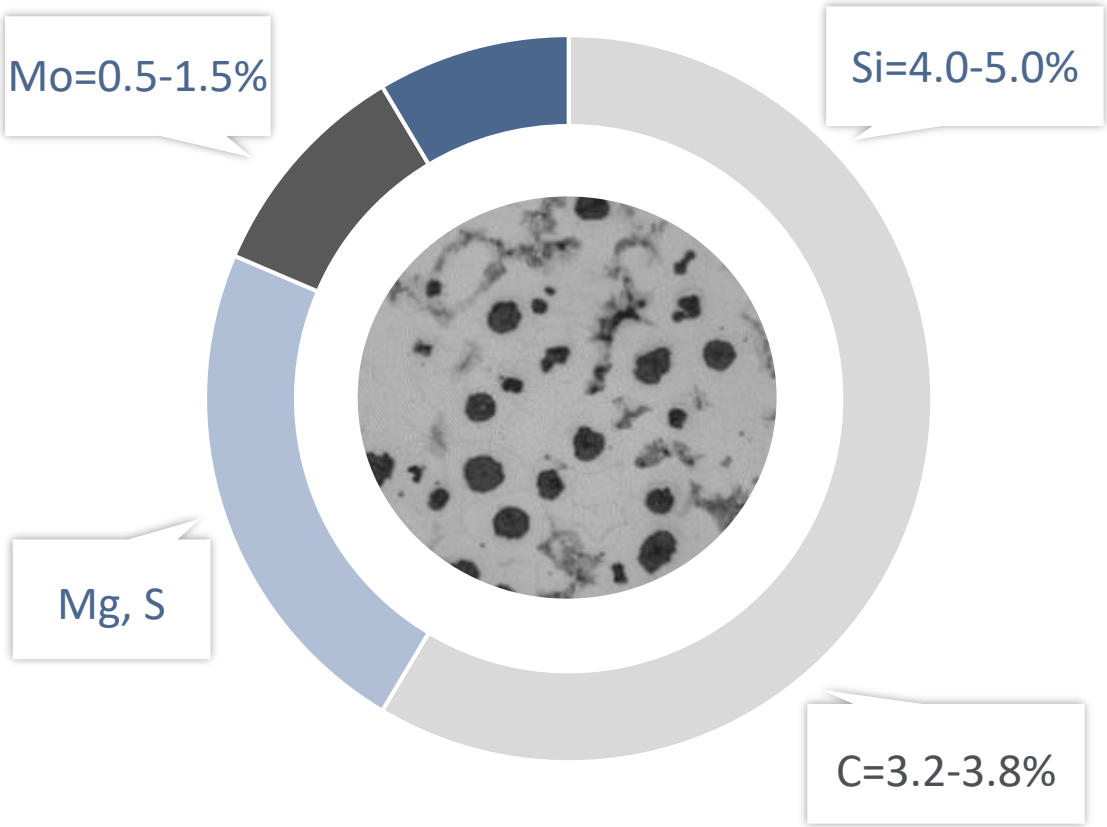
SI-MO DUCTILE IRON

Features

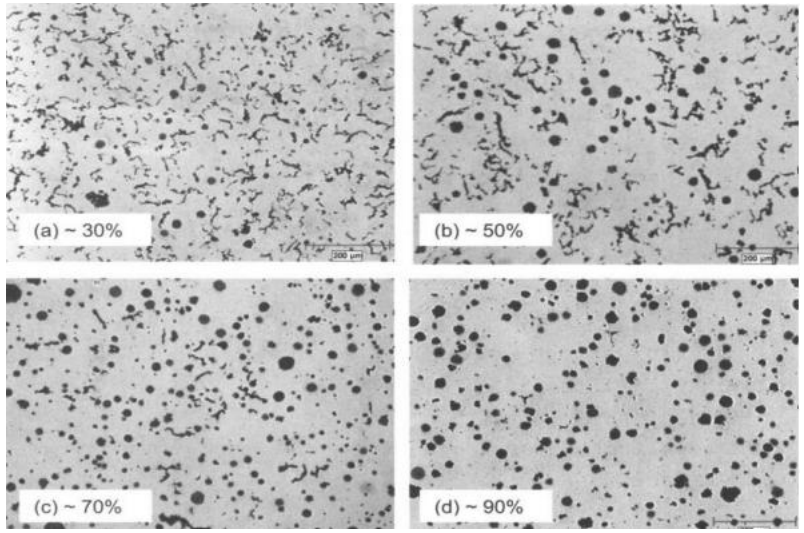
01. Si increases the resistance to corrosion forming a dense oxide layer (SiO2), it increase the critical temperature(A1) of phase change in cast iron.

02. Mo increases mechanical strength at high temperature, forming a special stable carbide (Fe3Mo3C) which strengthens the ferrite matrix.

03. Mg is an important element for spheroidization: nodular graphite contributes to the oxidation resistance of cast iron;



SI-MO DUCTILE IRON

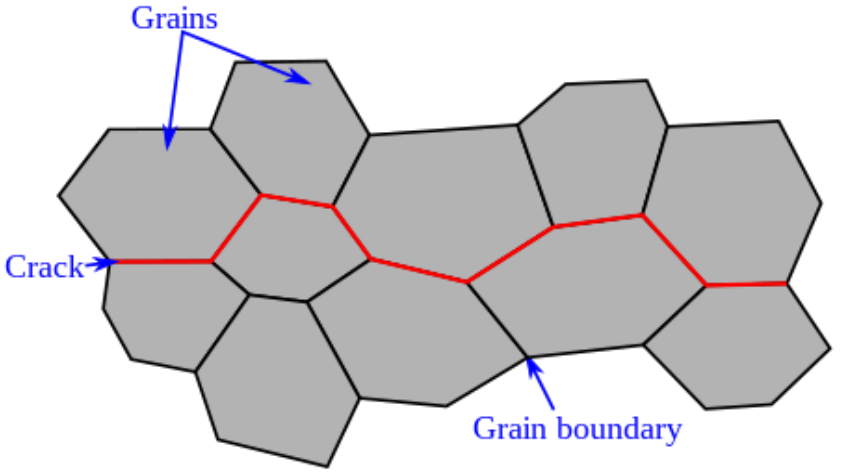


Correlation between graphite morphology and properties

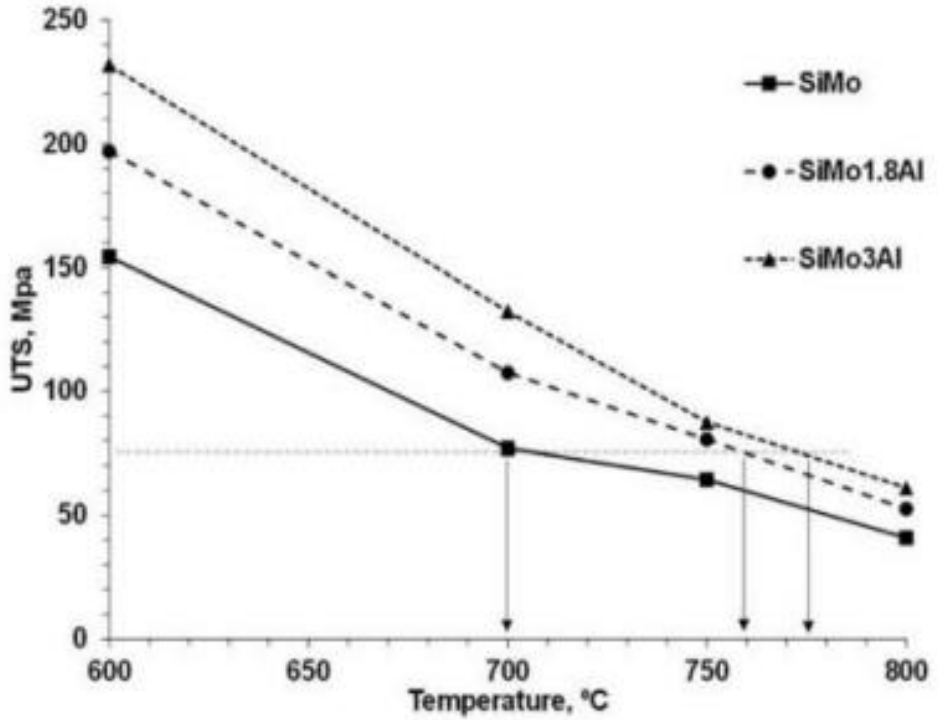
- spheroidal graphit
- compacted graphit
- hybrid graphit

Intergranular embrittlement

- ferritic spheroidal cast irons
- caused by the segregation at the grain boundaries of impurities



SI-MO DUCTILE IRON



01. The raising of the phase transformation temperature from ferrite to austenite;

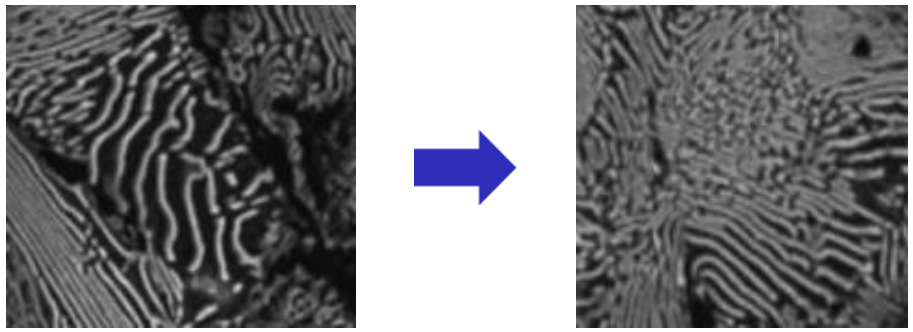
02. The decrease of the negative segregation phenomenon of silicon around graphite nodules;

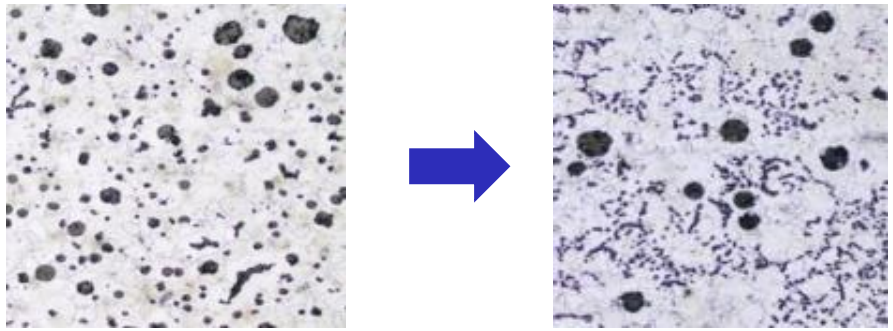
03. The formation of a film of alumina (Al_2O_3) surface protection.

Si-Nb Ductile iron

Gray cast iron

- Nb increases the volumetric fraction of perlite (more refined)
- Nb reinforces the matrix with extremely fine NbC carbides





Ductile iron with Al

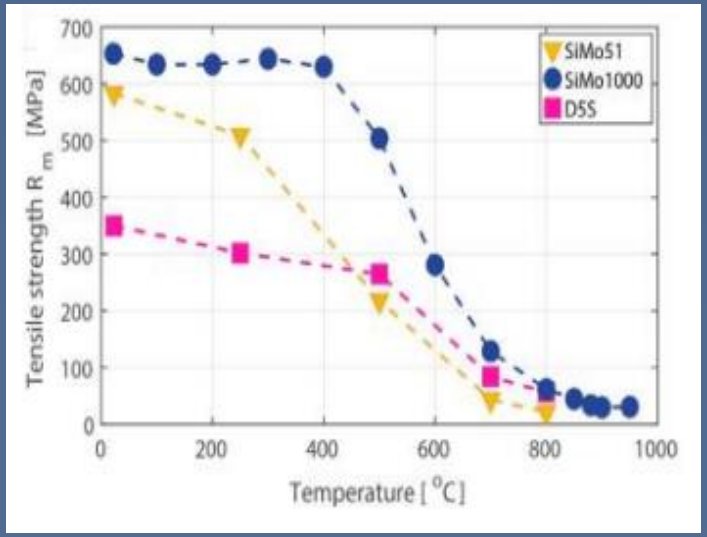
- Nb is an excellent substitute for Mo
- Nb improves the stability of the alloy phases
- formation of the kappa phase

APPLICATIONS

automotive engines | hot rolling mills | molds for glass containers

crucibles for aluminum casting | boxes for gas turbine compressors | furnaces

Exhaust manifold



SiMo51

It is the cast iron traditionally used for the exhaust manifold

SiMo1000

It is a ferritic cast iron with added alloys of Si, Mo, Al and Ni

Ni-resist D5S

- It is an austenitic cast iron with a content of Ni of 30-35 percent
- Austenitic matrix at all temperatures
- typically used in gasoline engines

CONCLUSIONS

Conclusions

In recent years, thanks to the many important researches conducted and the development of foundry technology, interest in cast iron has increased.

It has been seen that the addition of performance chemical compounds, a well prepared solidification process and using heat treatments , improve a lot of properties

2023

Thank you for your attention

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