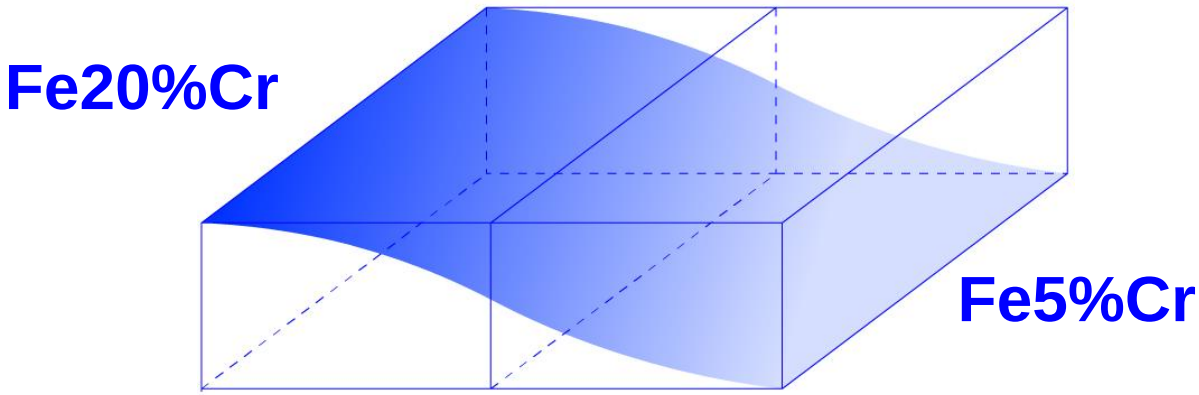
Determination of the critical limit of the $\delta \rightarrow \gamma$ massive transformation in Fe-Cr and Fe-Cr-C alloys using Fe5%Cr-Fe20%Cr diffusion couples



Béchir CHEHAB, Jim GARRETT, Hatem ZUROB, Yves BRECHET, Muriel VERON, Jean Denis MITHIEUX, Jean Christophe GLEZ

ALEMI McMaster 18-19th June 2007

Outlook

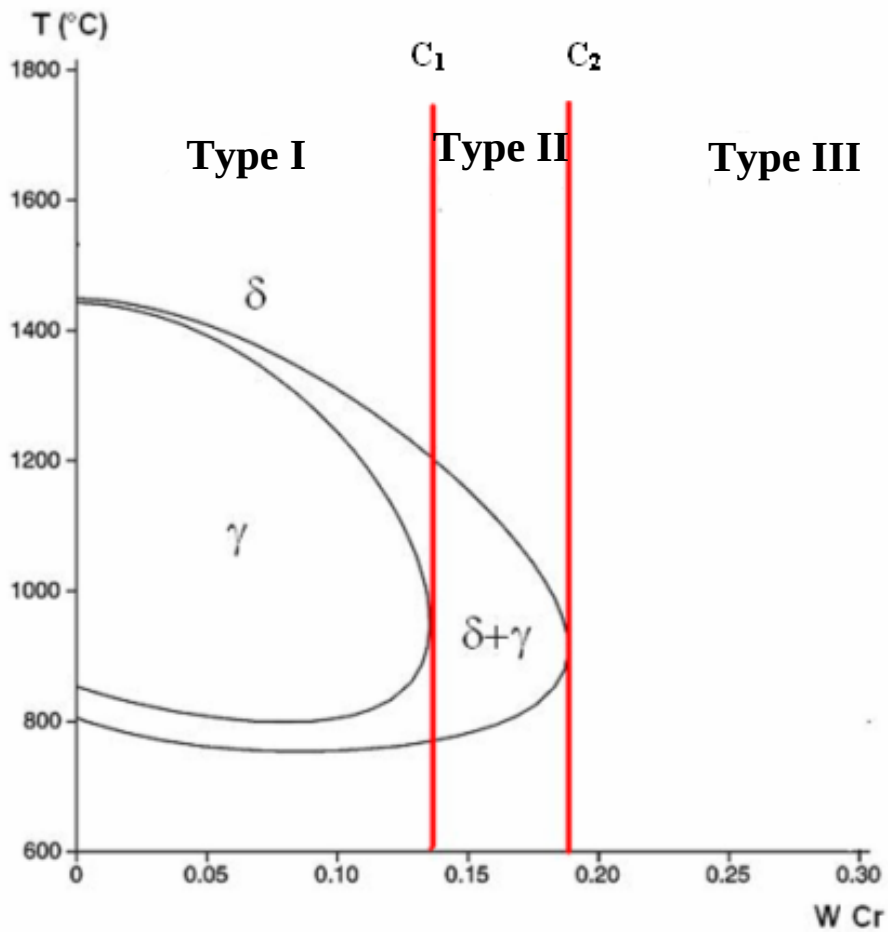
I) Introduction

II) Experimental method for making Fe-Cr diffusion couples

III) Results on Fe-Cr alloys

IV) Results on Fe-Cr-C alloys (under investigation)

I) Introduction



Fe-Cr phases diagram (definition of the different types of alloys) **[Lacoude and Goux, 1966]**

II) Experimental method for making Cr diffusion couples

Fe-20%Cr

Fe-5%Cr

1cm

Polishing up to 1µm

spot welding

Room temperature pressing (23KN)

quartz tube under vaccum

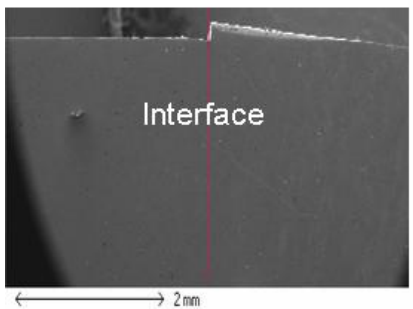
Stainless steel slug (162gr)

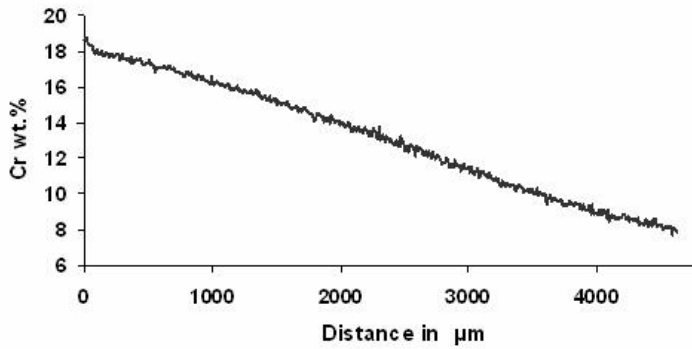
Boron nitride

Future diffusion couple

5h@1200°C

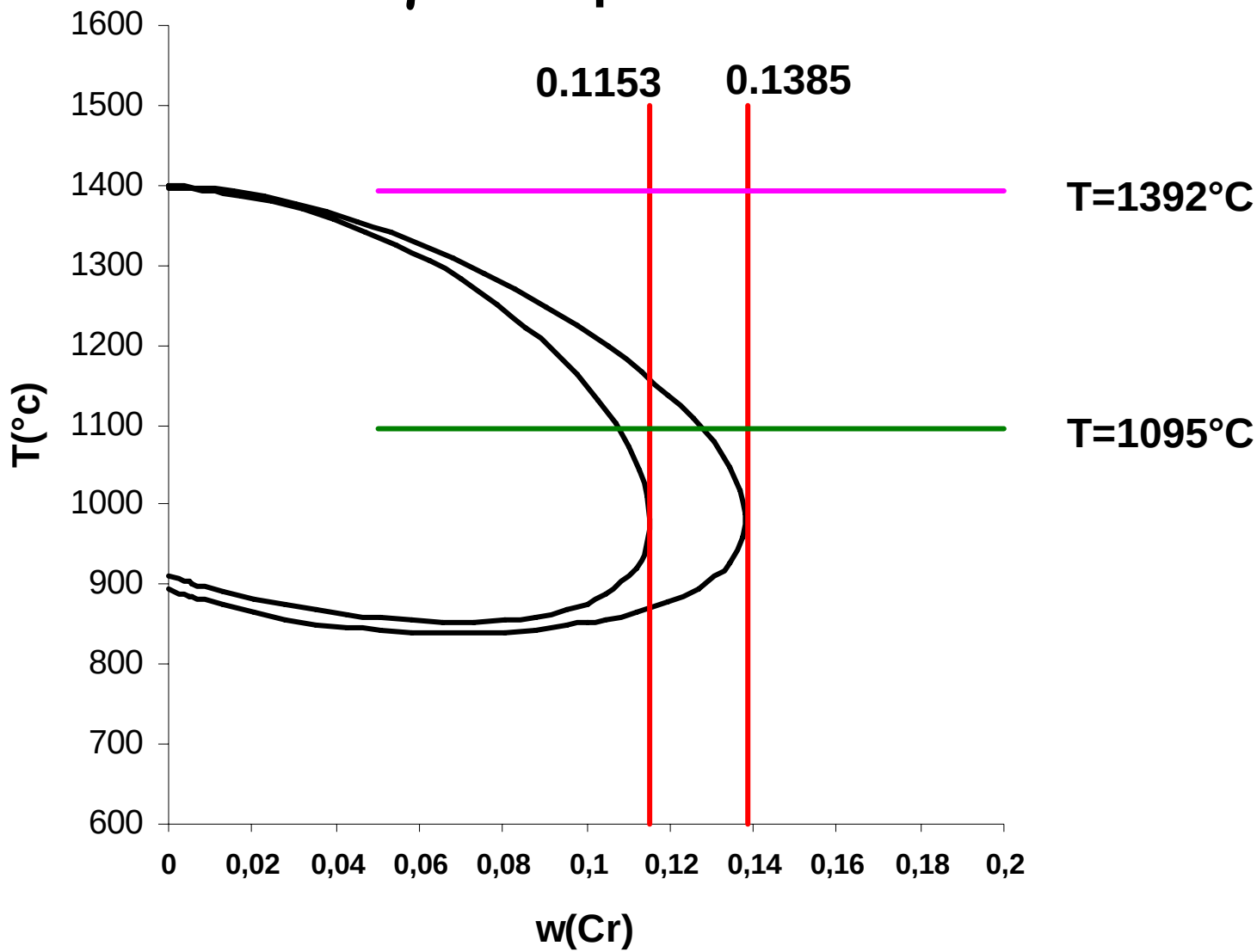
96h@1392°C under Ar



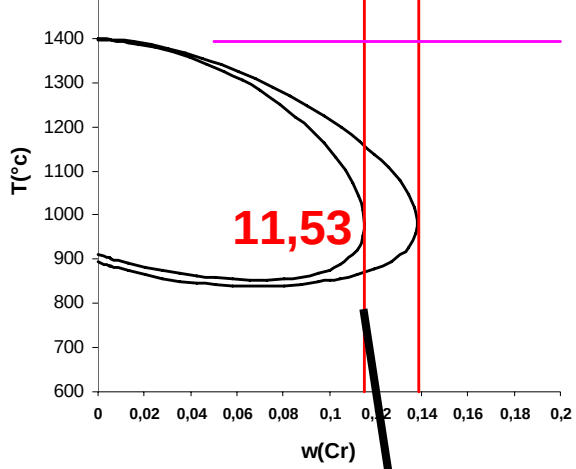


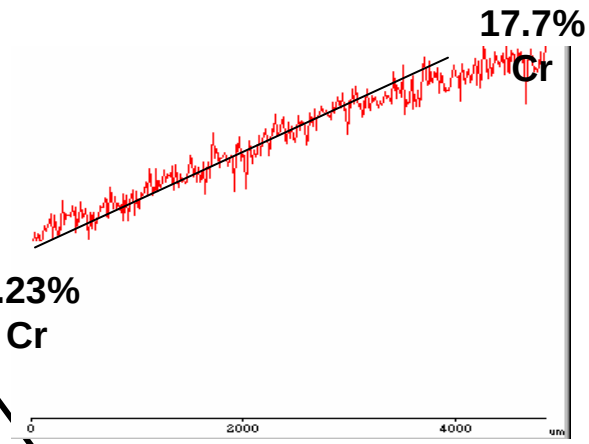
III) Results on Fe-Cr alloys

γ Loop


1600
1500
1400
1300
1200
1100
1000
900
800
700
600
T(°c)
0
0,02
0,04
0,06
0,08
0,1
0,12
0,14
0,16
0,18
0,2
w(Cr)
0.1153
0.1385
T=1392°C
T=1095°C

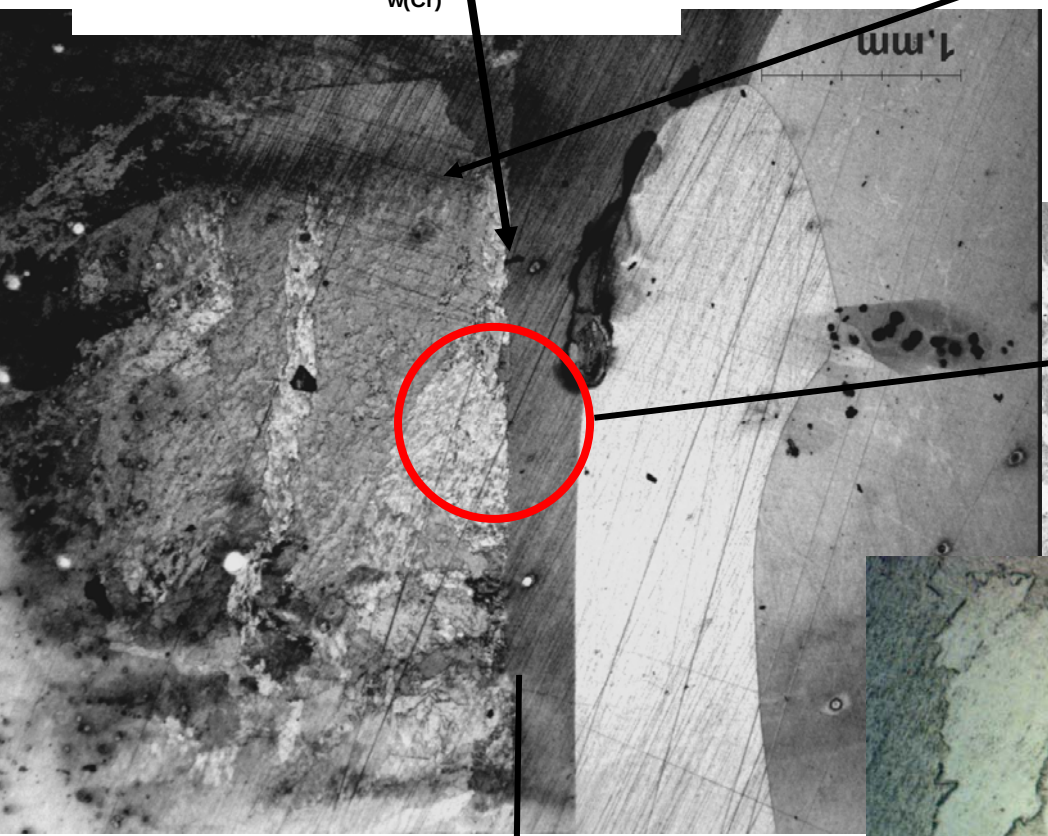
Quench after 1h@1392°C

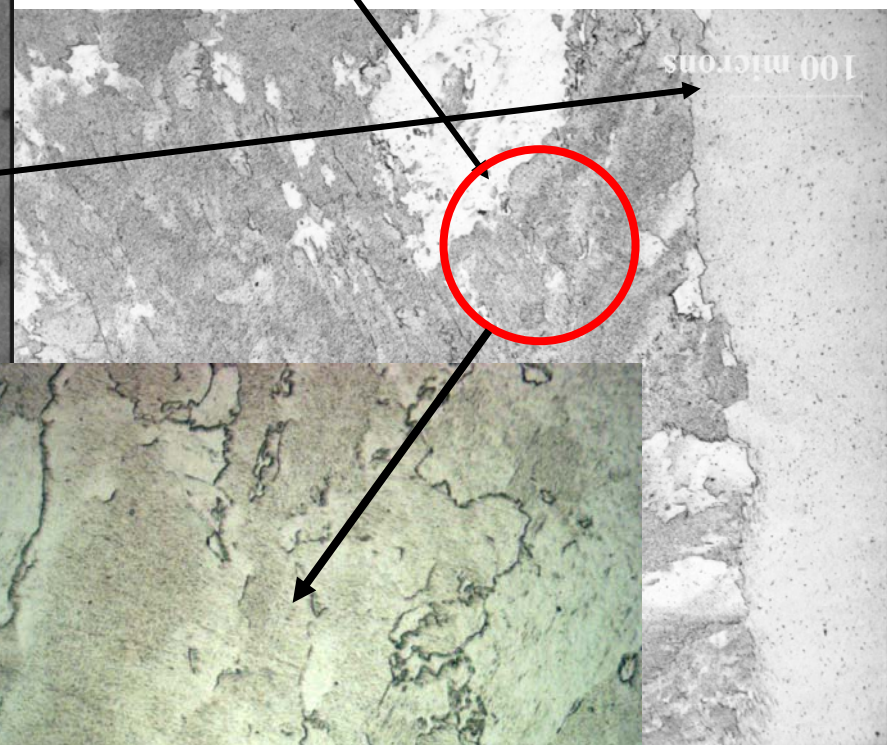


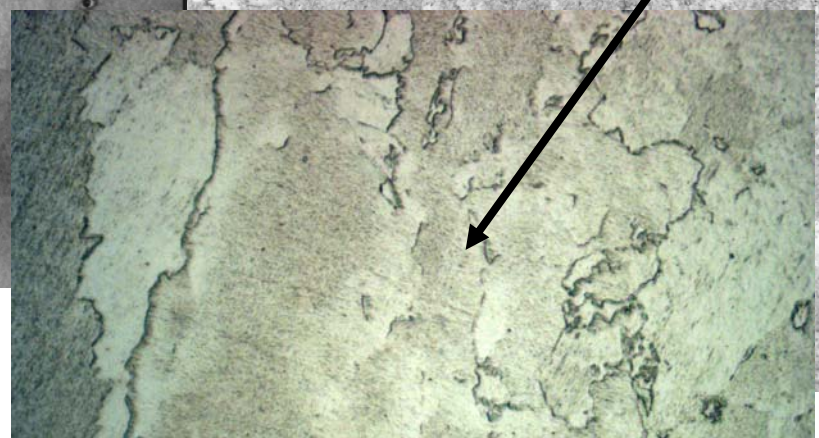


Massive ferrite

7.23%
Cr

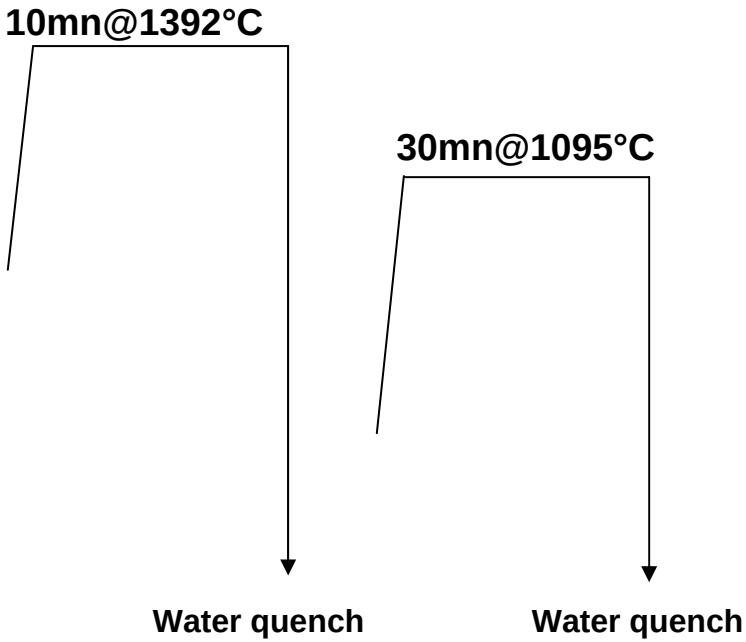


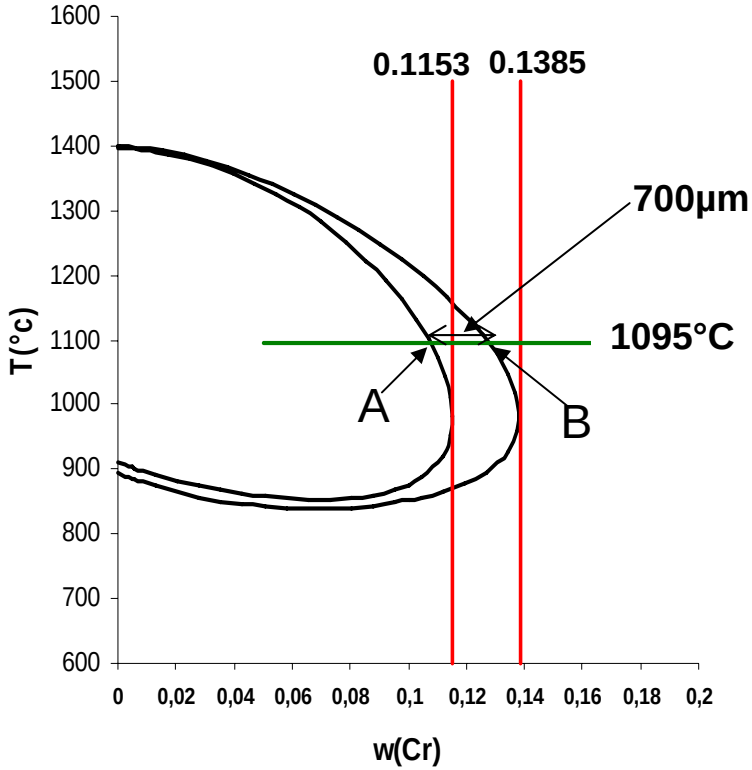


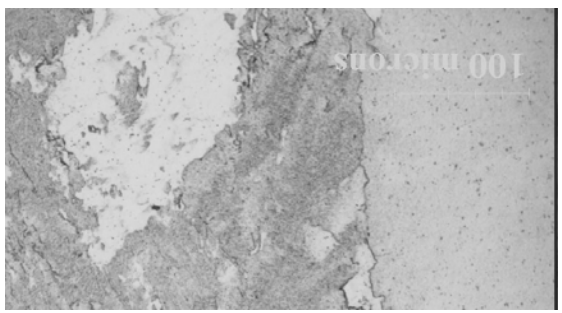


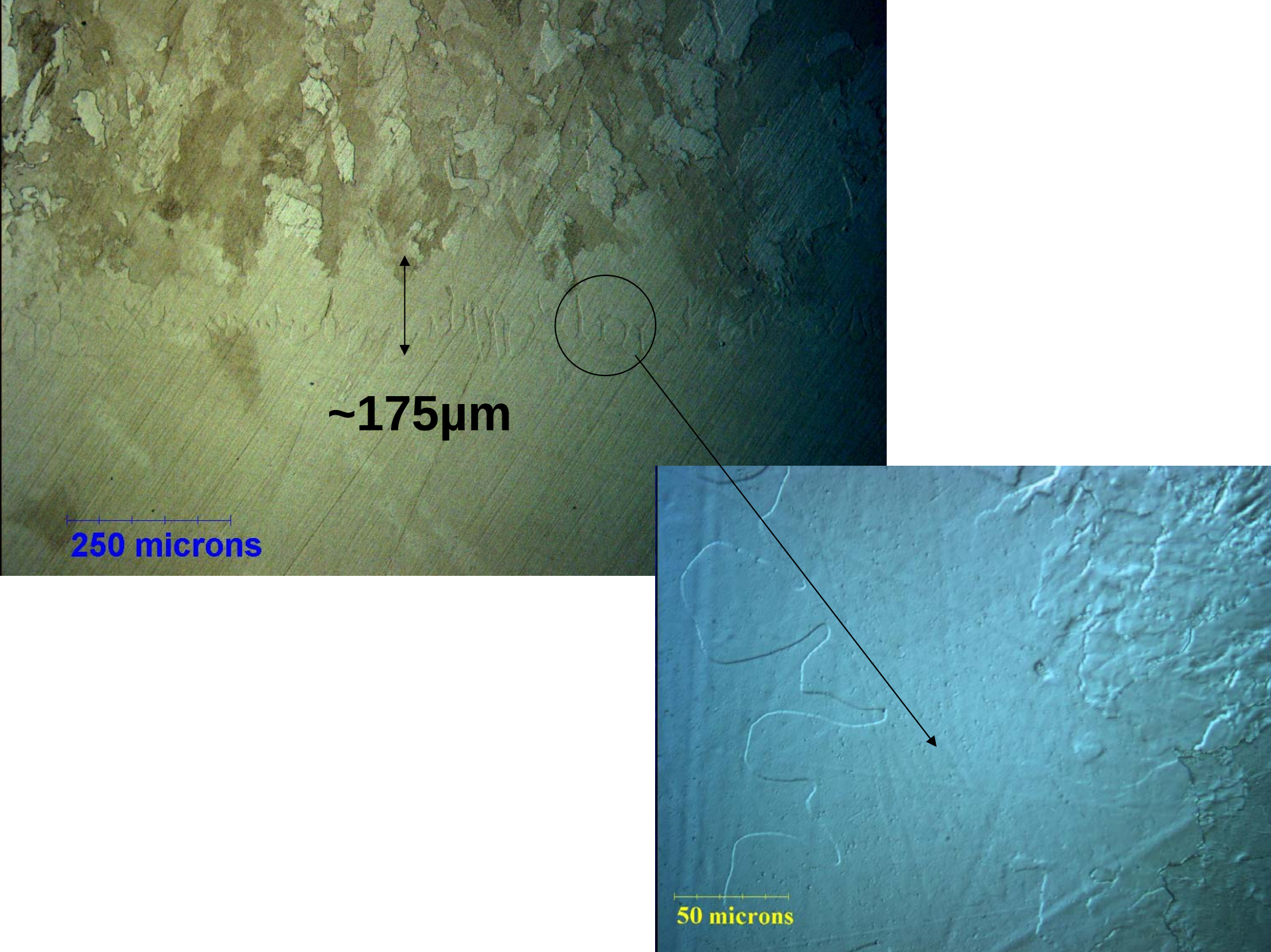
Critical limit ~11,7%Cr

Quench after 30mm@1095°C

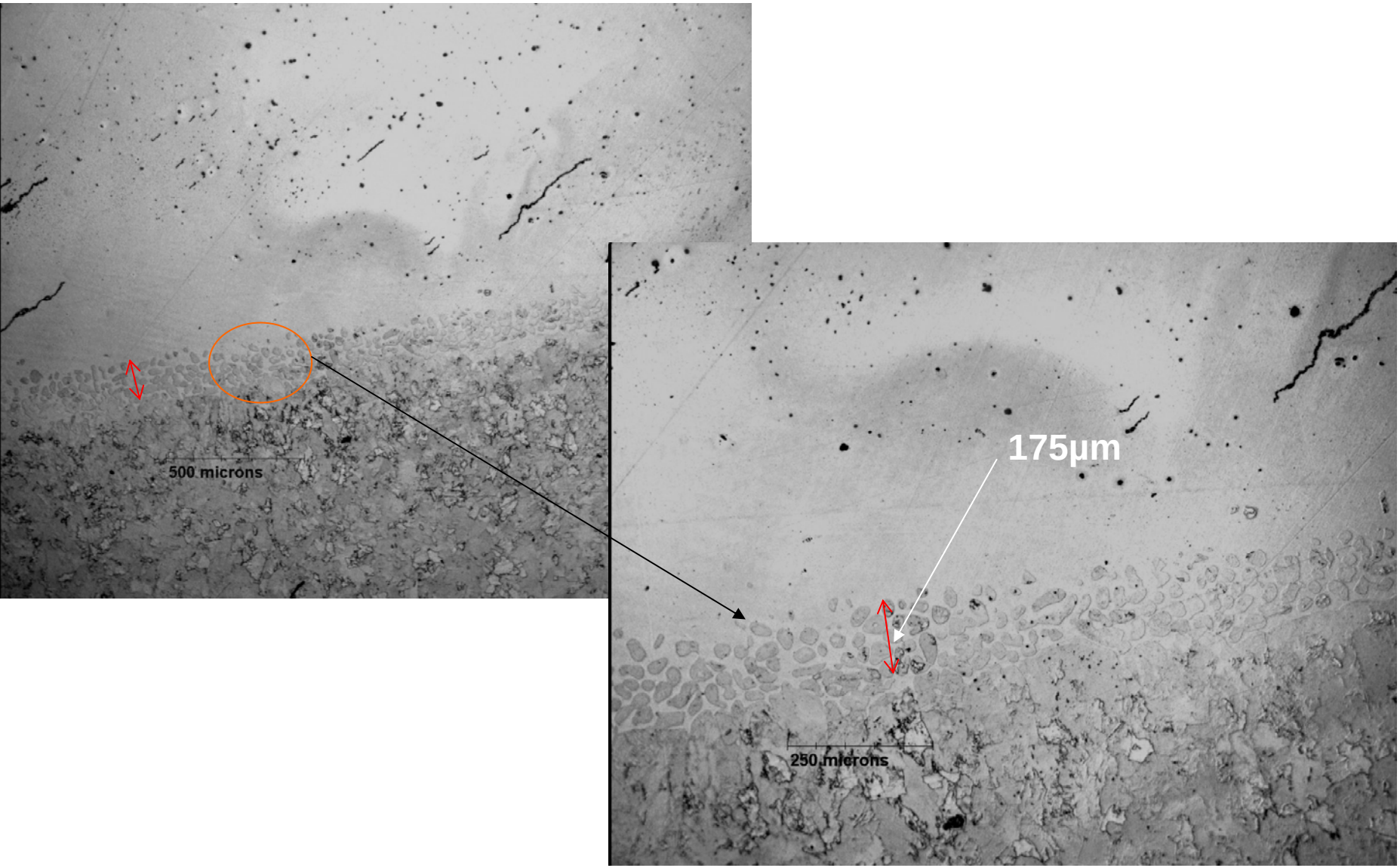







~175µm
250 microns
50 microns

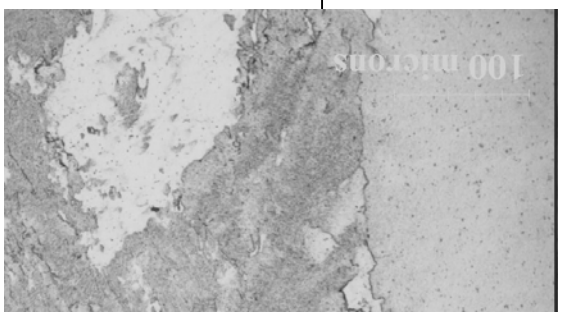
Quench after 60mm@1095°C



Effect of the ferrite morpholgie before quench

10mn@1392°C

Water quench



5mn@1392°C

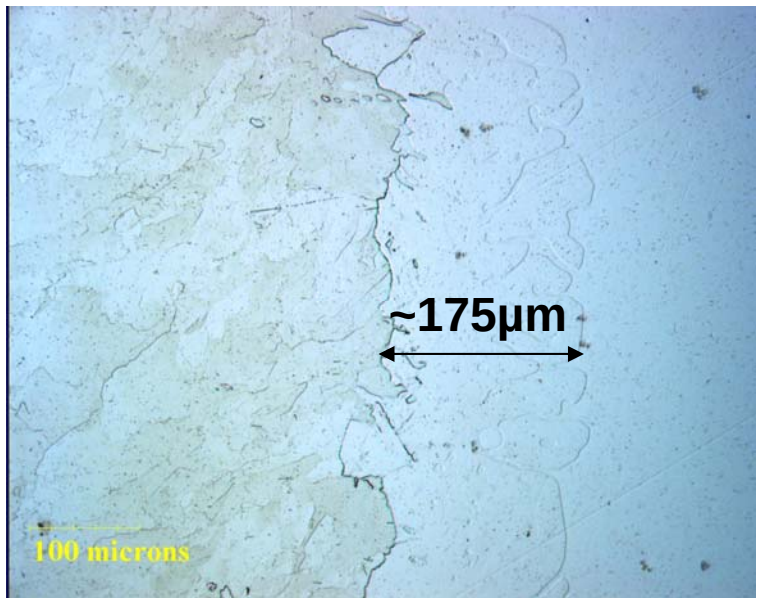
30mn

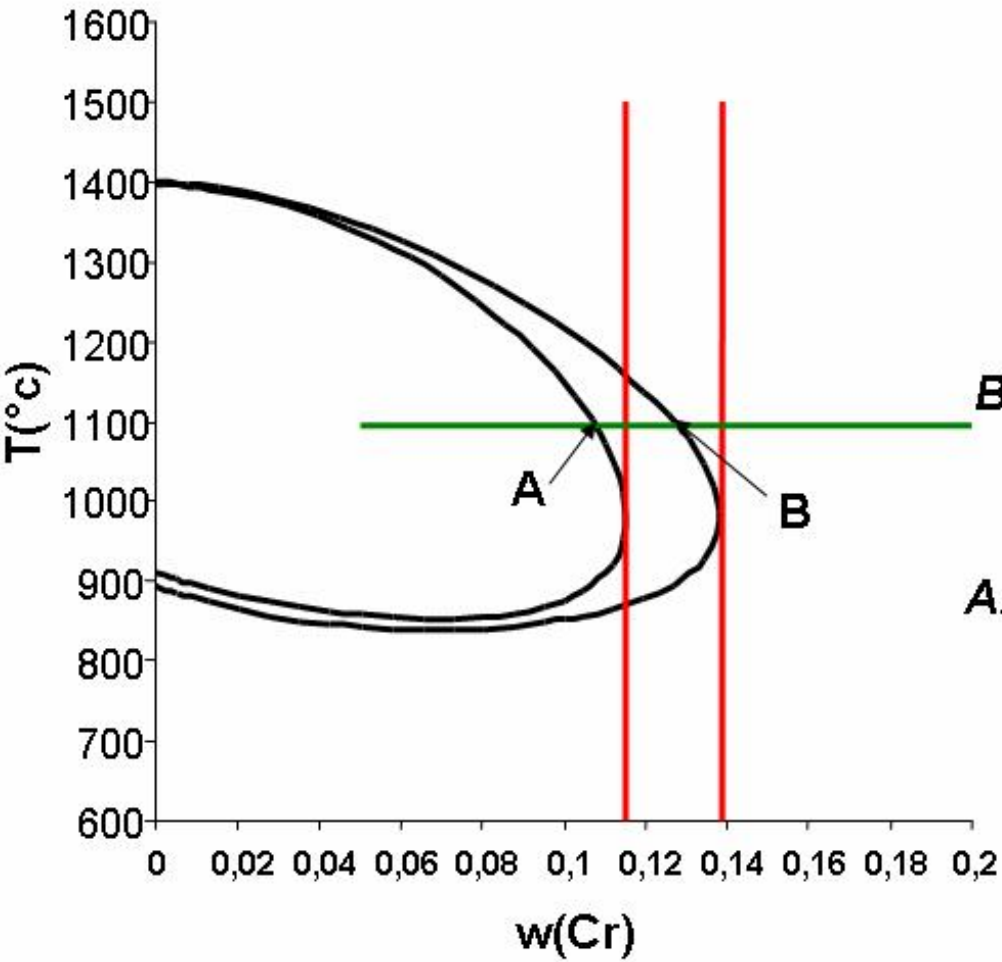
1095°C

20mn

30mn@1095°C

Water quench




1600
1500
1400
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1100
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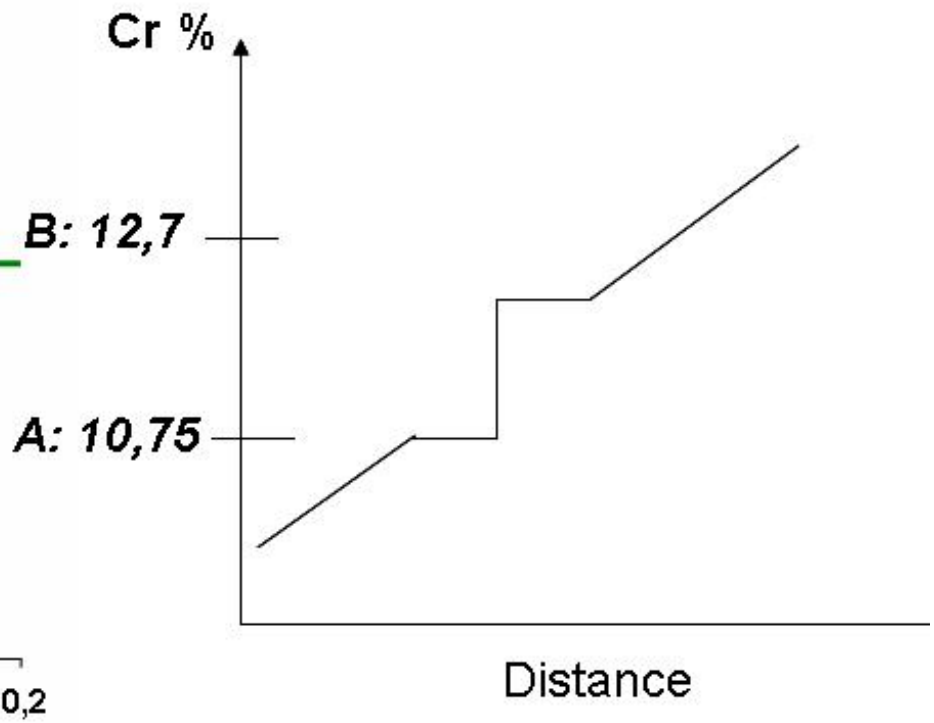
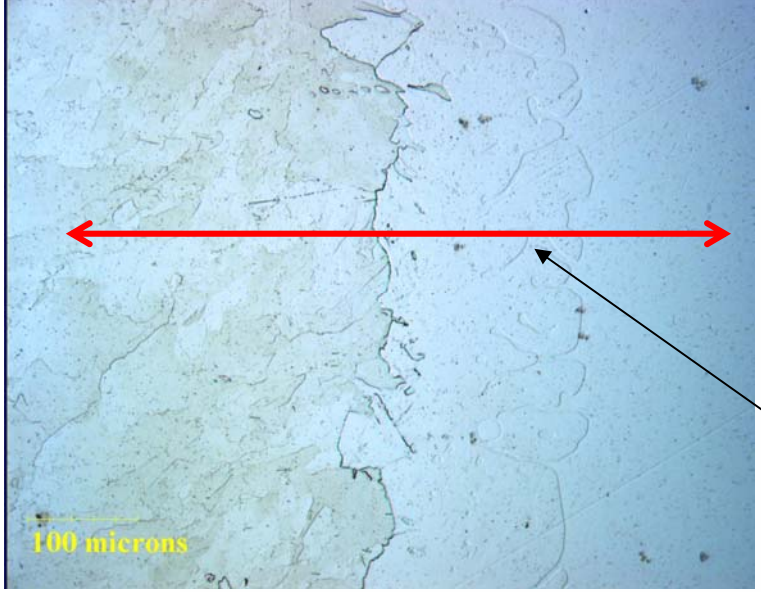
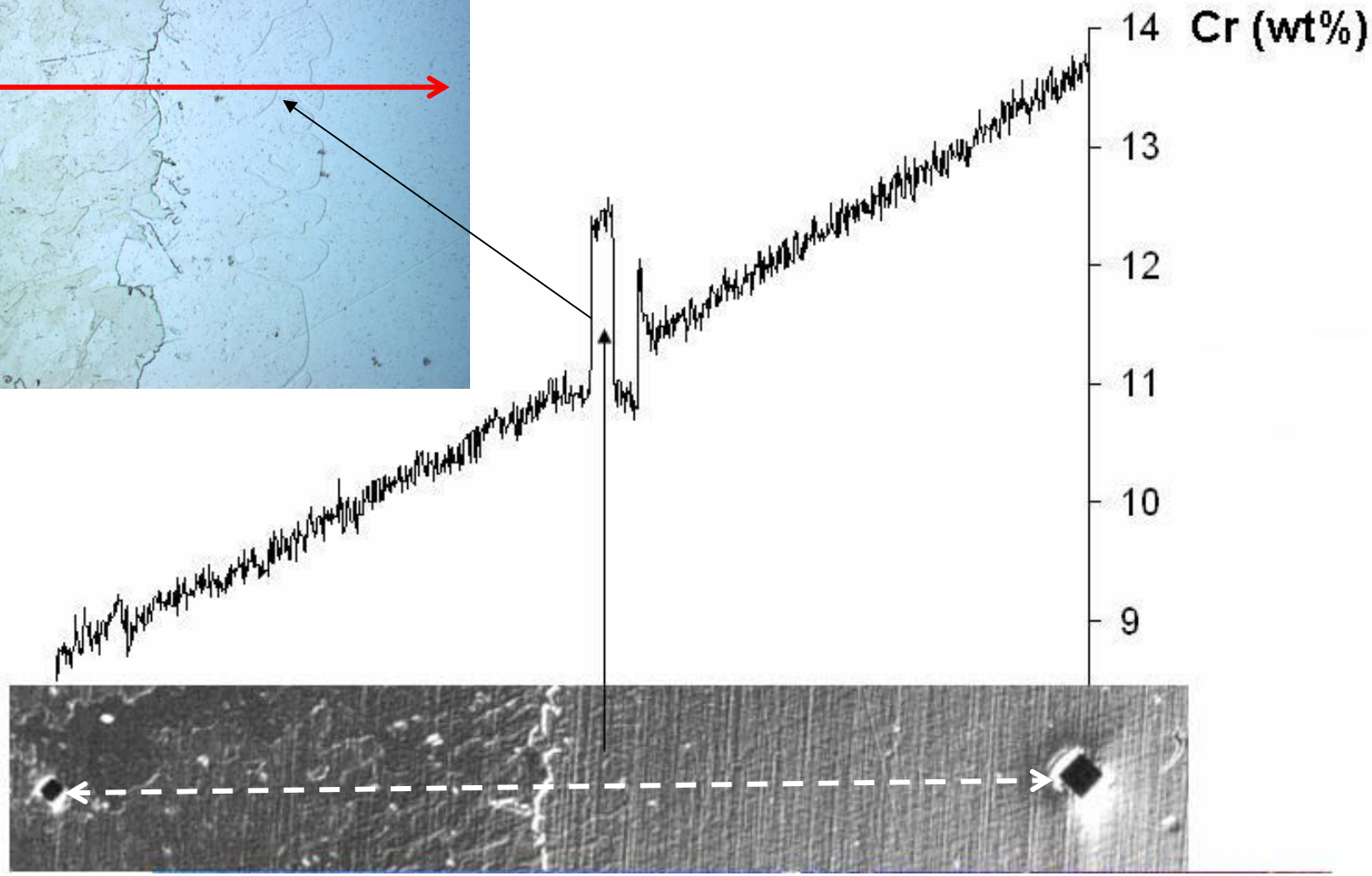
700
600
T(°c)
A
B
0
0,02
0,04
0,06
0,08
0,1
0,12
0,14
0,16
0,18
0,2
w(Cr)

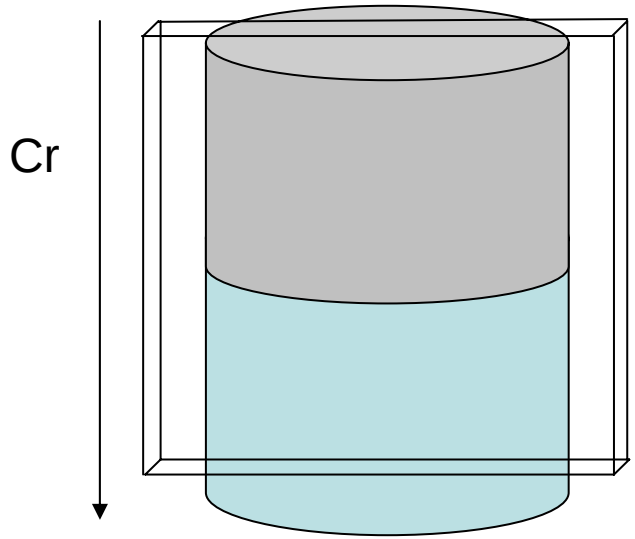

Cr %
B: 12,7
A: 10,75
Distance


100 microns


14
13
12
11
10
9
Cr (wt%)

III) Results on Fe–Cr–C alloys

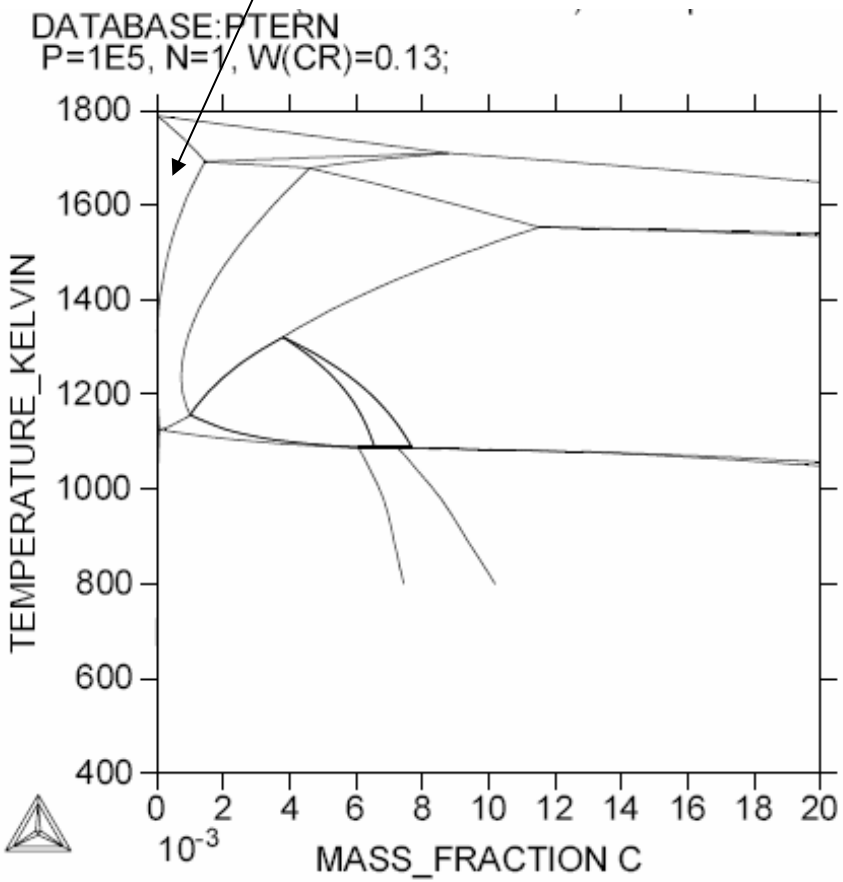
Carburization



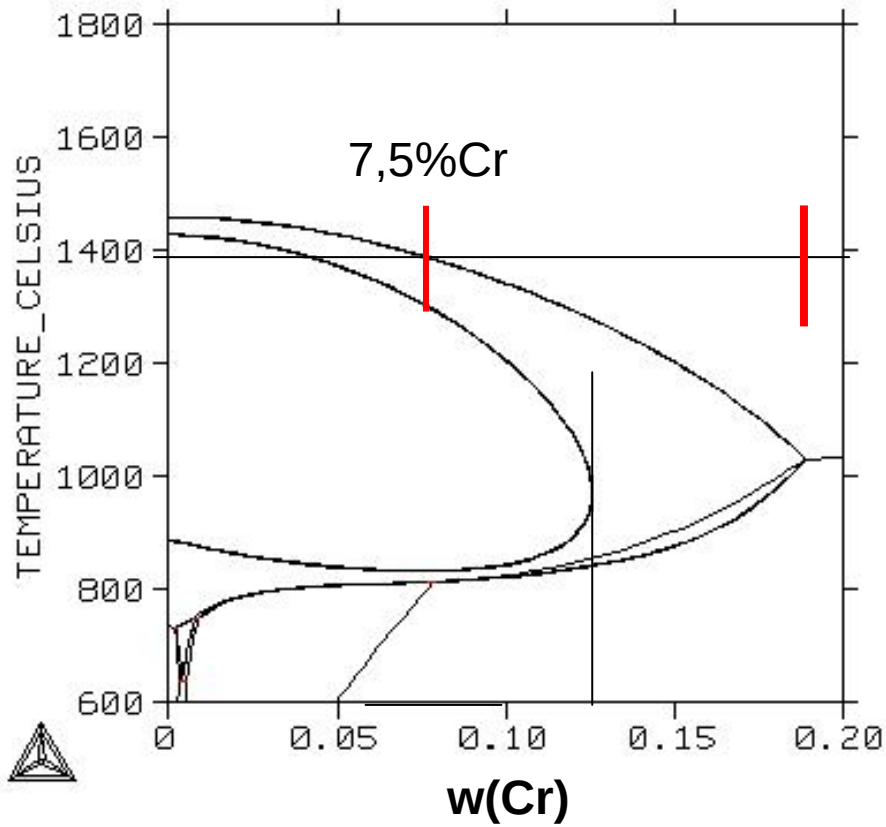
Homogenous carburization (0.05% C)

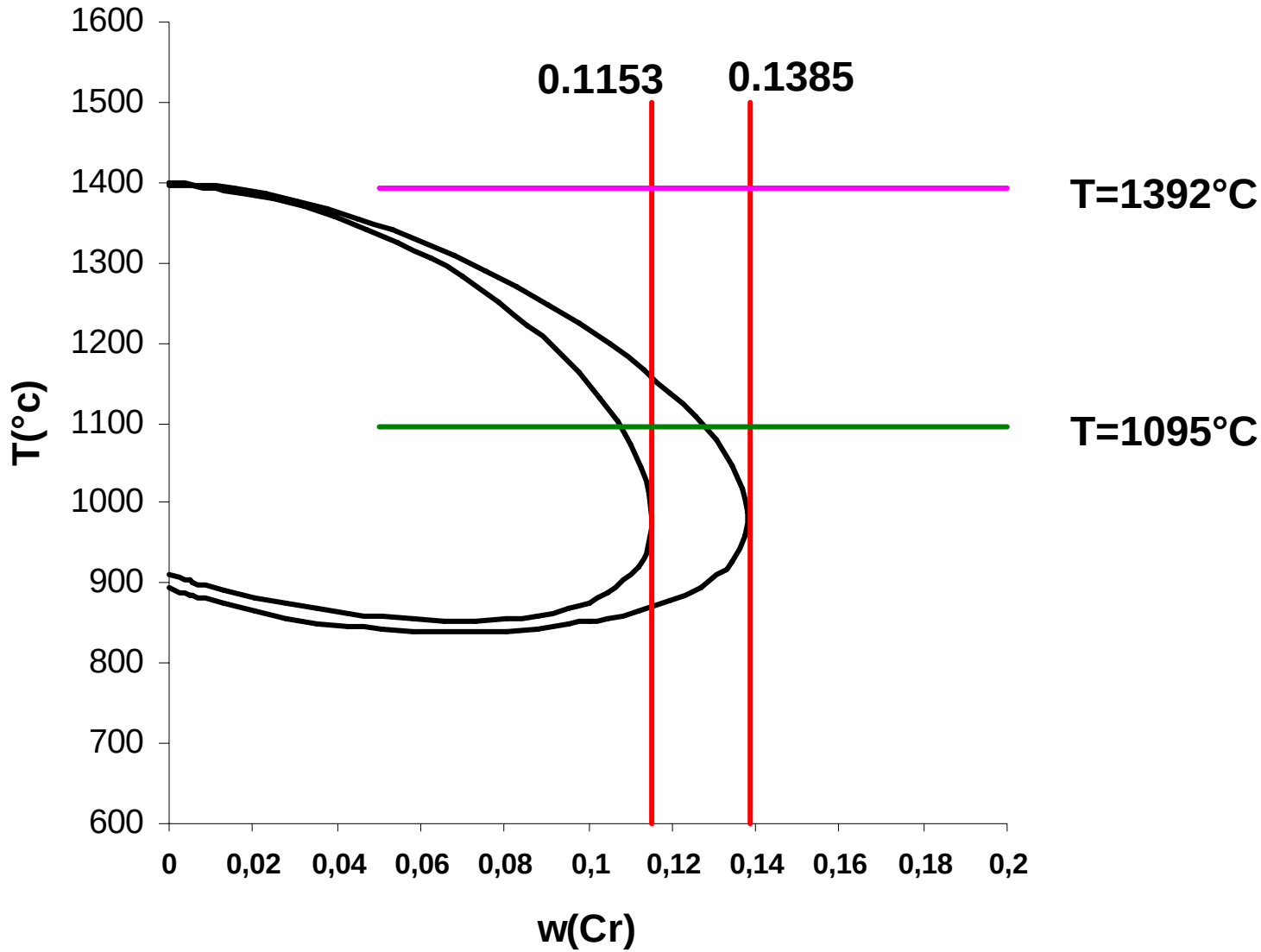
δ ferrite

T = 1665k , C_{max} = 0.1%



Fe-0.05%C-Cr




1600
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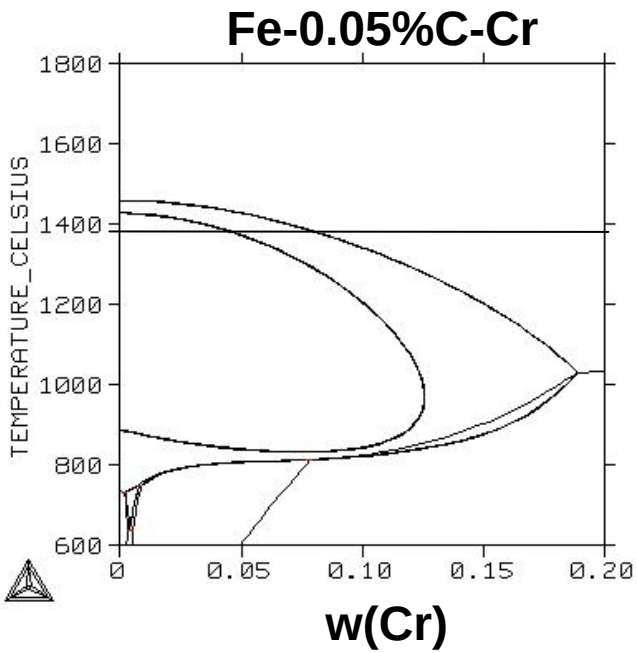
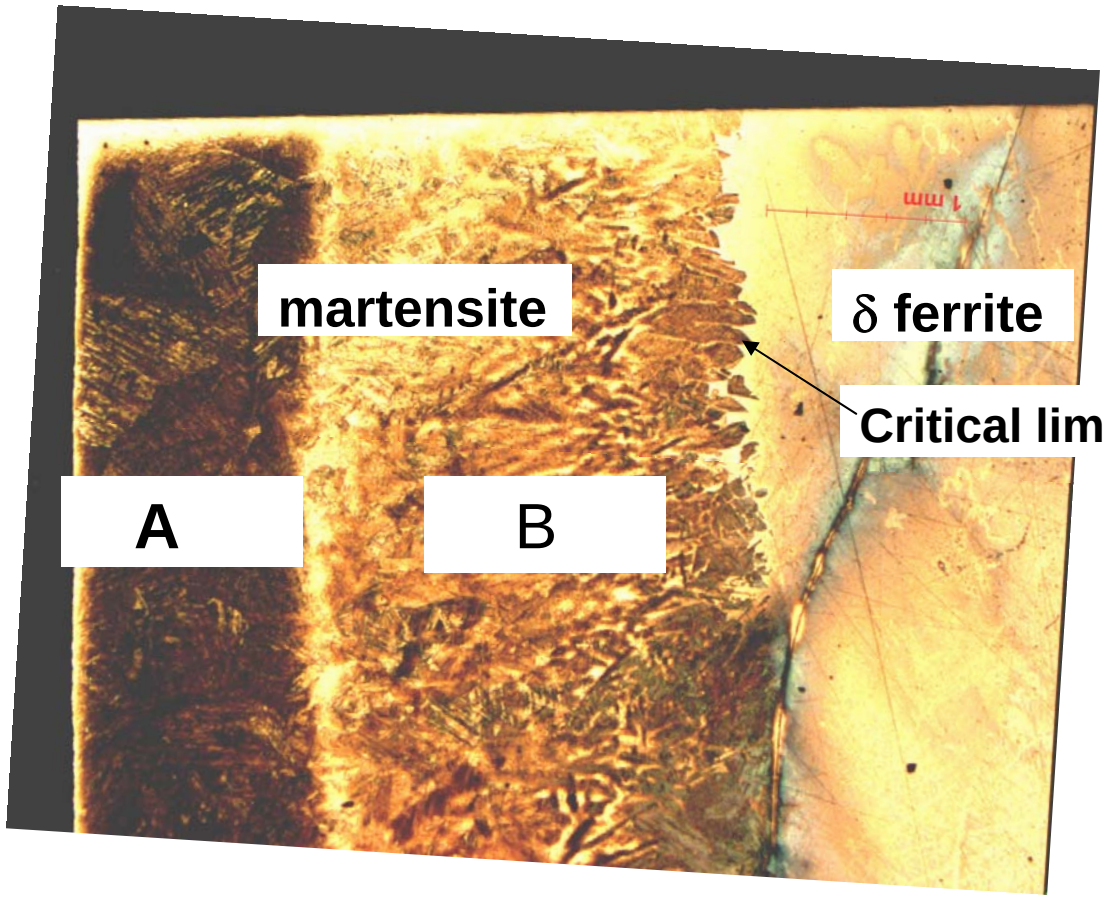
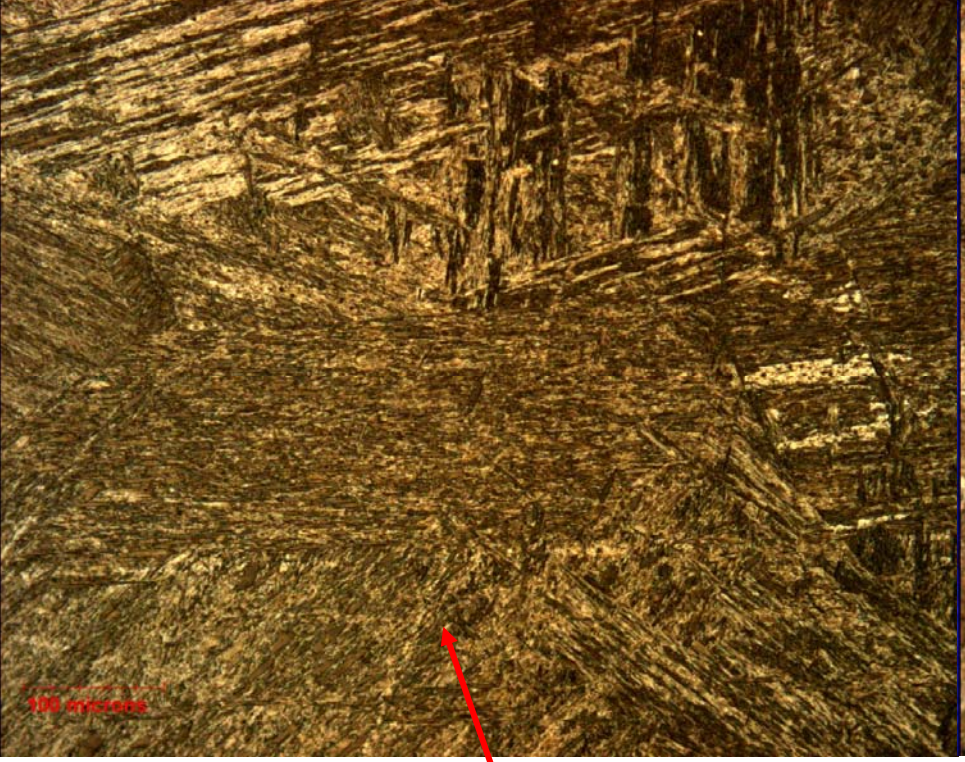
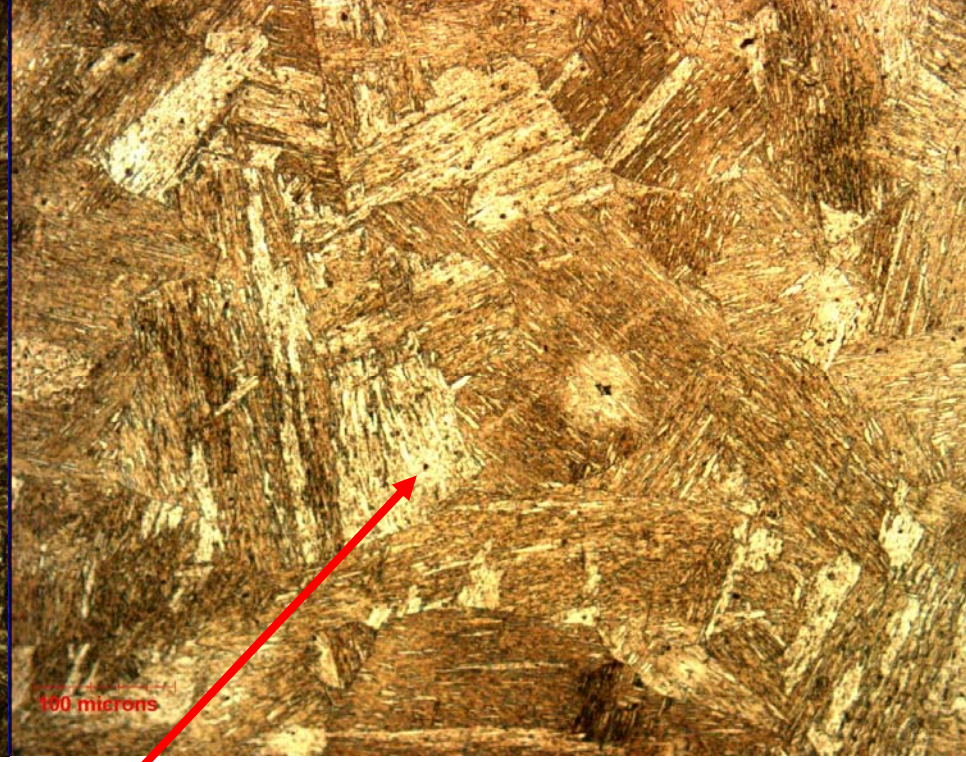
T(°c)
0
0,02
0,04
0,06
0,08
0,1
0,12
0,14
0,16
0,18
0,2
w(Cr)
0.1153
0.1385
T=1392°C
T=1095°C

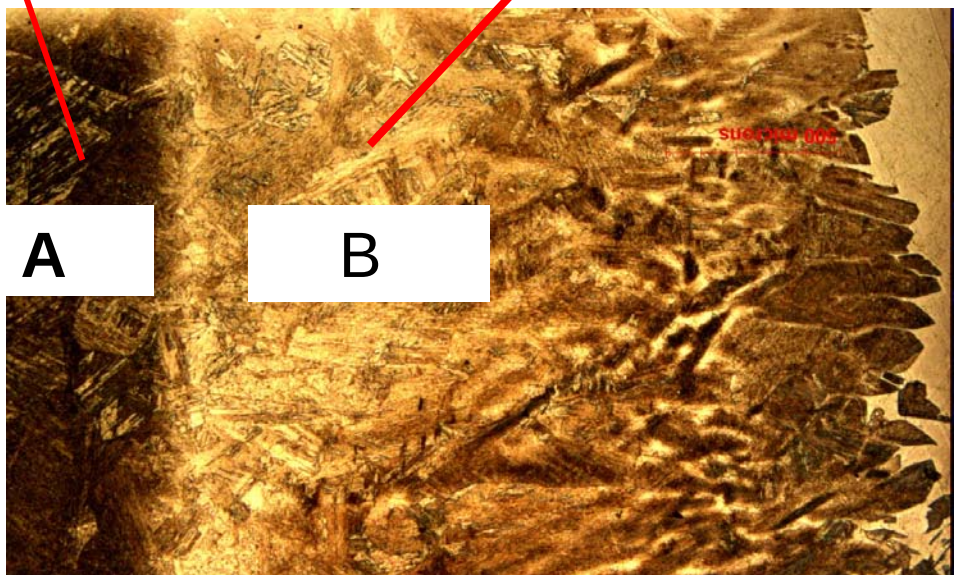
Cr diffusion couple carburized homogenously 30 mn à 1392°C + Oil quench



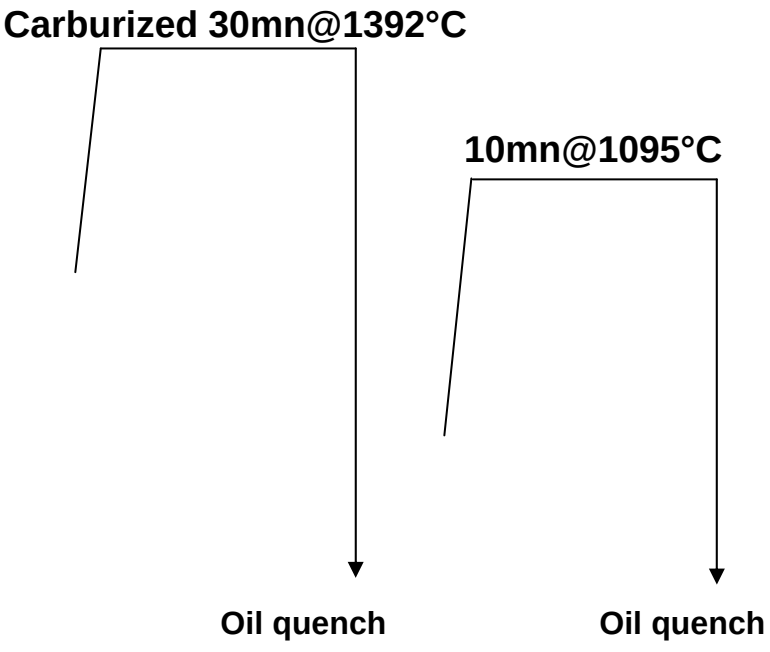


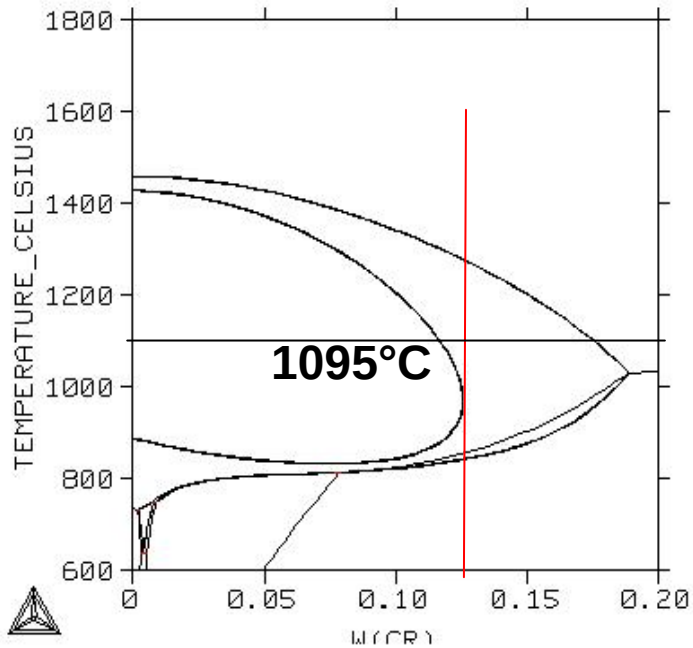

100 microns

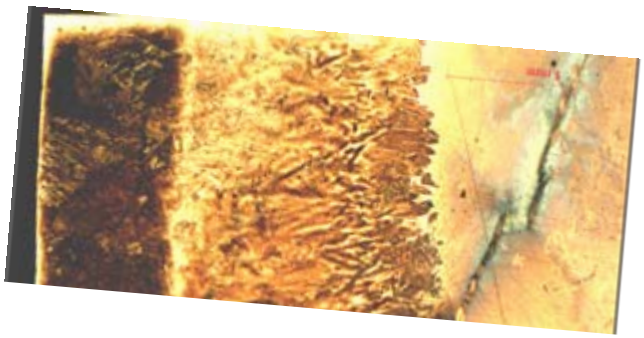

100 microns

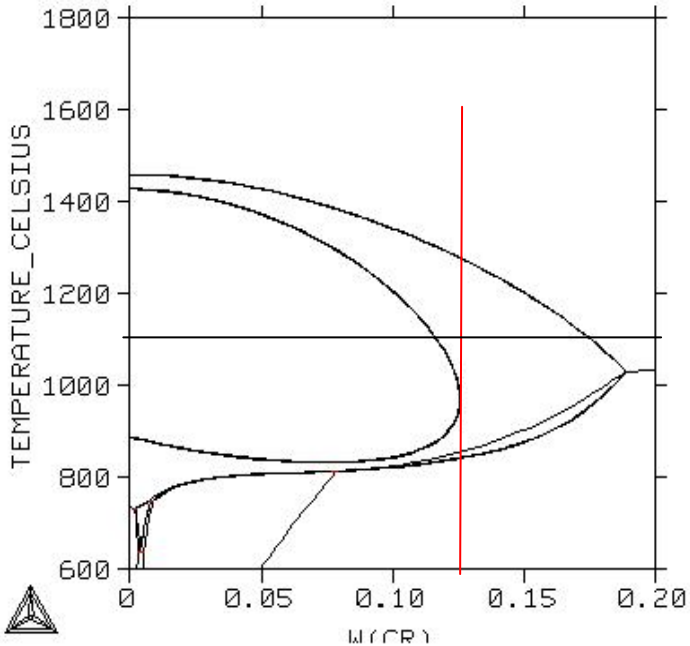

A
B

Quench after 10mm@1095°C





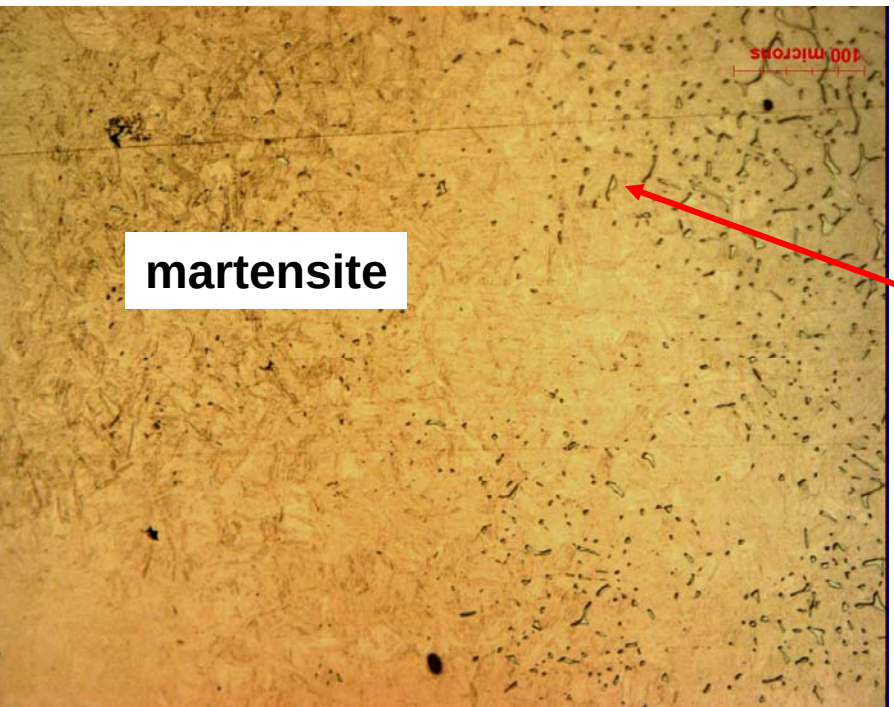




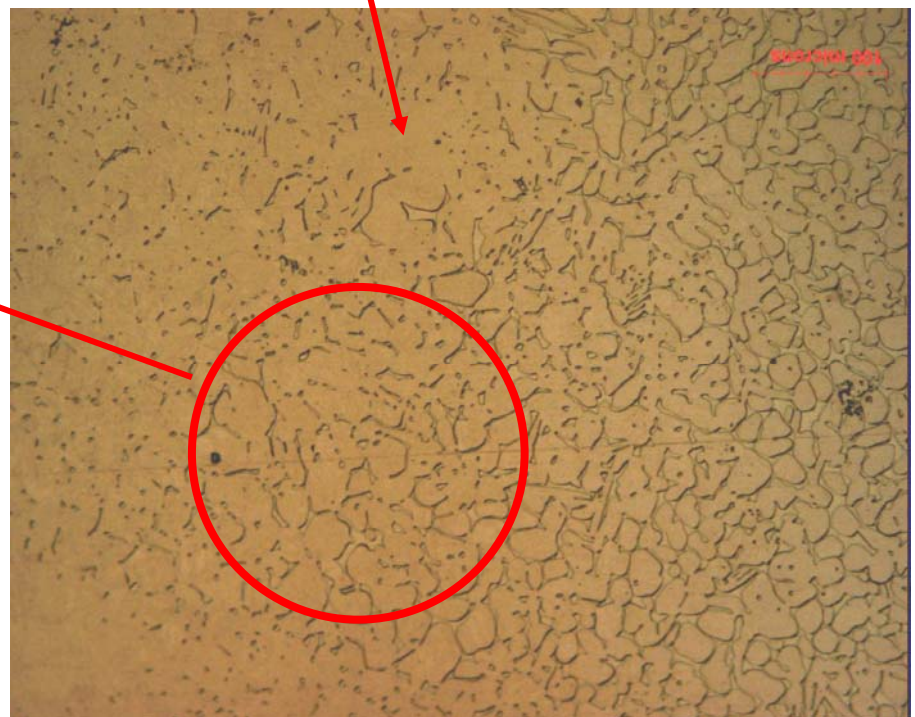
martensite

Dual phase zone
Ferrite + martensite

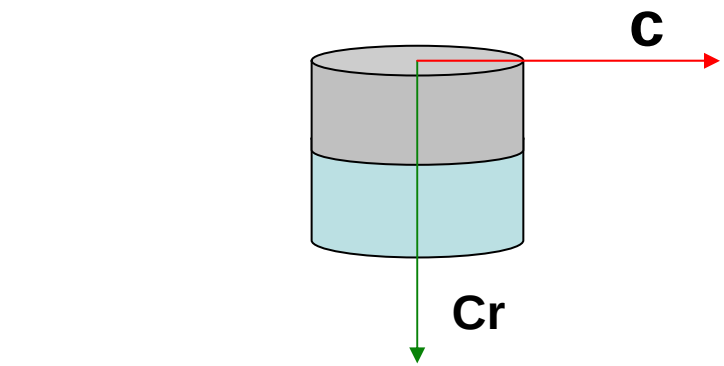
Ferrite

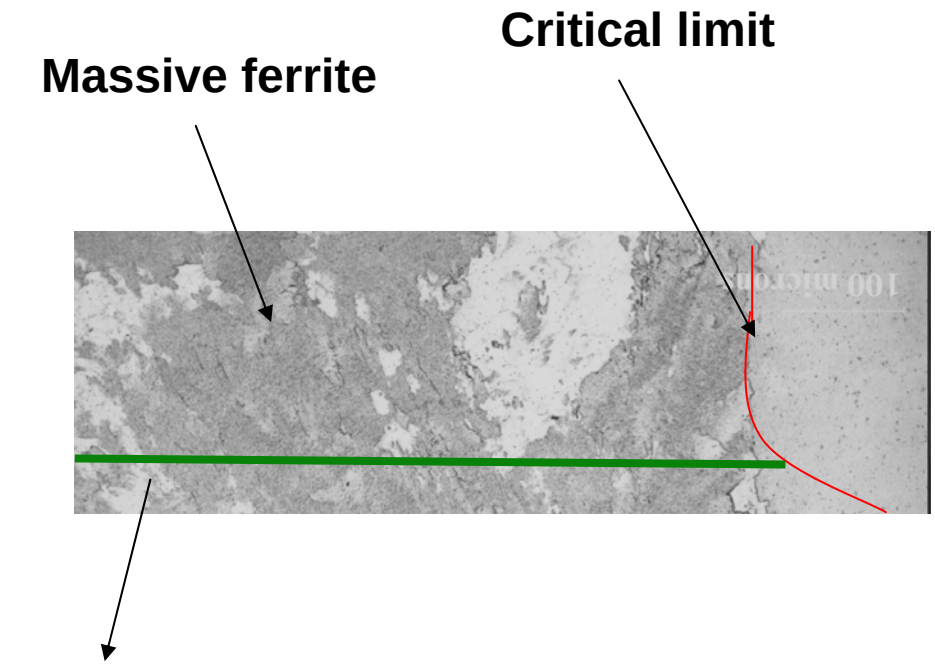


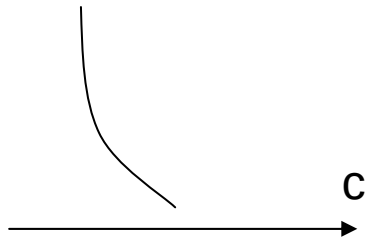
martensite



The idea of a carbon profile (if it works…)

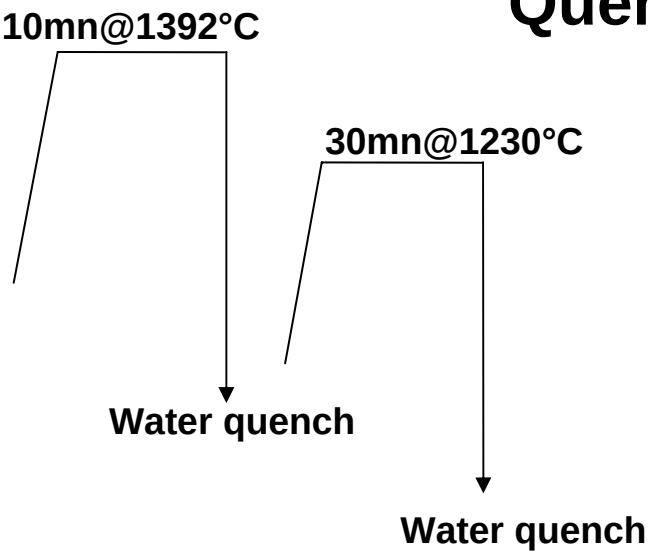


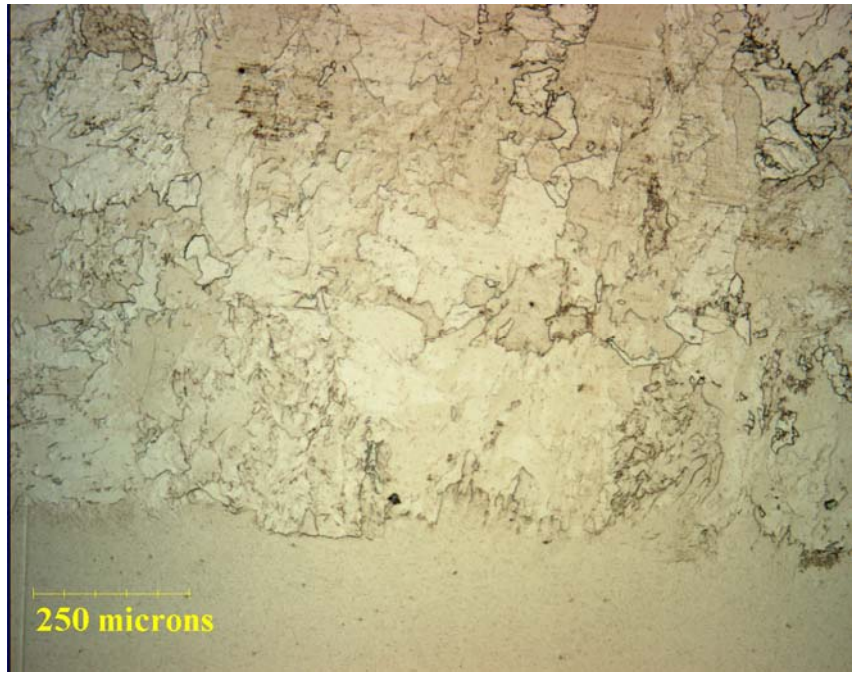


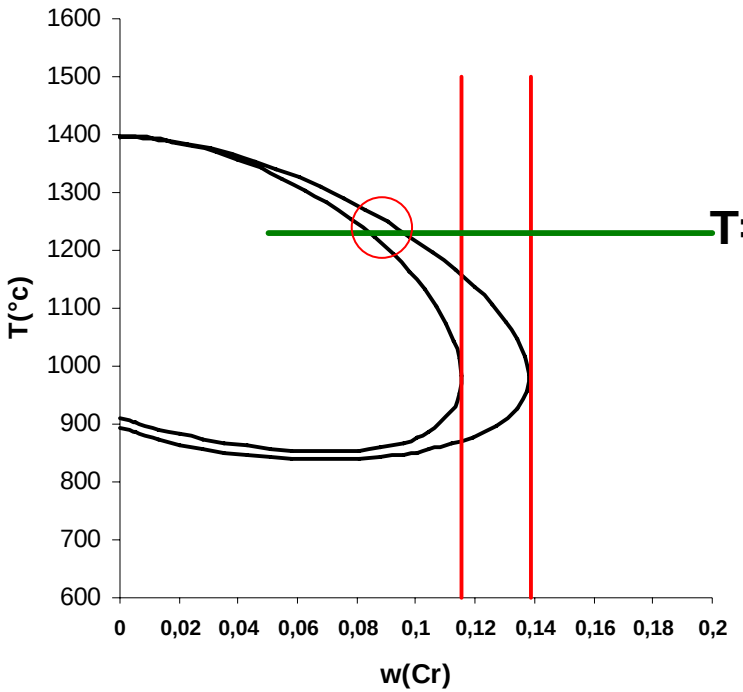


Carbon profile

Quench after 30mm@1230°C







T=1230°C

Shifting of the critical limit by Cr evaporation in the surface