

Characterization of Fe-Mn-Al-C alloys

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- Introduction

Fe-Mn-Al-C → C content 0.2 – 0.4 wt%
Al content up to 15 wt%
Mn content varying from 0% up to 10 wt%

Aim → Improve the phase diagram
Understand phase transformations

Experimental work → Differential thermal analysis
Light Optical Microscopy

- Material

Fe-Al-Mn-C

Alloy	wt% (Fe balanced)		
	C	Al	Mn
B – Low Mn	0.2	9.8	1.7
C – High Mn	0.2	11.0	10.0
D – High Al	0.2	17.6	10.0
E – High C	0.4	17.8	10.0

- Phase diagrams

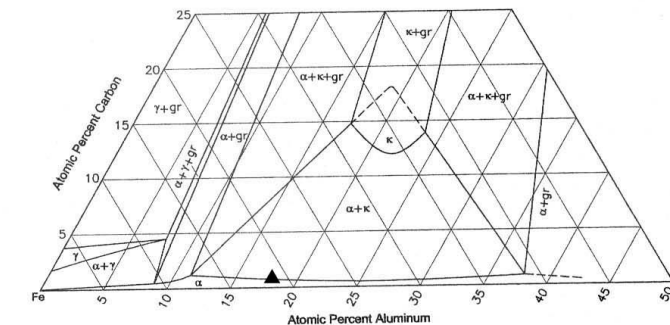
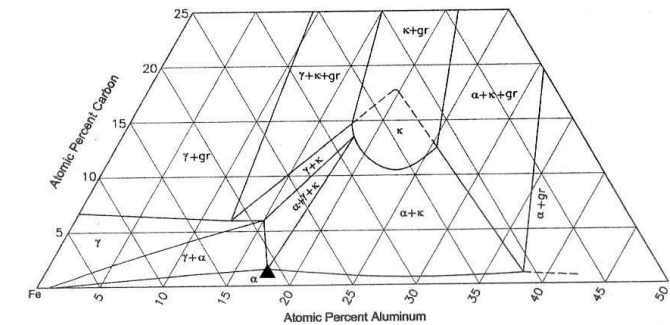
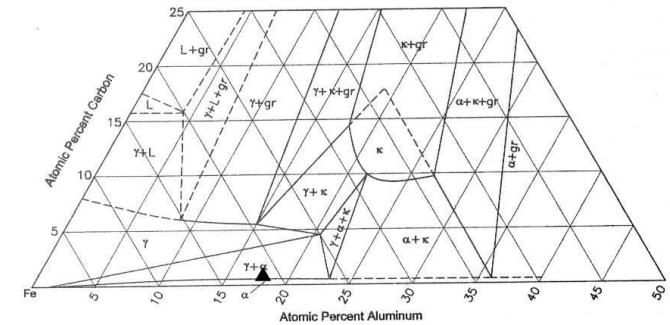
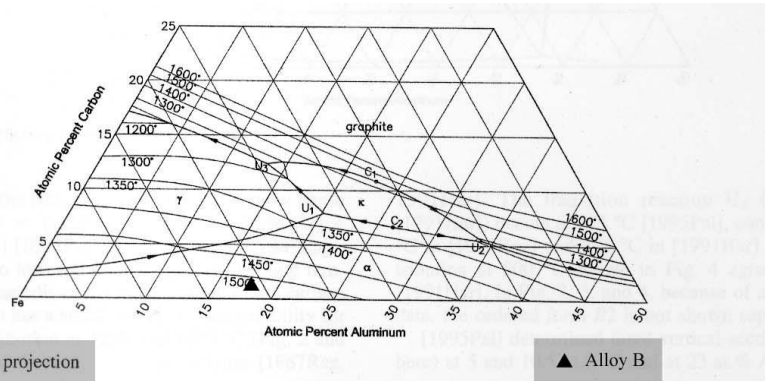


Fig. 5 Al-C-Fe Isothermal sections

▲ Alloy B

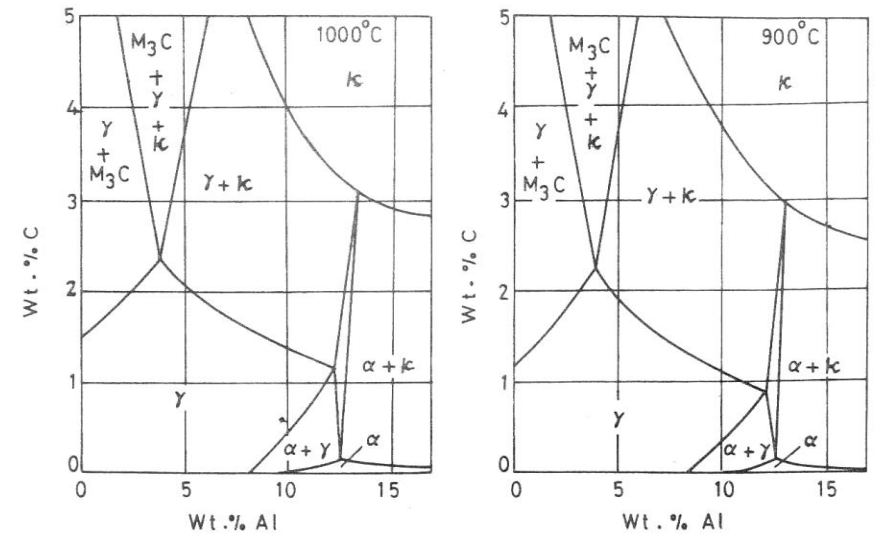
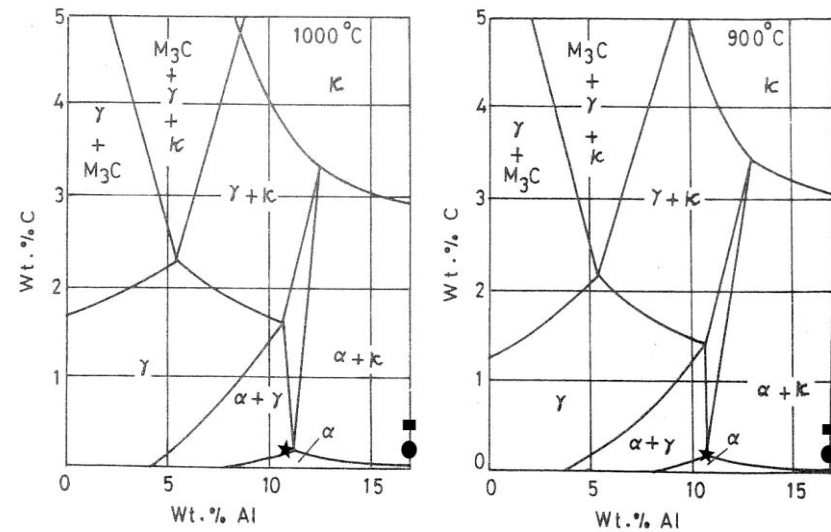
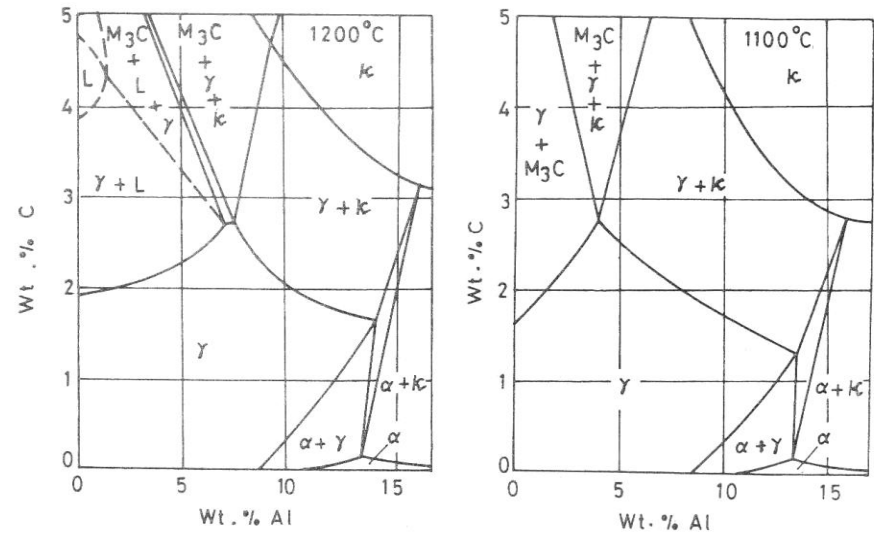
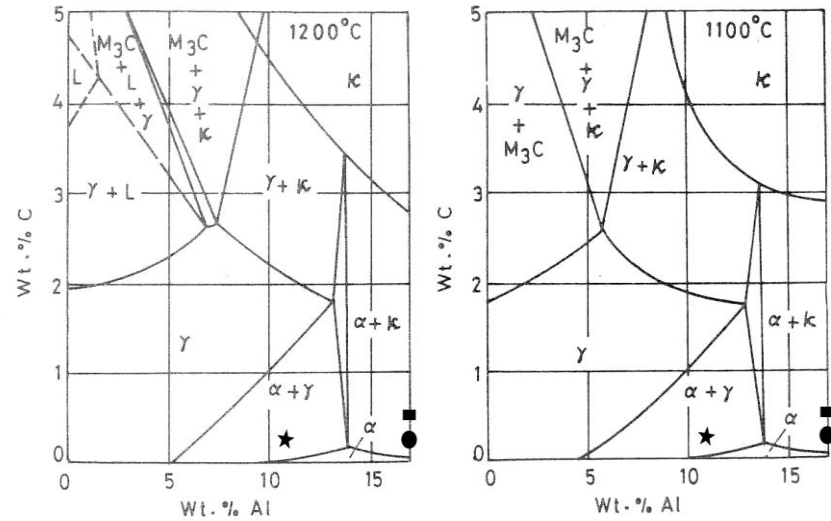
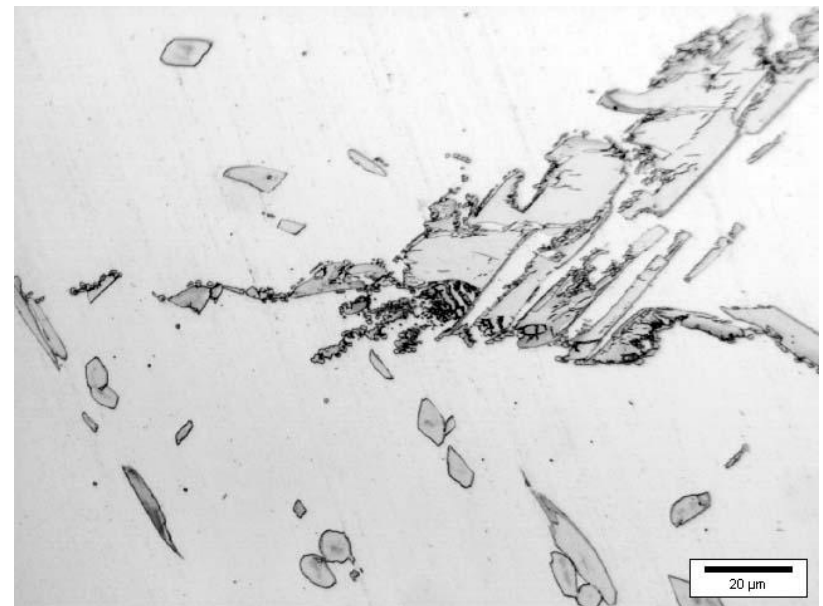
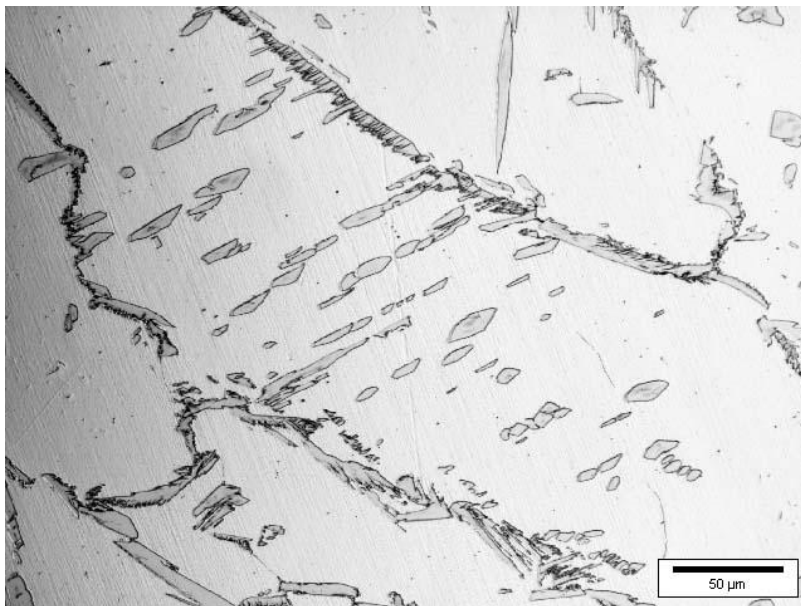
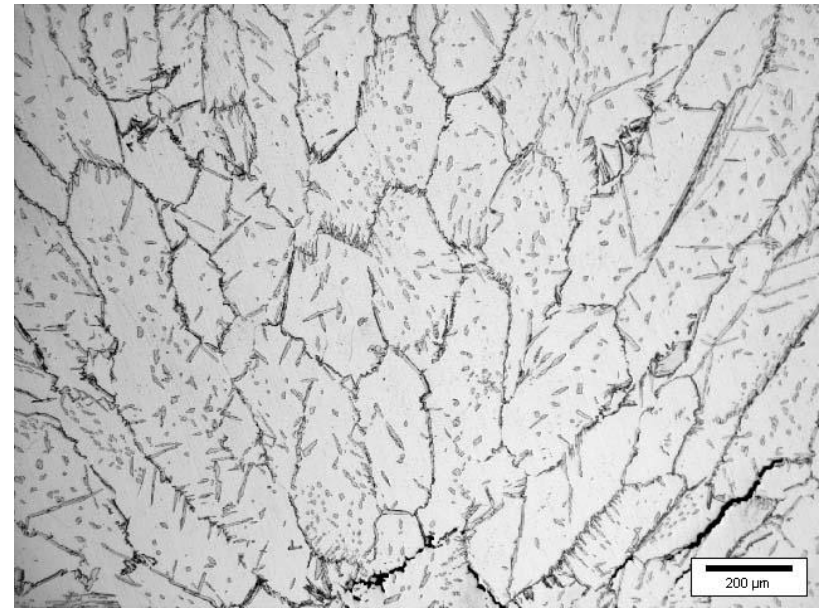
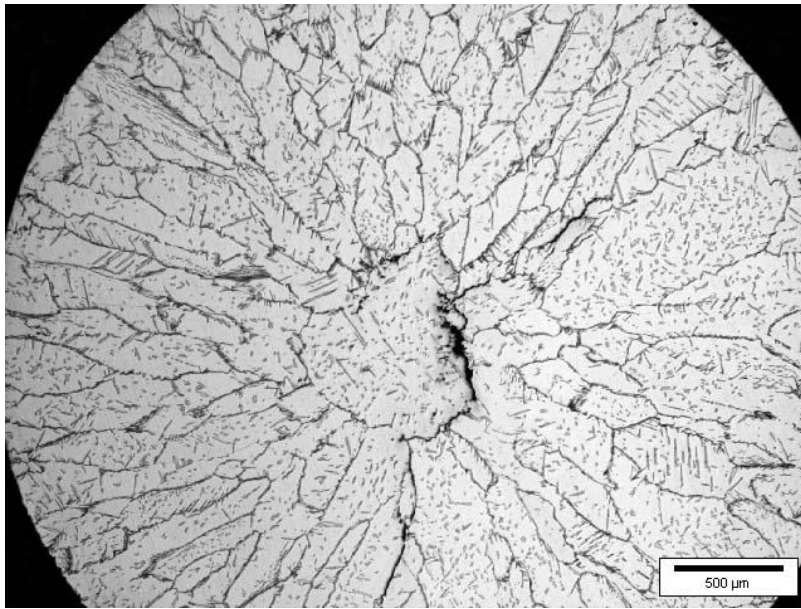


Figure 6 Al-C-Fe-Mn Isothermal Sections at 20 Wt.% Mn

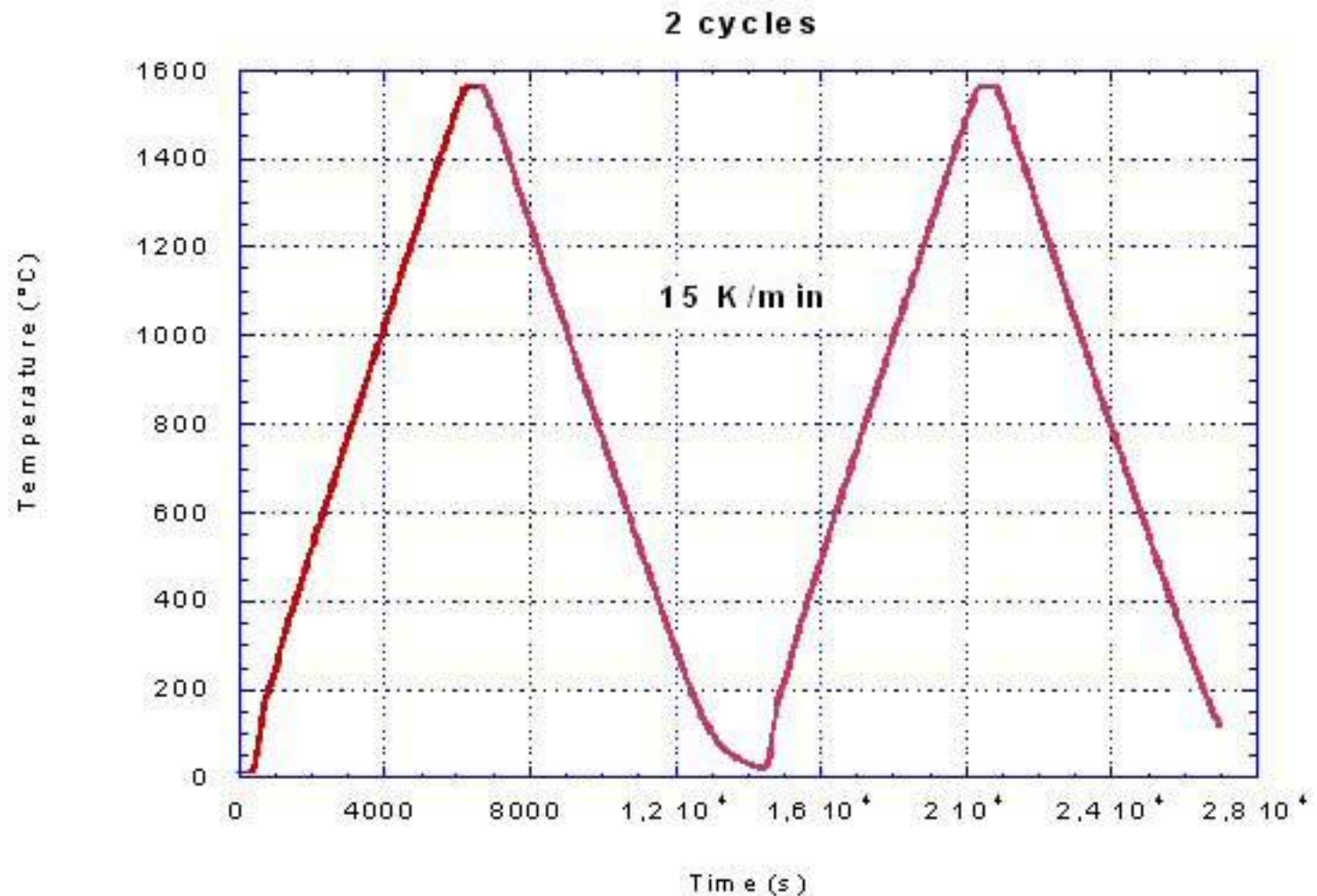
Figure 7 Al-C-Fe-Mn Isothermal Sections at 30 Wt.% Mn

■ Alloy E
● Alloy D
★ Alloy C

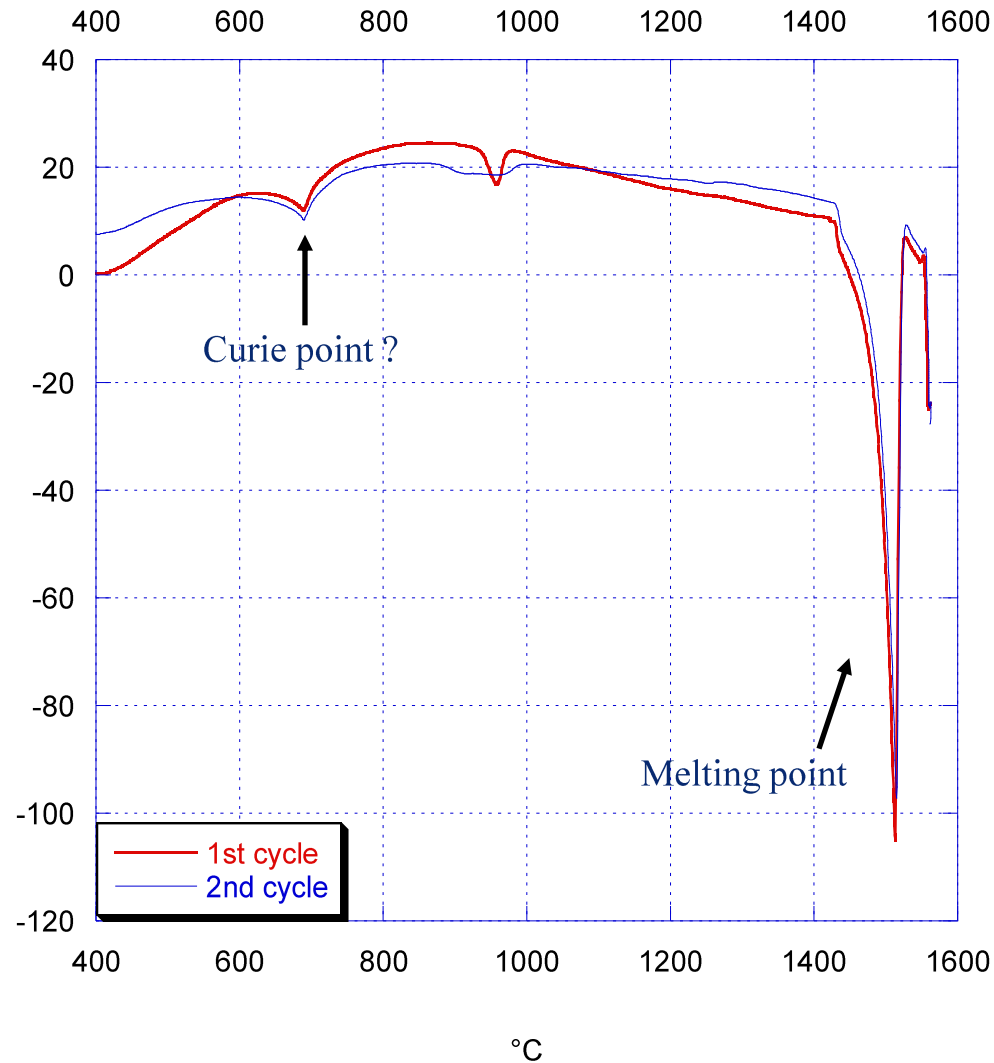
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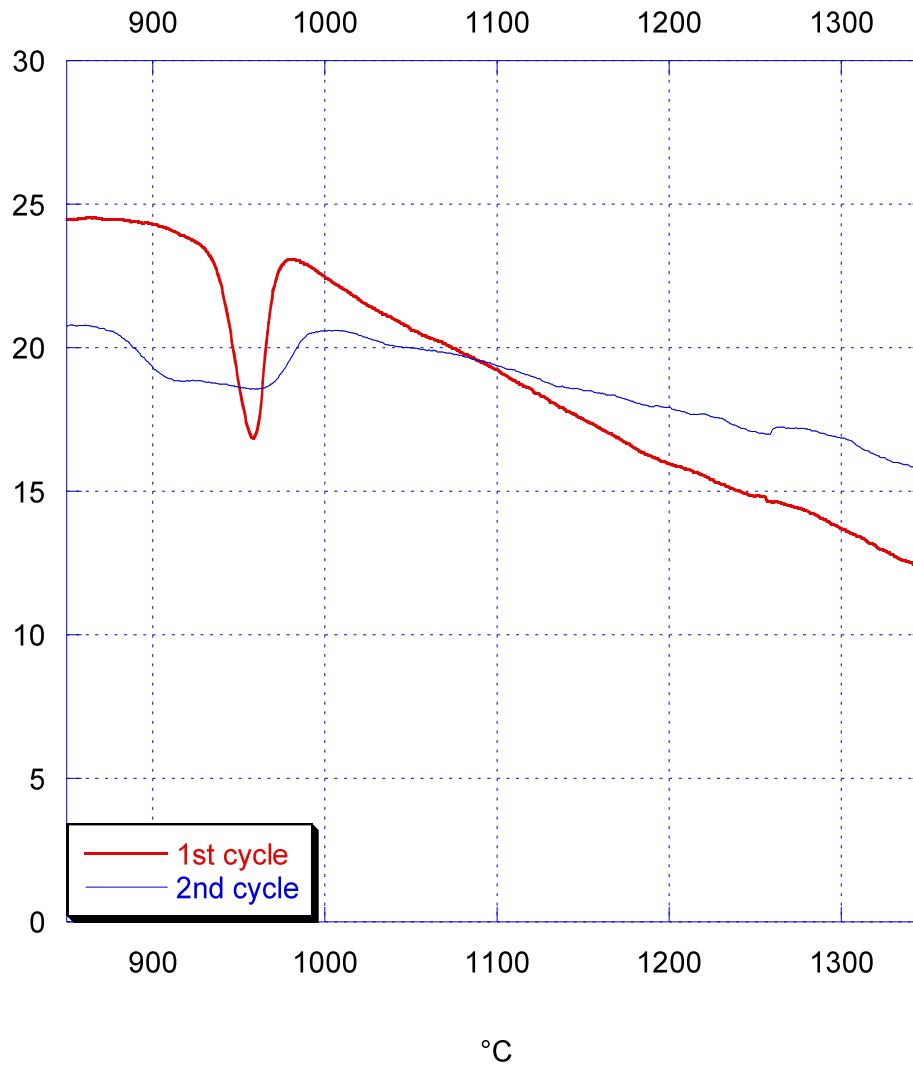
- DTA cycles heating up to 1575 °C



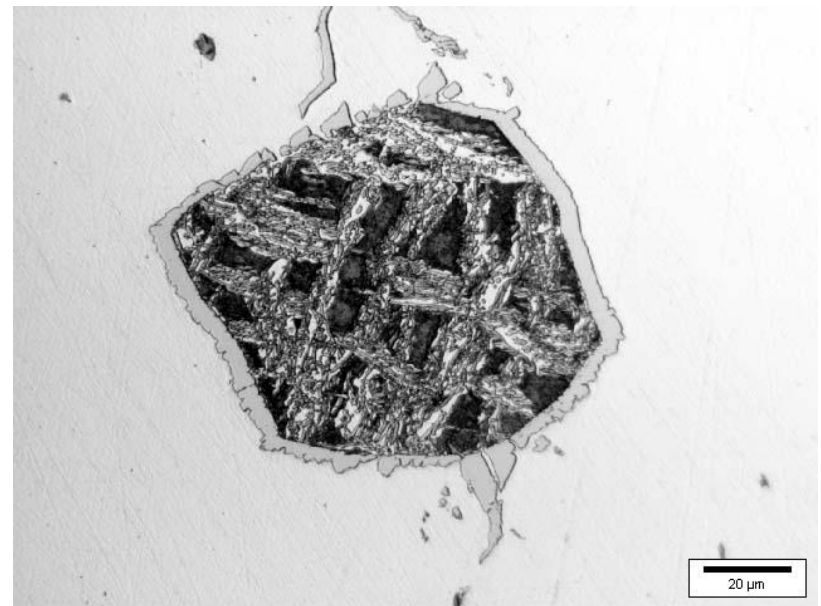
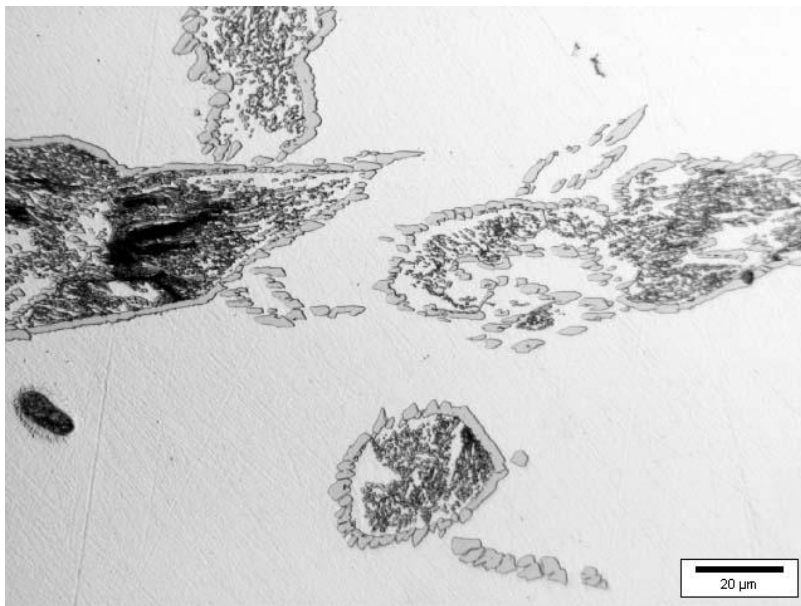
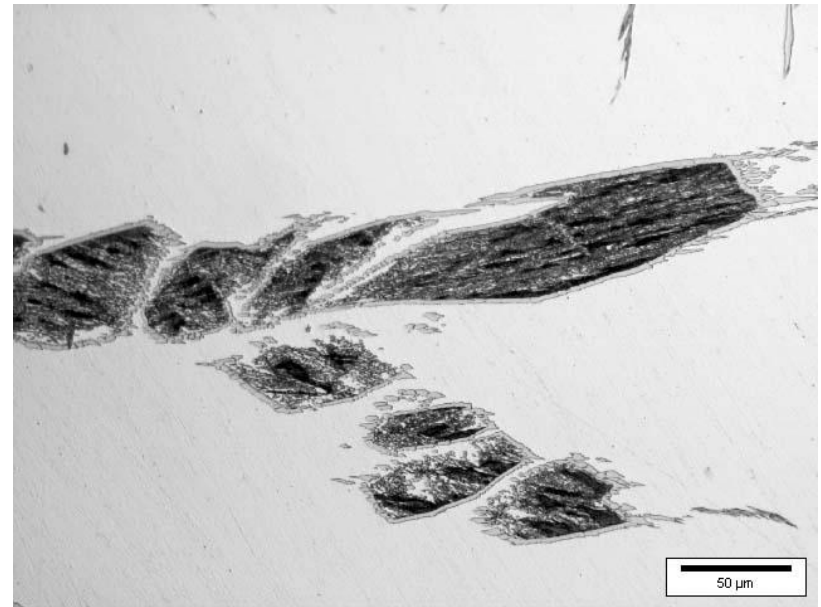
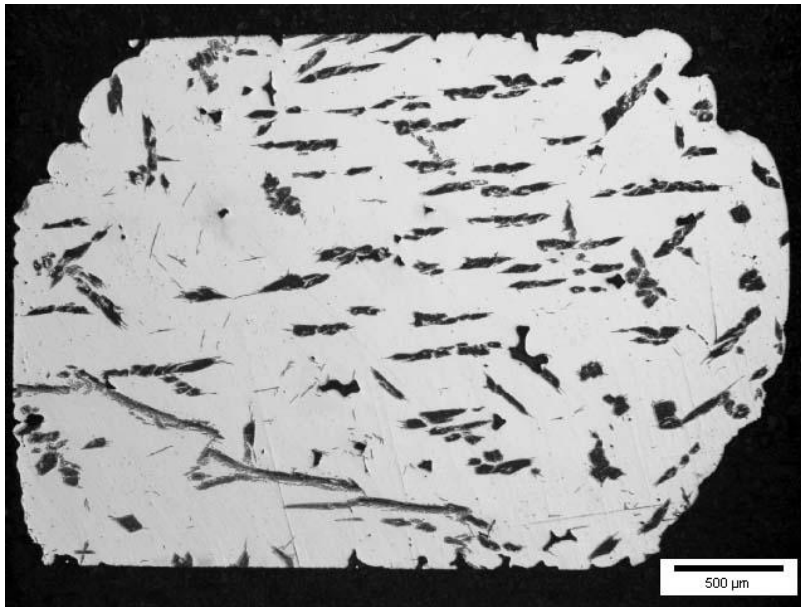
- DTA curves Alloy B – heating up to 1575 °C



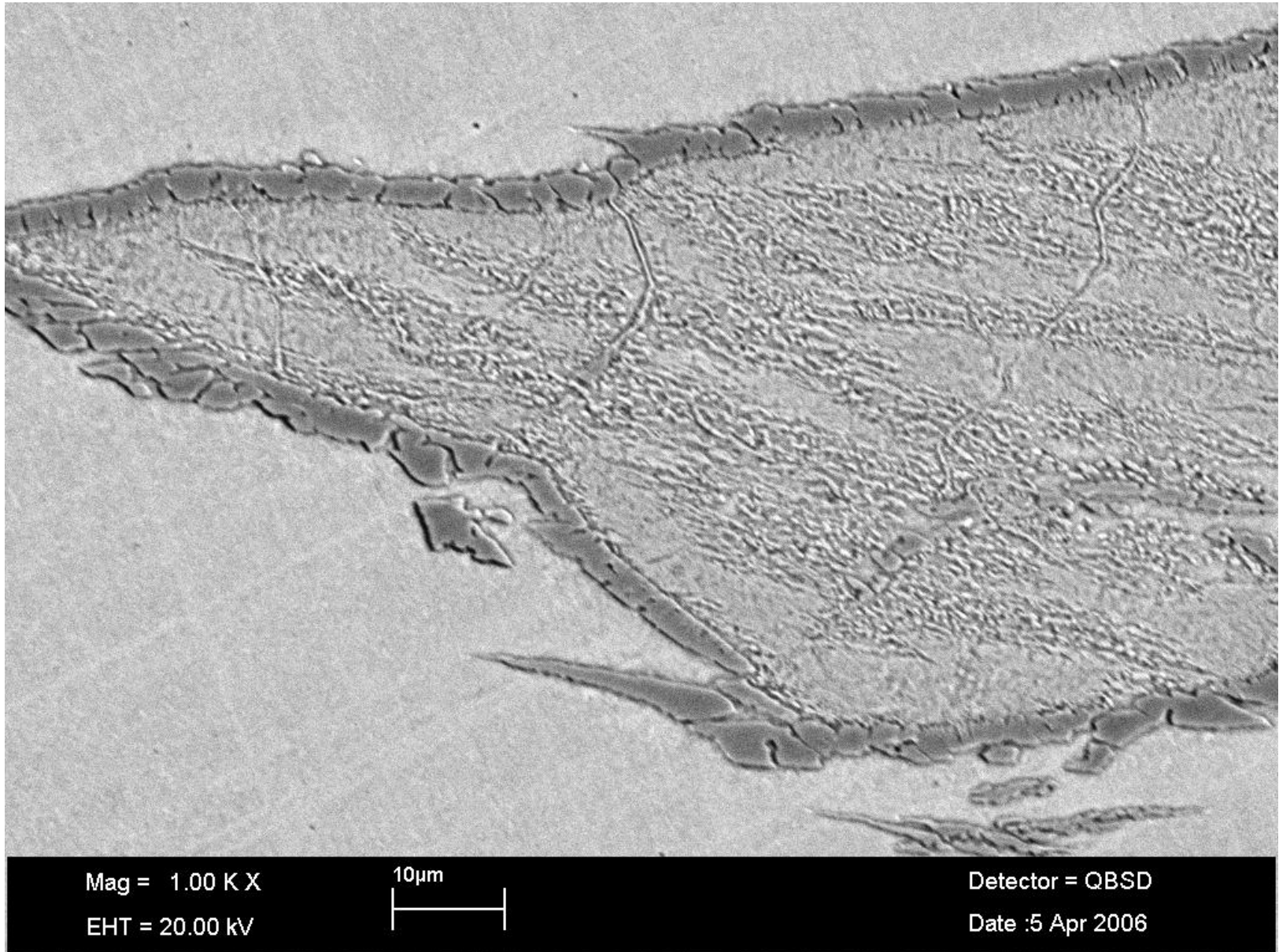
- DTA curves Alloy B – heating up to 1575 °C



B



B



- Phase diagrams

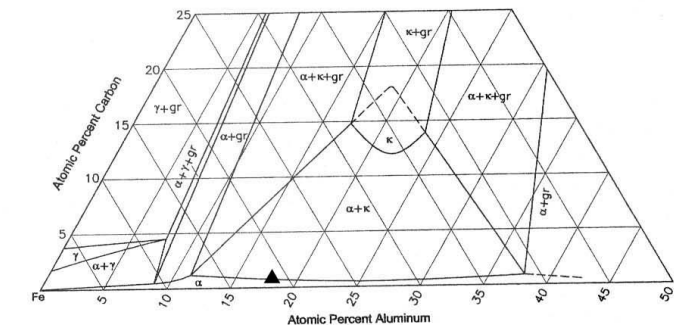
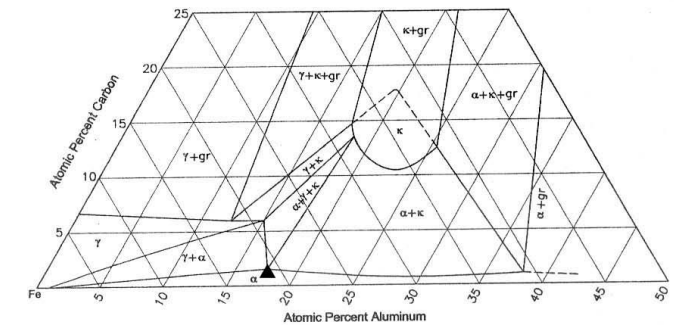
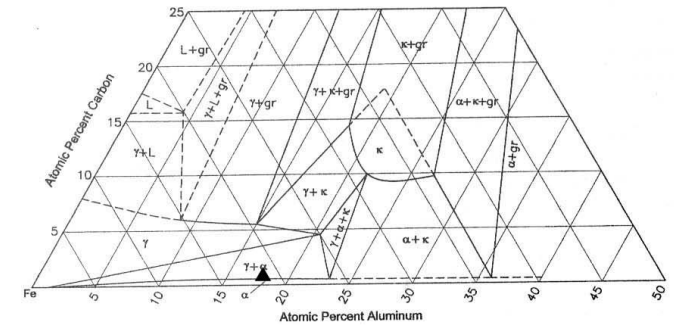
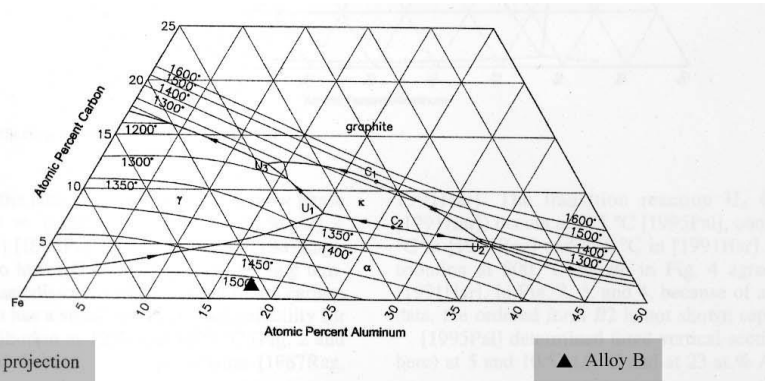
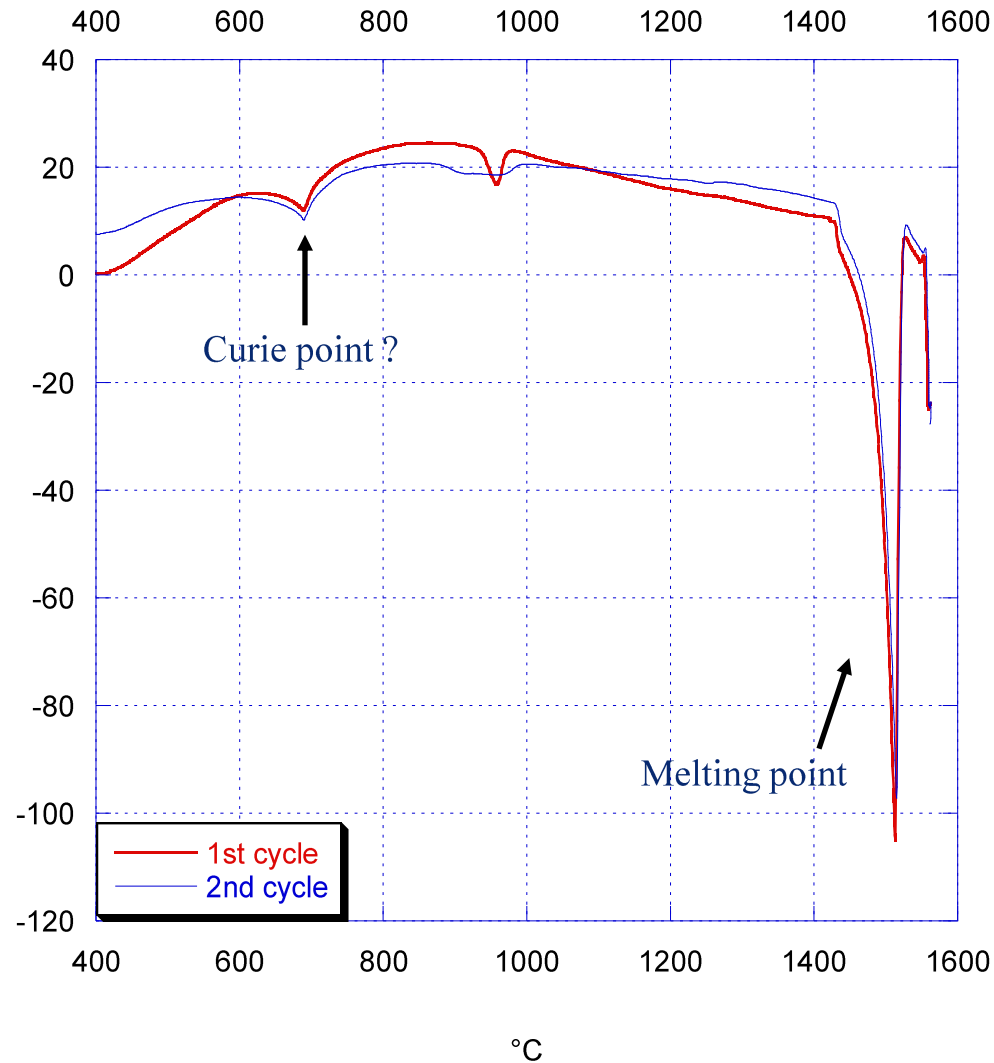


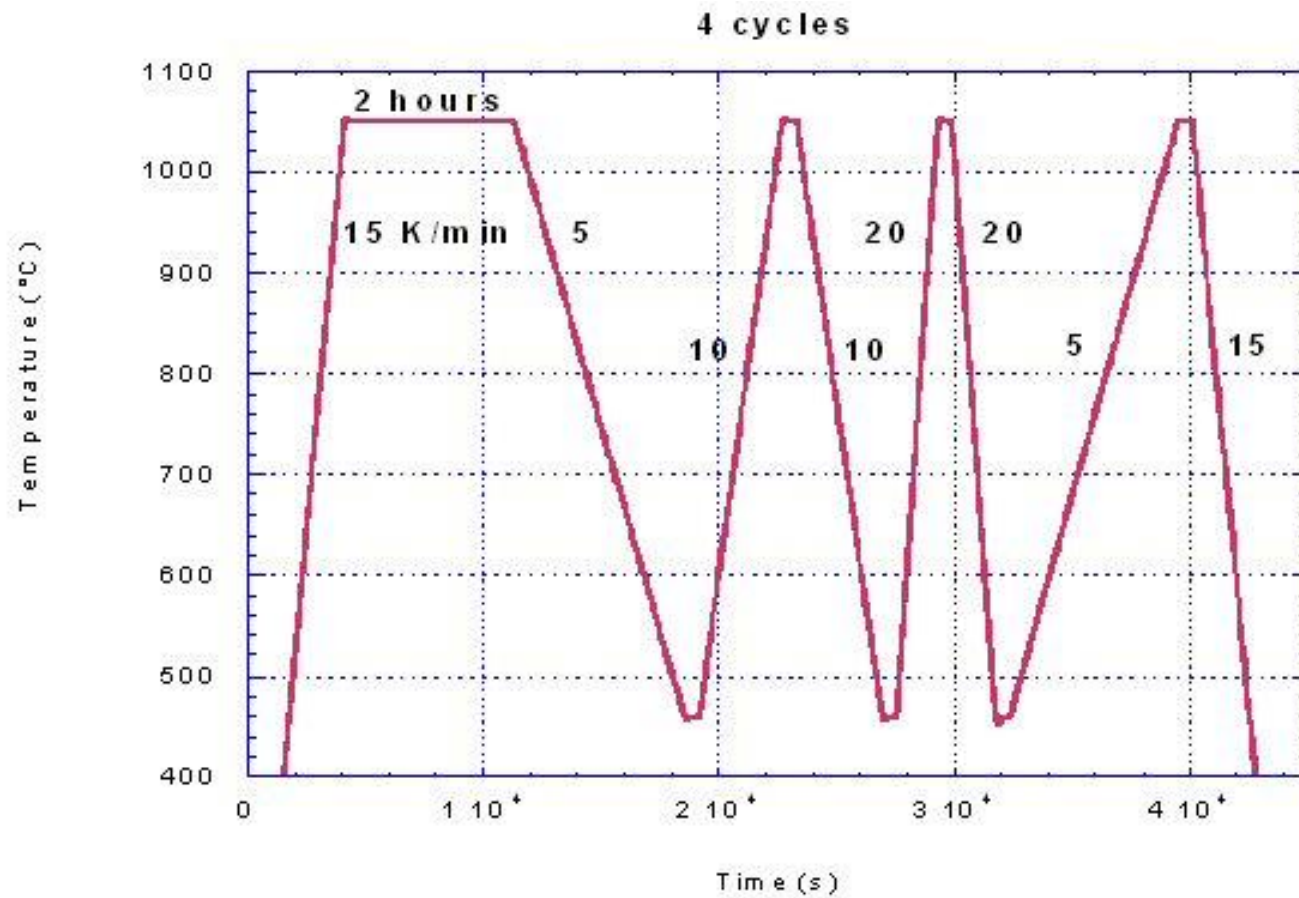
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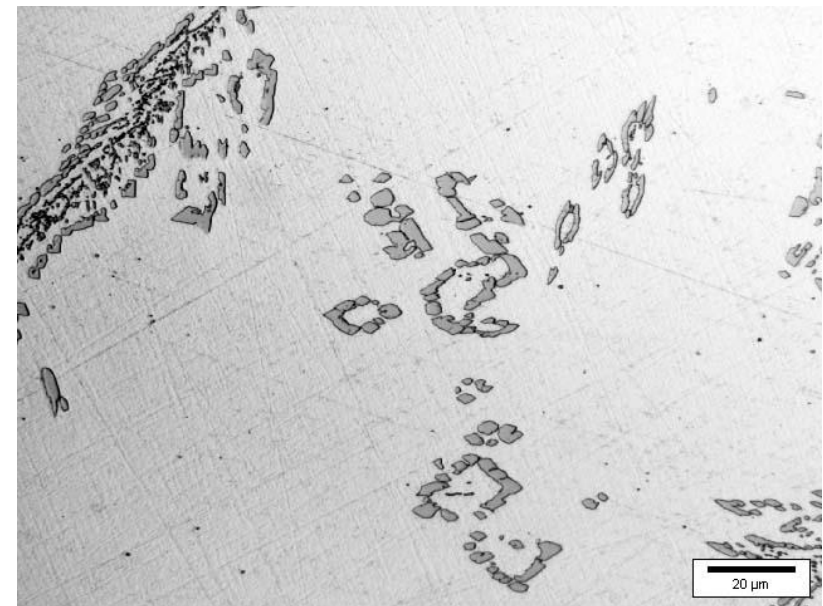
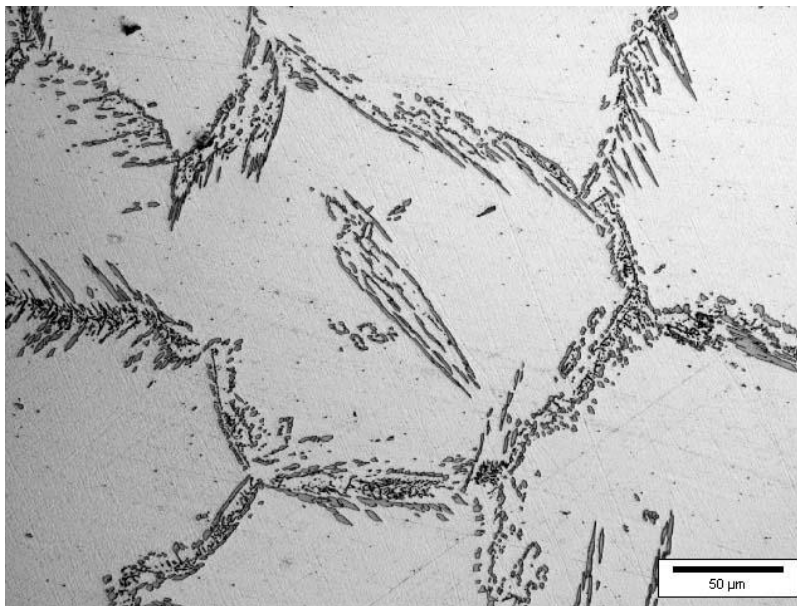
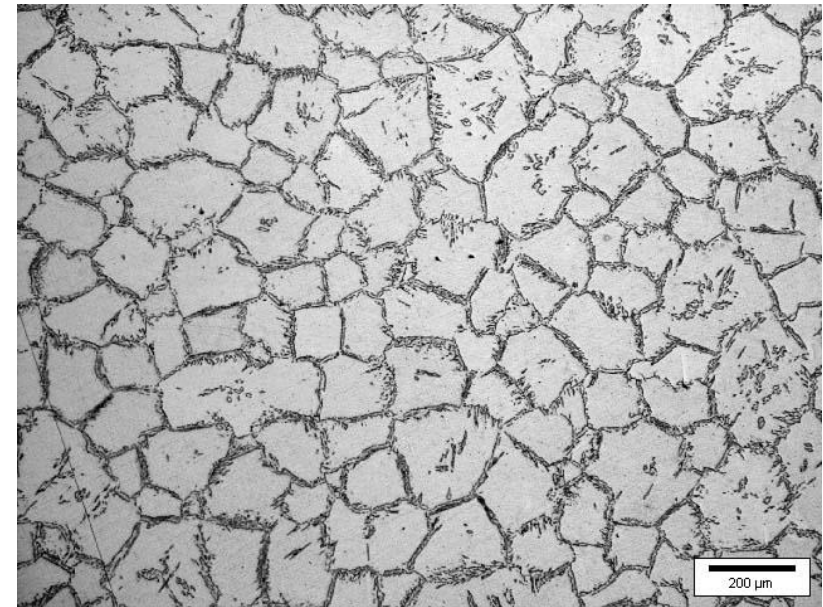
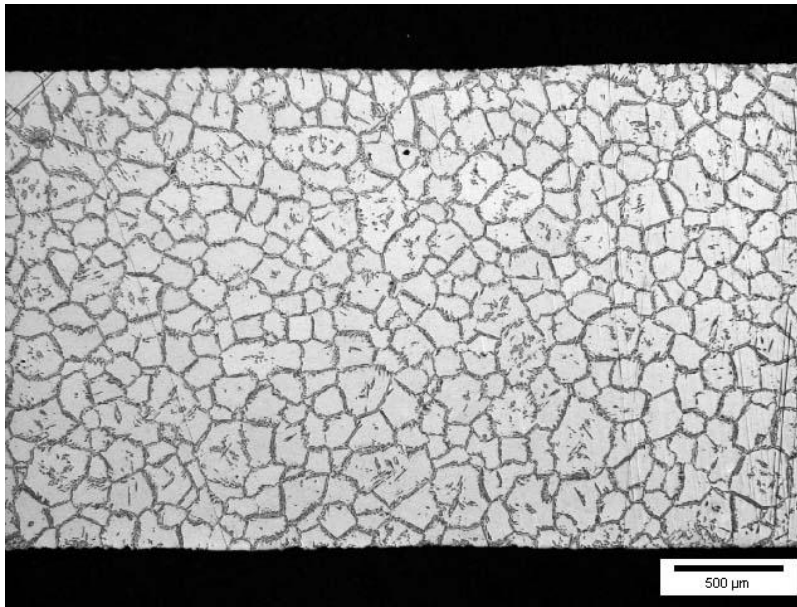
- DTA curves Alloy B – heating up to 1575 °C



- DTA cycles 500°C - 1100 °C



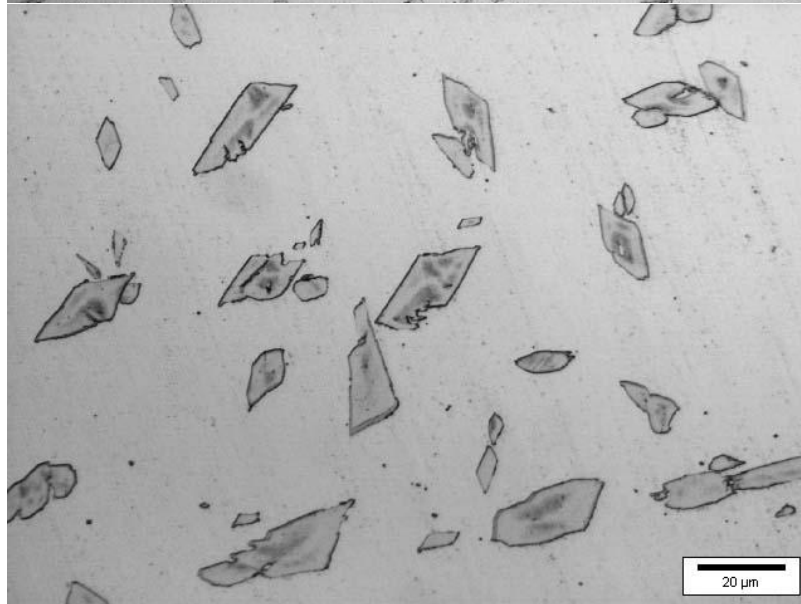
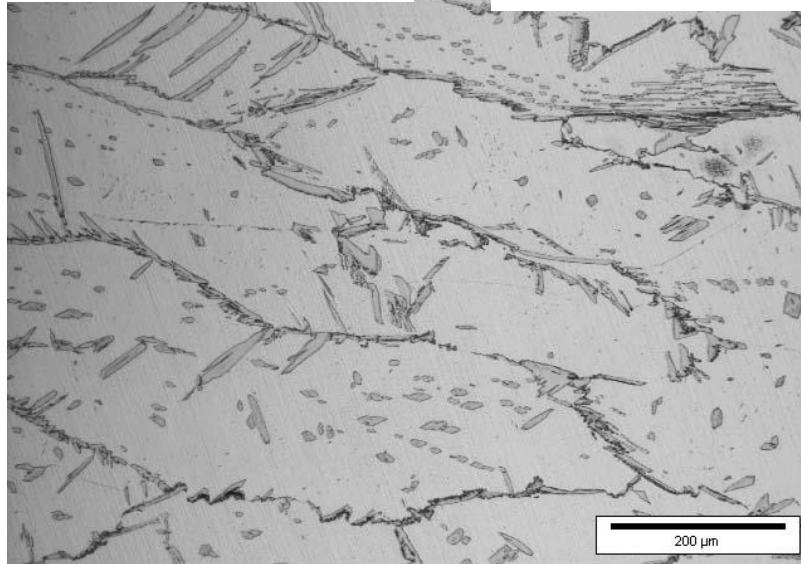
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B

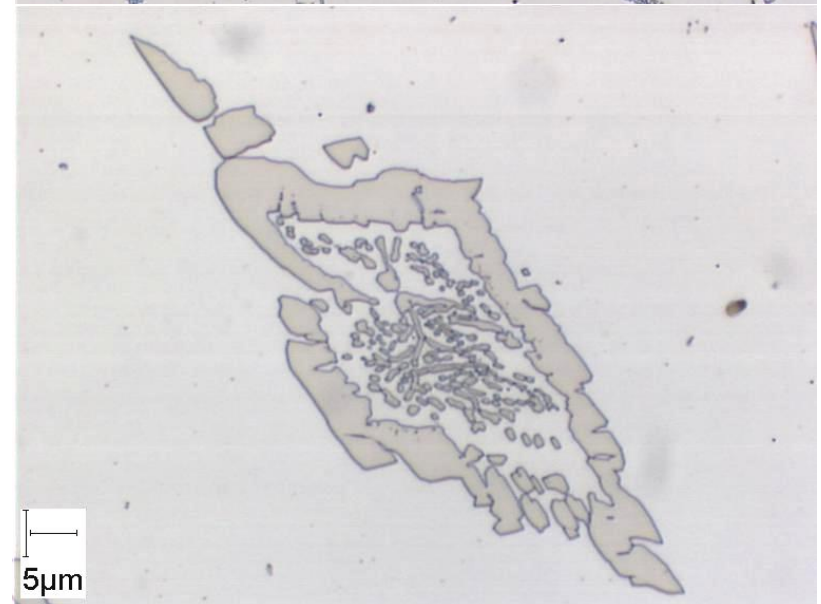
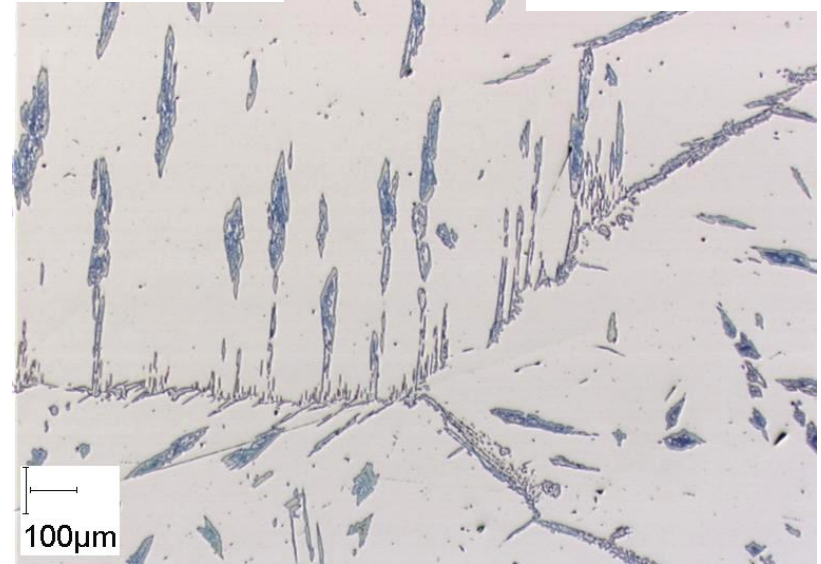
Size Ø5 mm l 250 mm

0.2C 9.7Al 1.7Mn

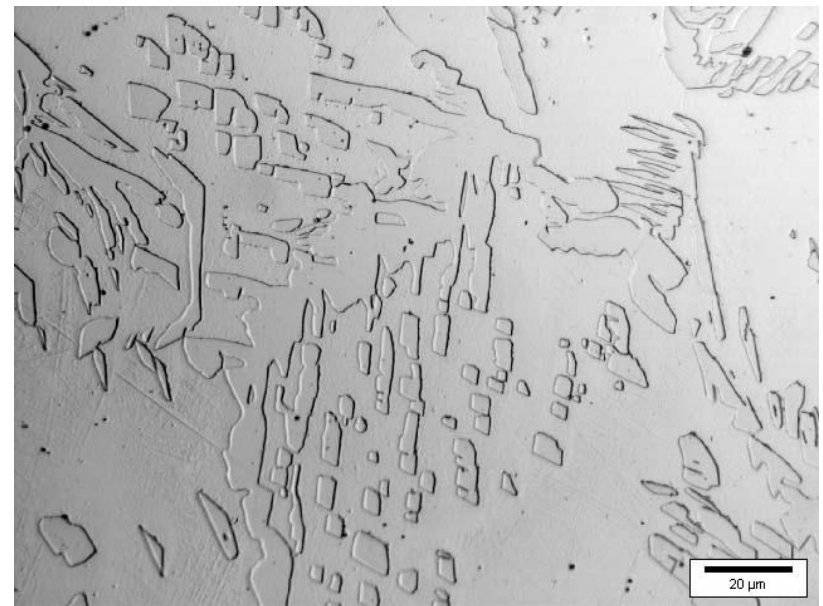
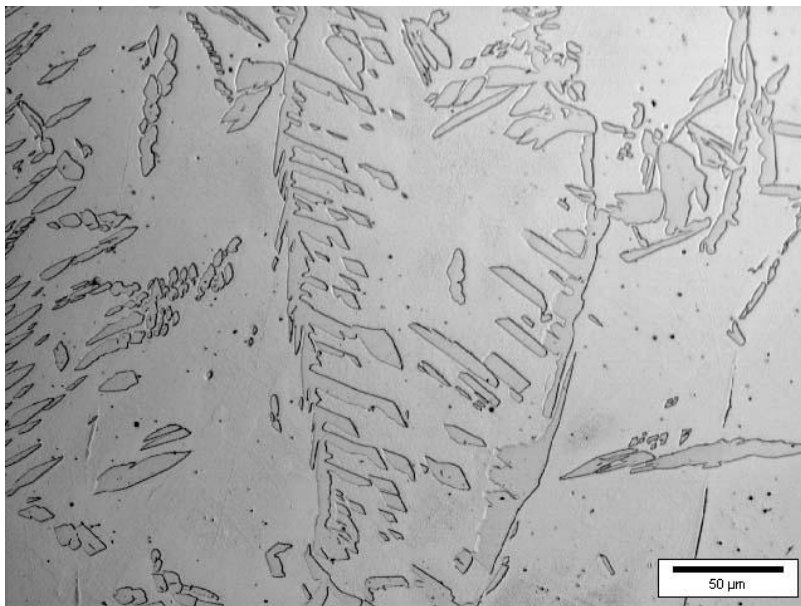
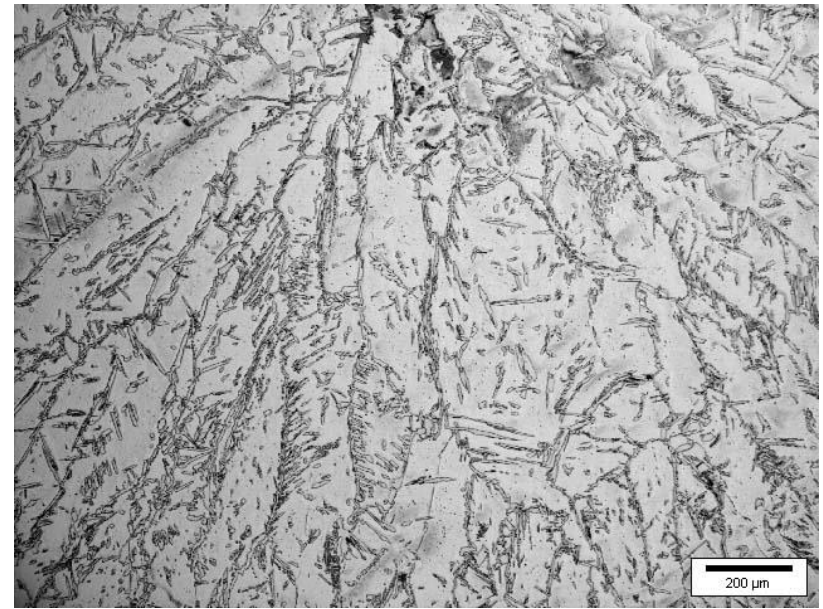
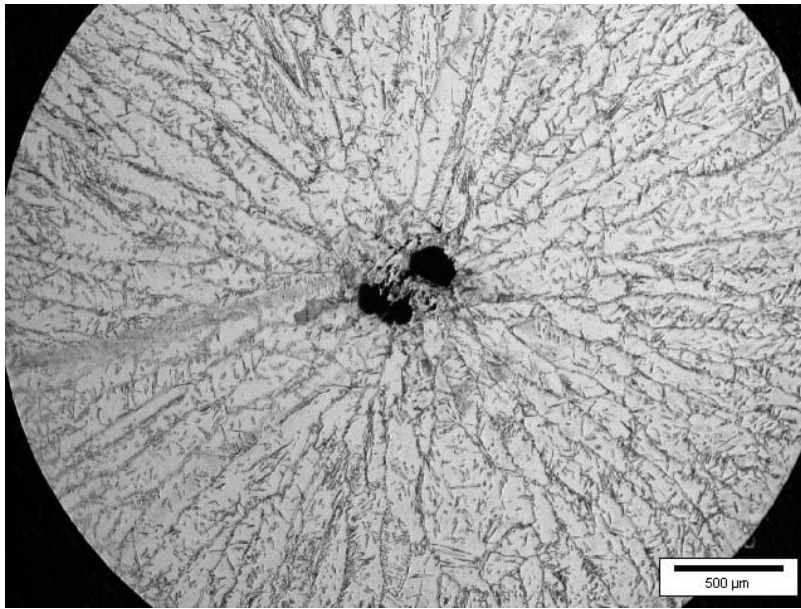


Sample size ?

0.2C 9Al 1.6Mn

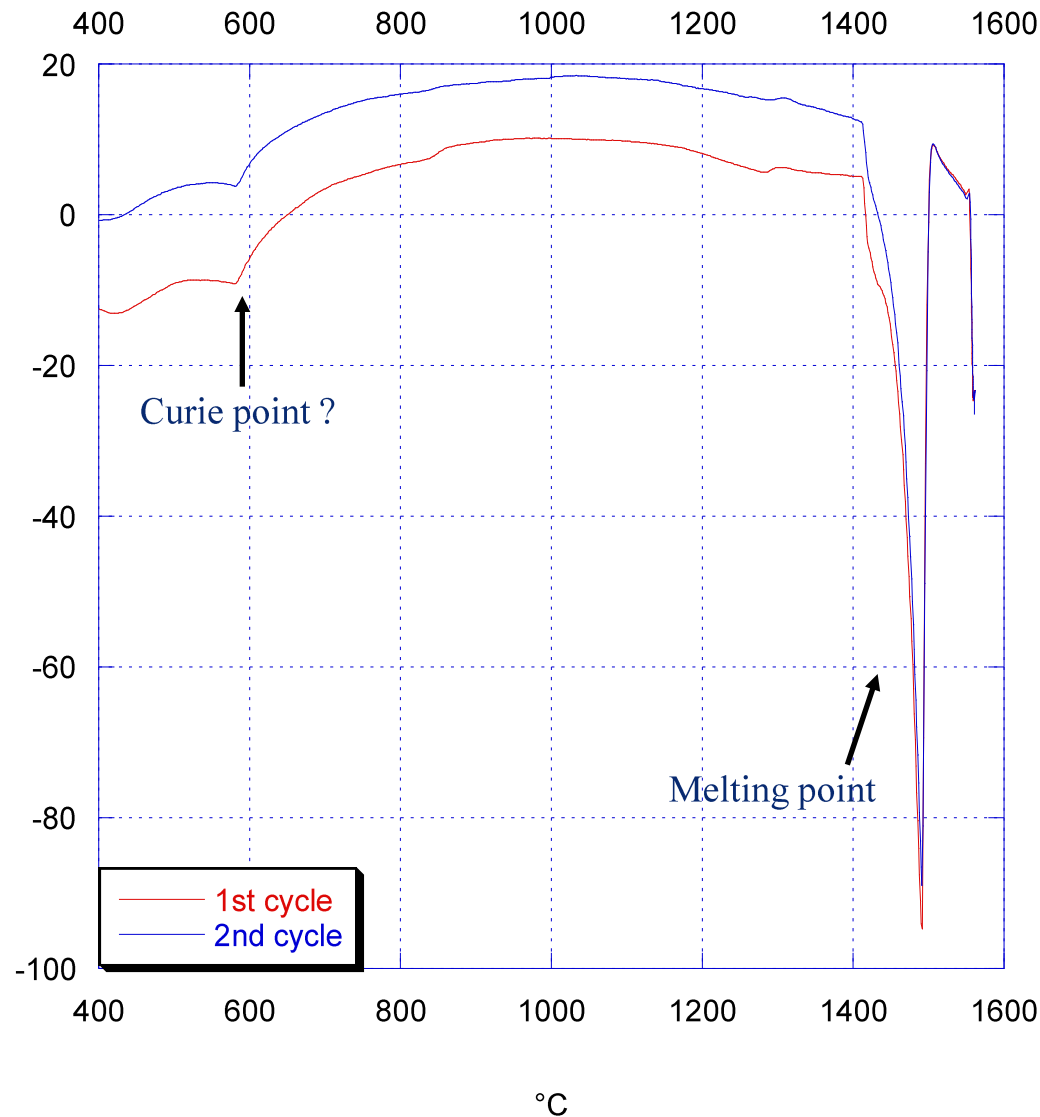


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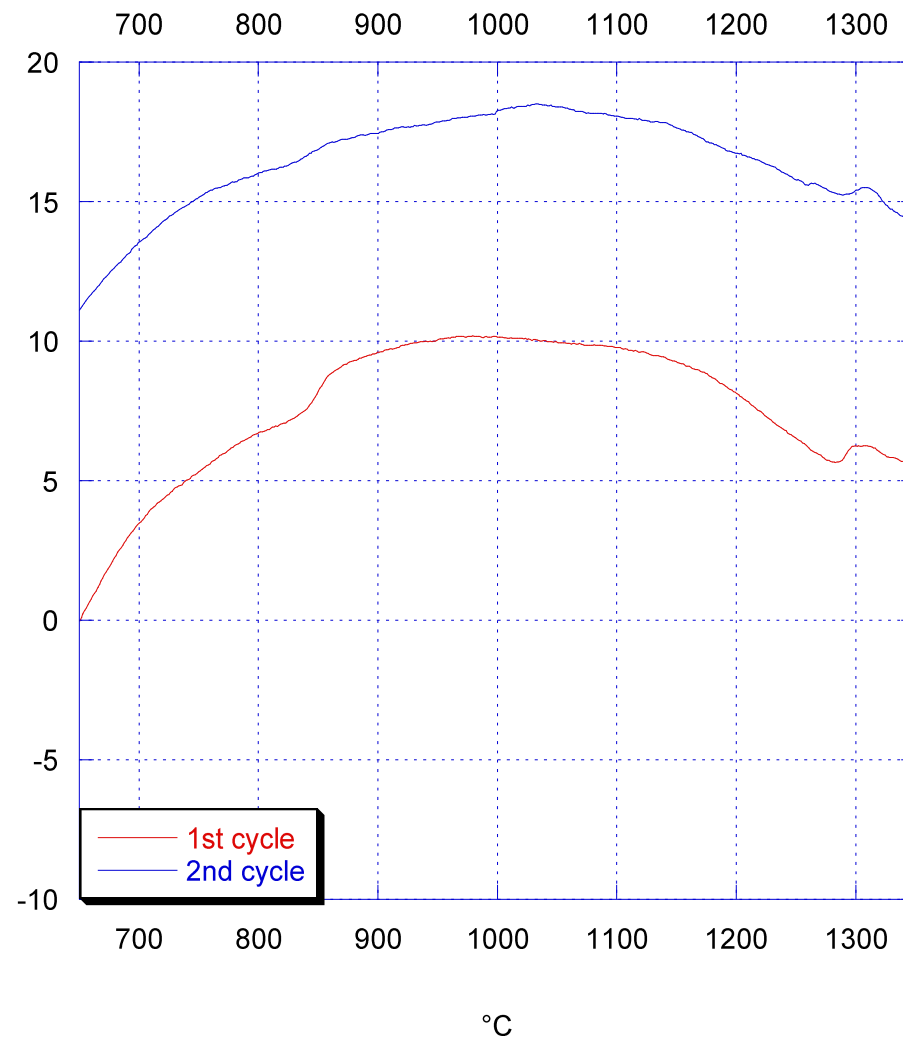


- DTA experiments

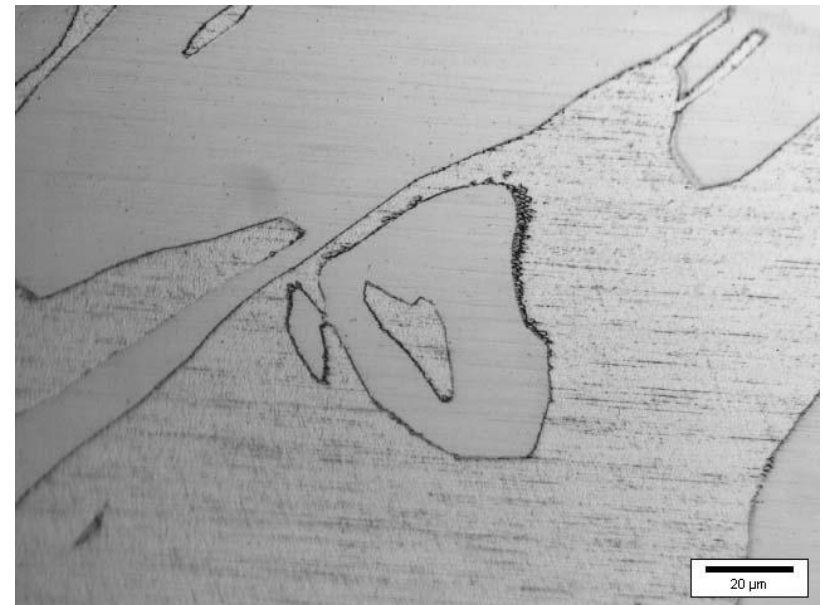
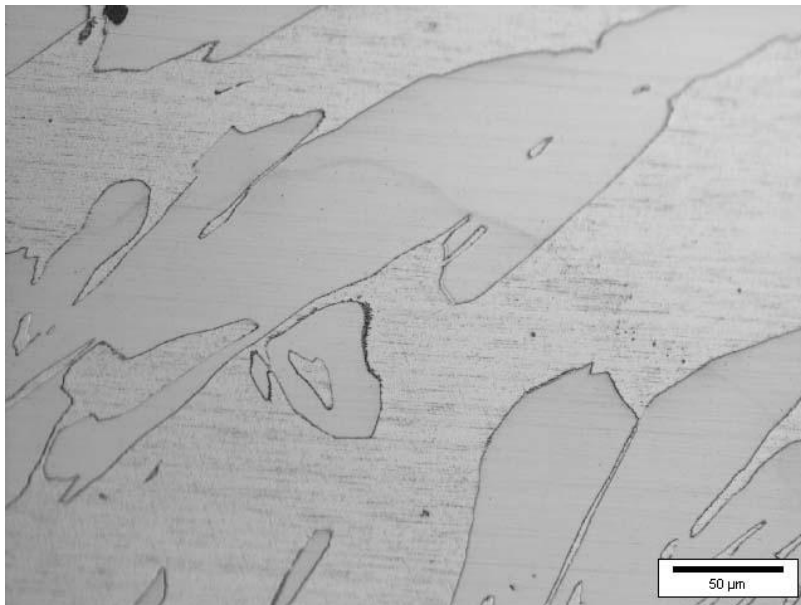
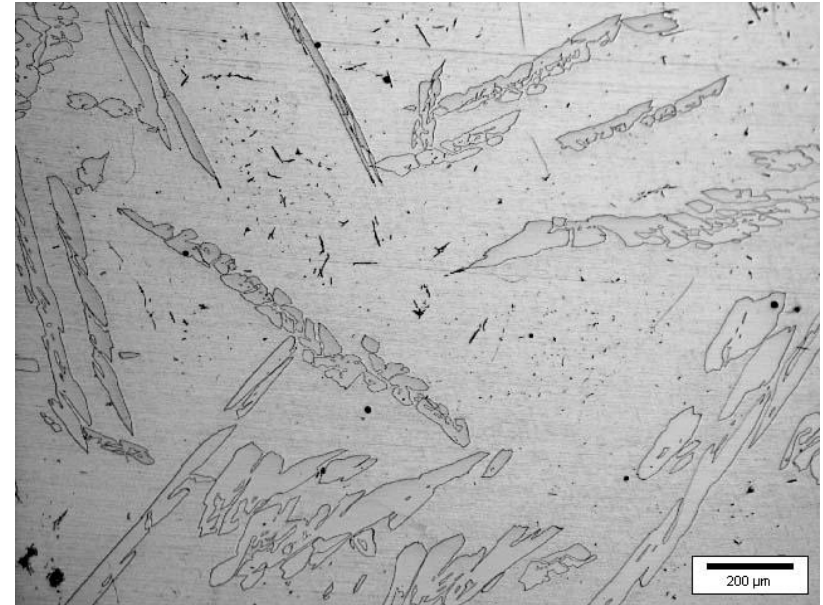
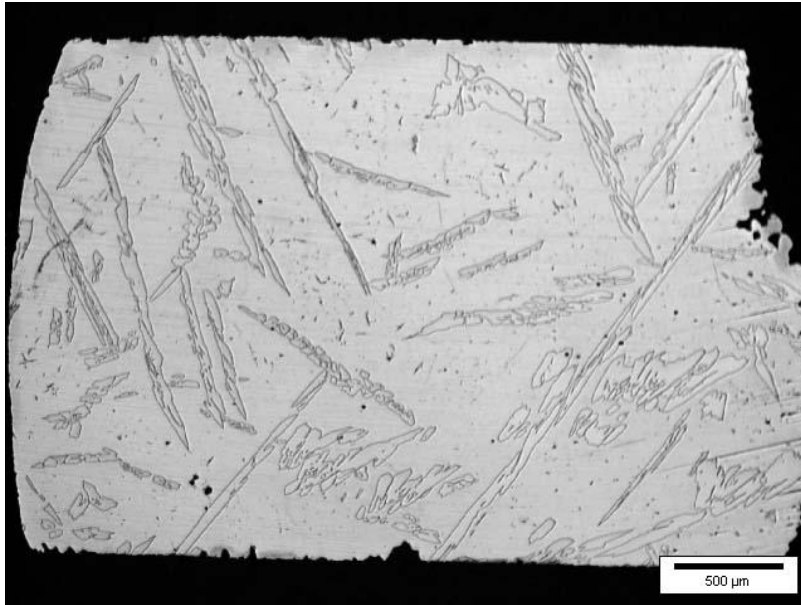
Alloy C – heating up to 1575°C



- DTA experiments Alloy C – heating up to 1575 °C



C



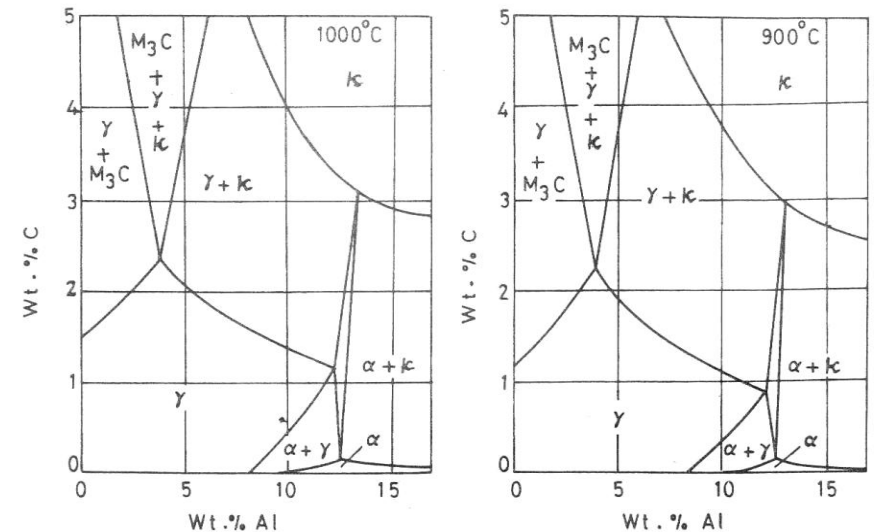
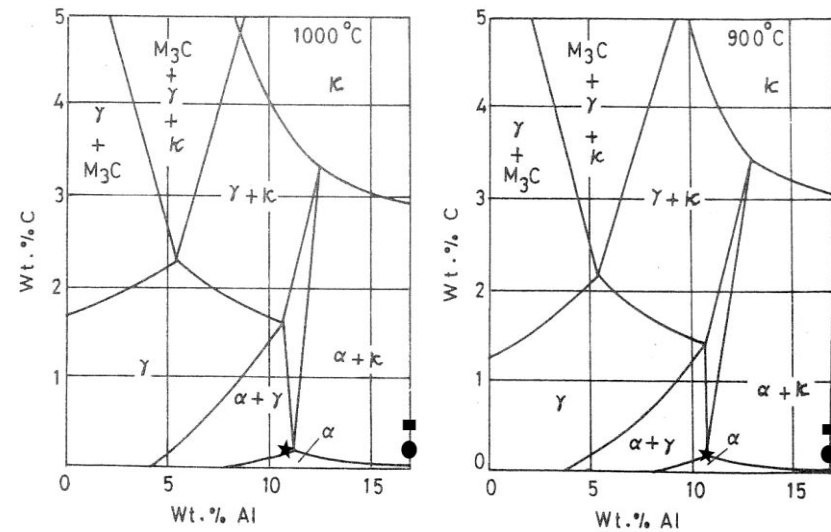
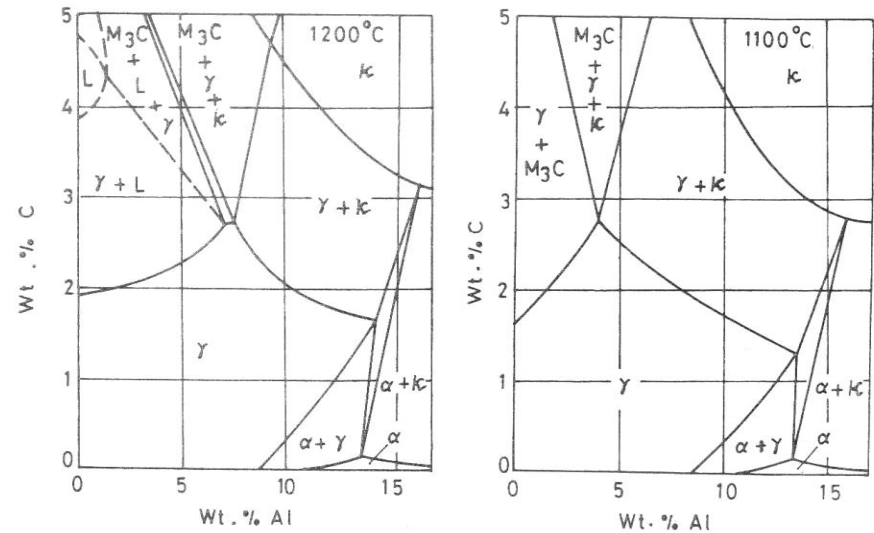
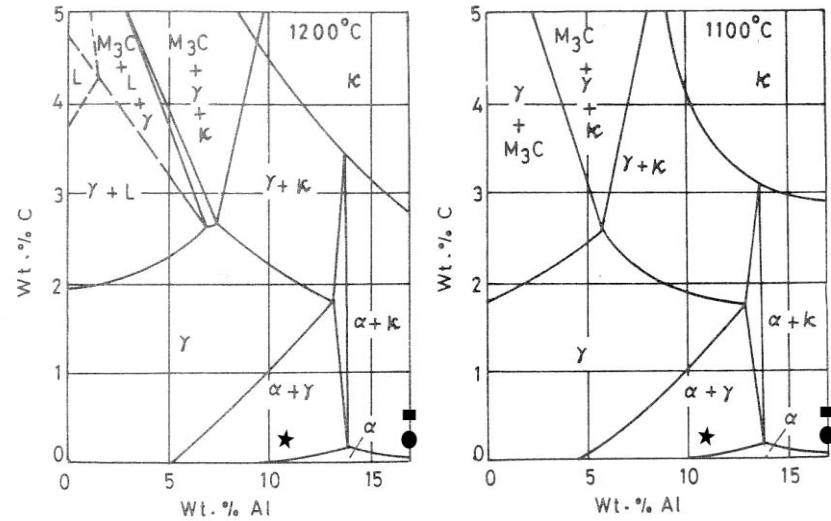


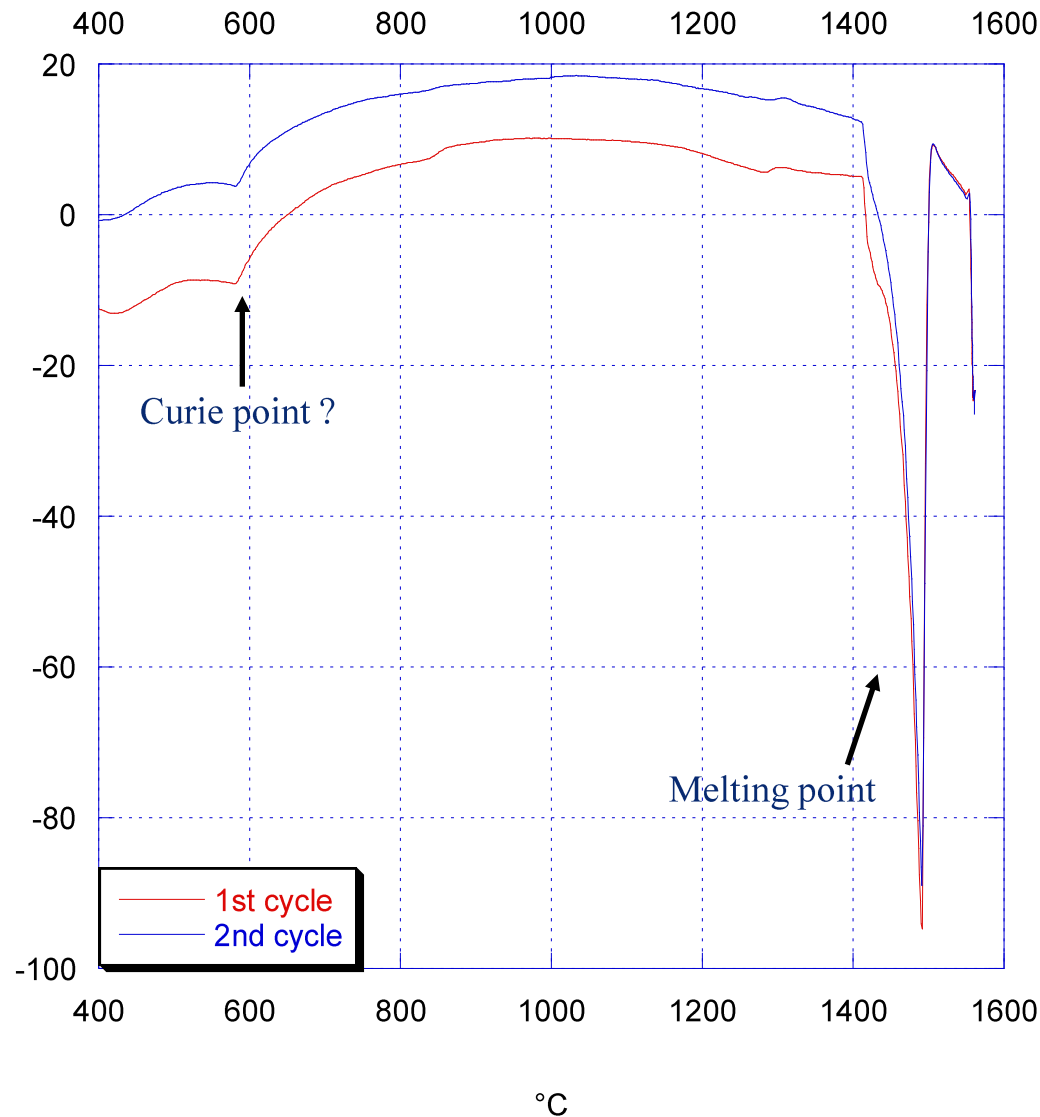
Figure 6 Al-C-Fe-Mn Isothermal Sections at 20 Wt.% Mn

Figure 7 Al-C-Fe-Mn Isothermal Sections at 30 Wt.% Mn

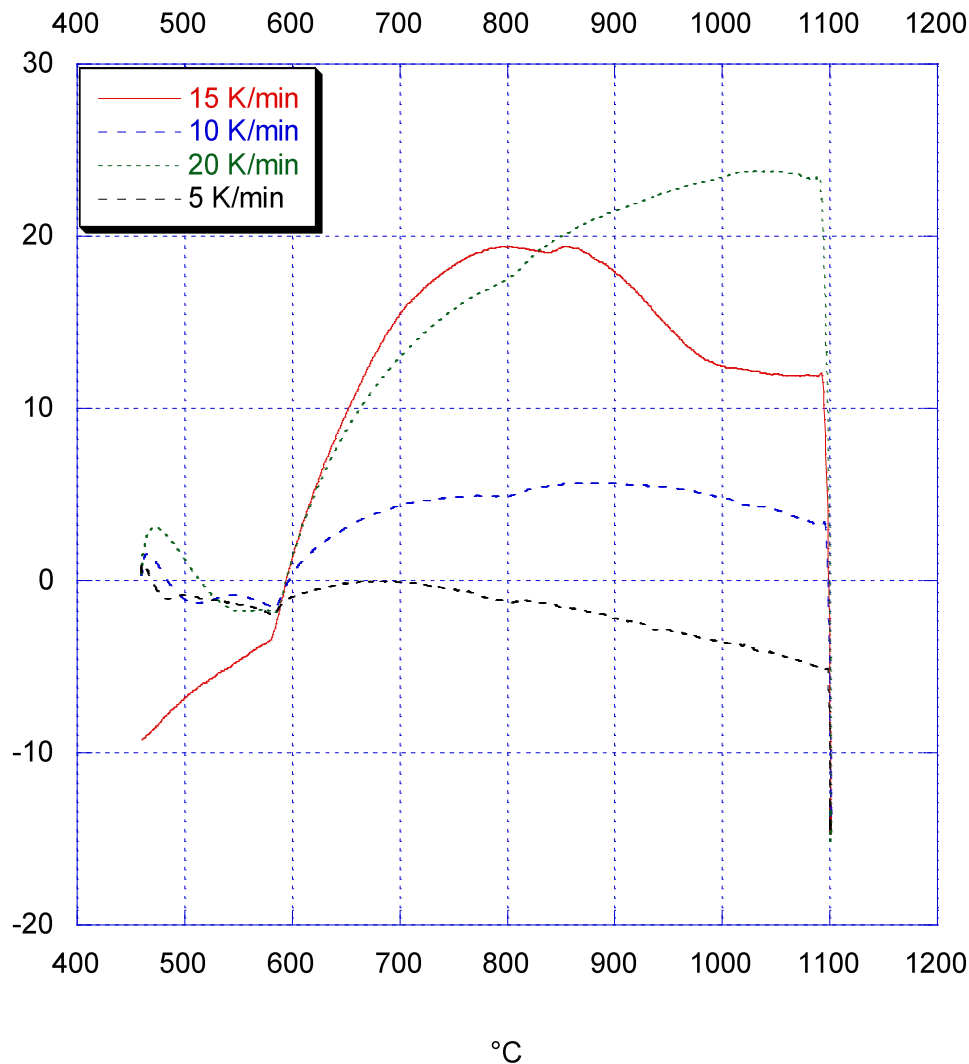
■ Alloy E
● Alloy D
★ Alloy C

- DTA experiments

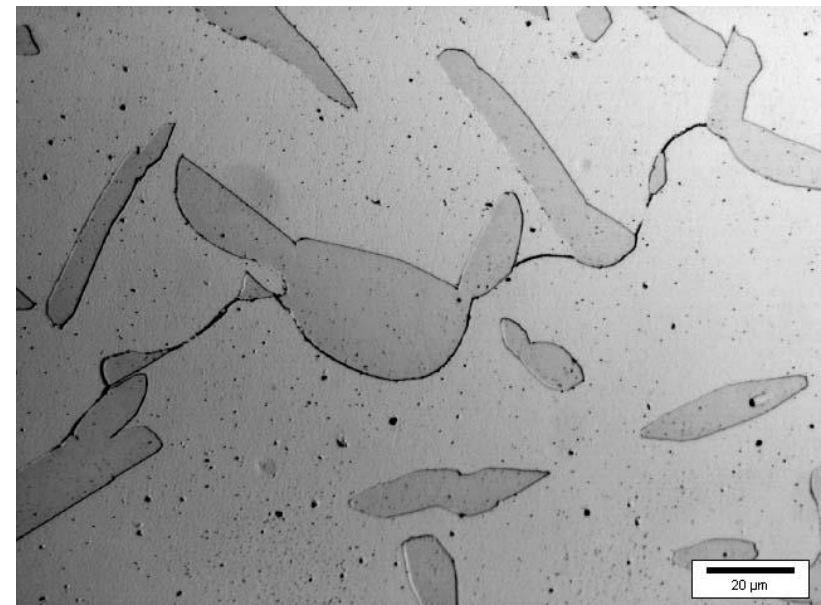
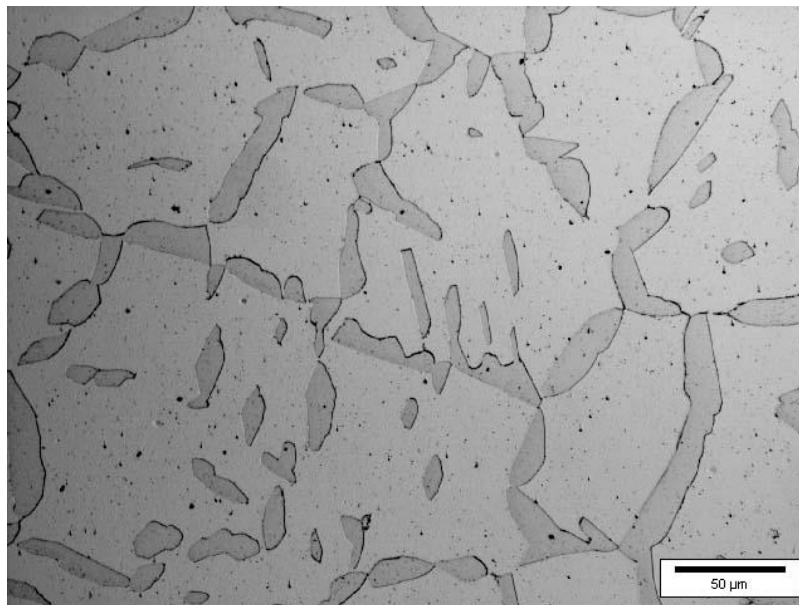
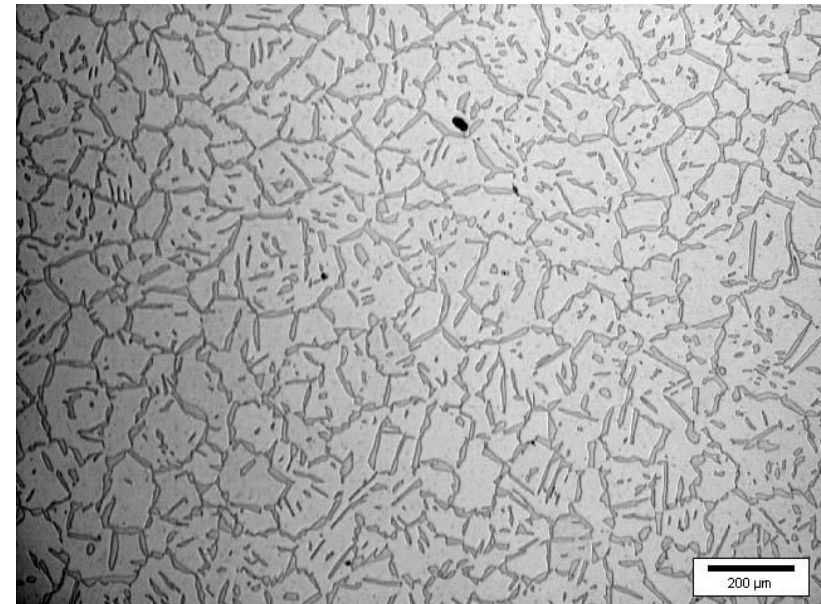
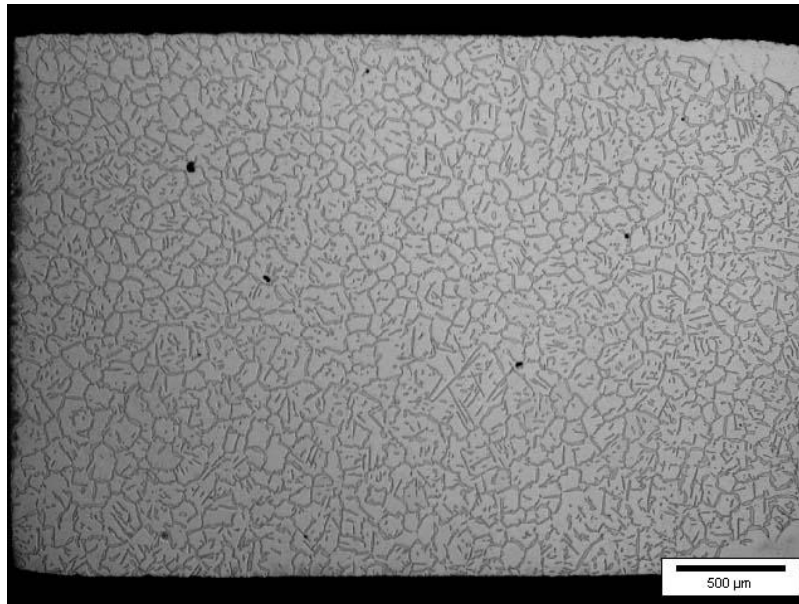
Alloy C – heating up to 1575°C



- DTA experiments Alloy C 4 cycles - heating
(Between 450 – 1100 °C)



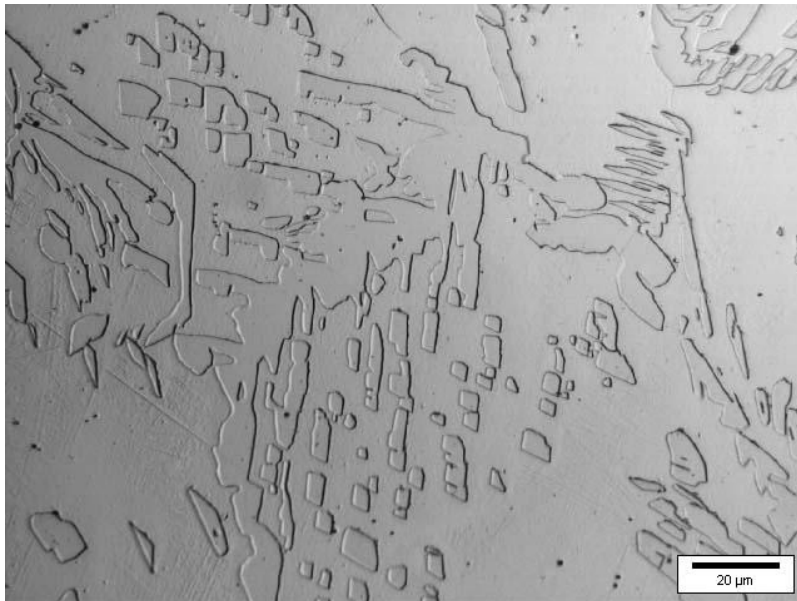
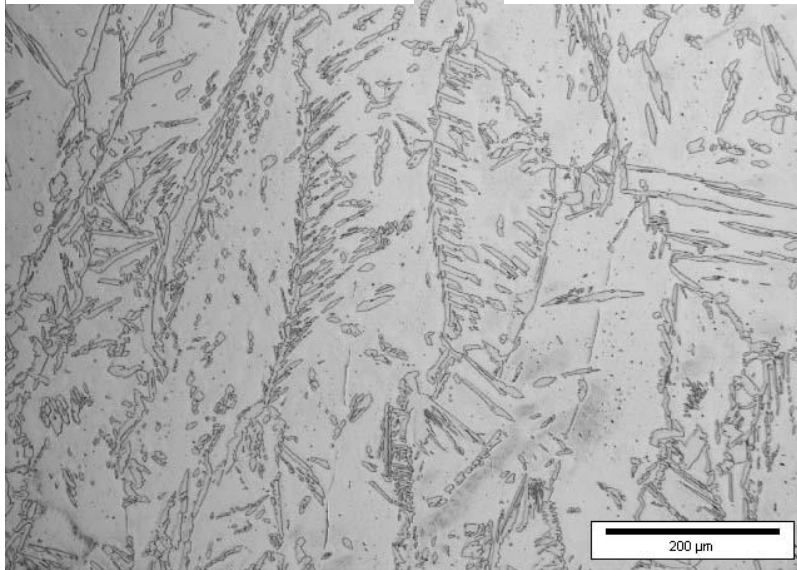
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C

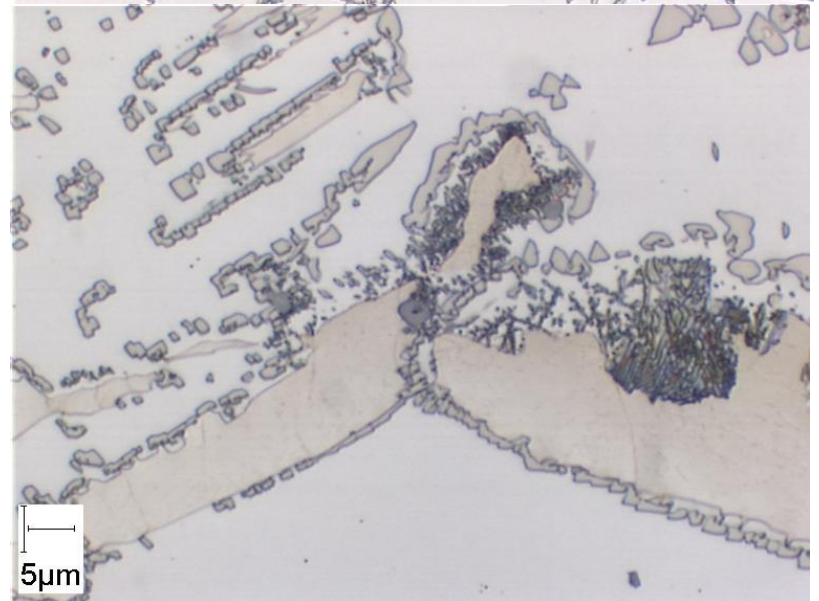
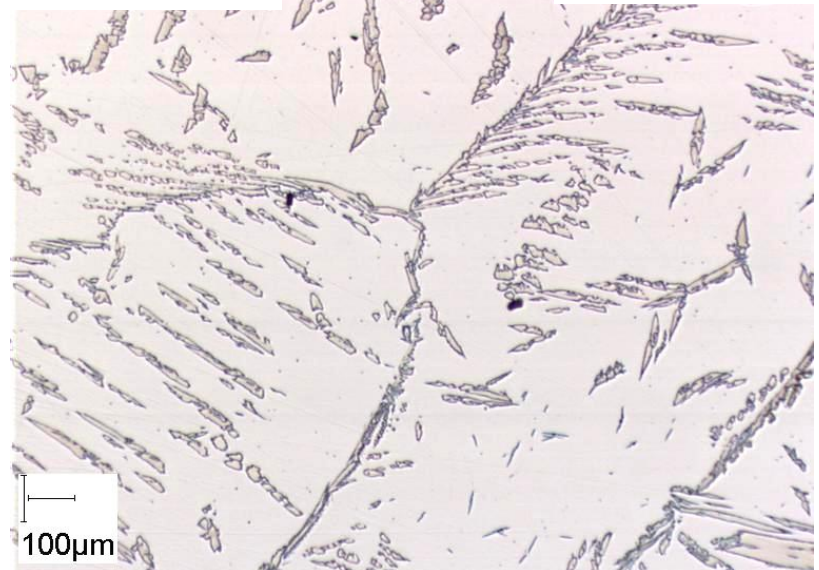
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0.2C 11Al 10Mn



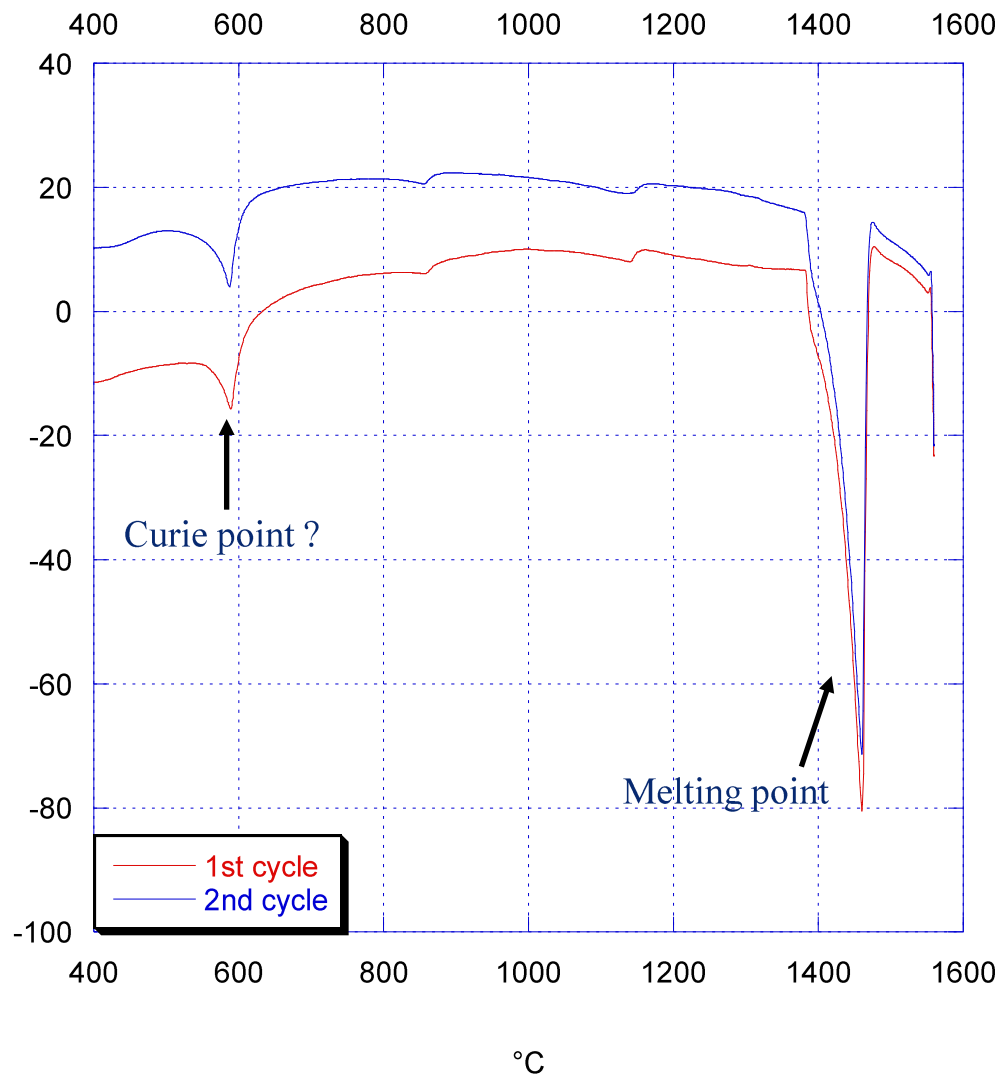
Sample size ?

0.2C 9Al 8Mn

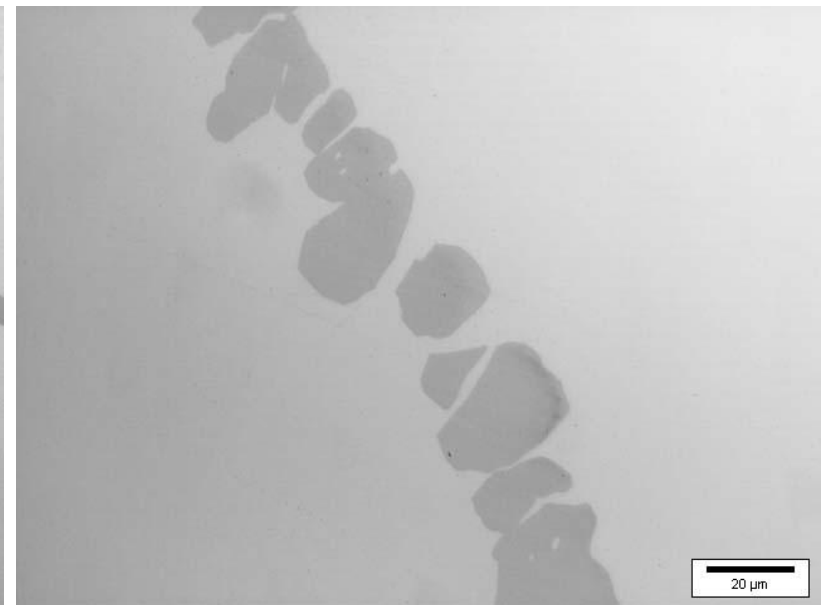
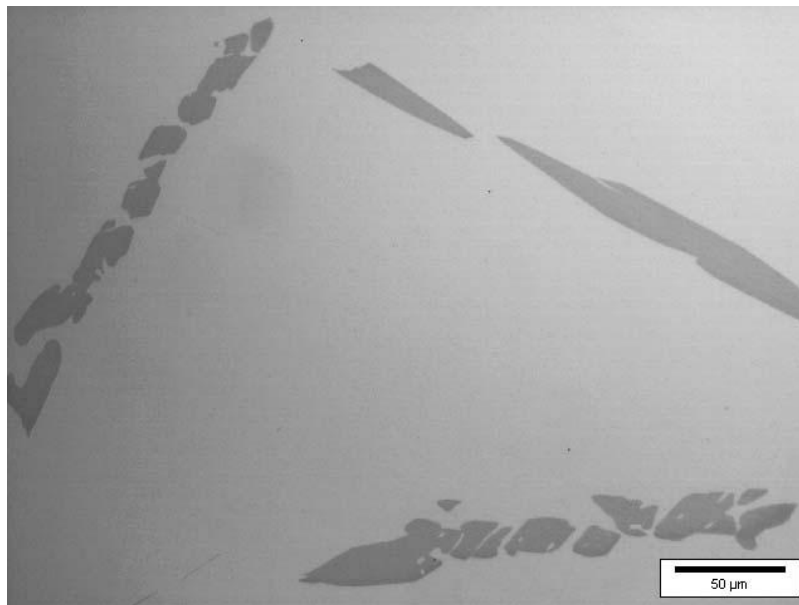
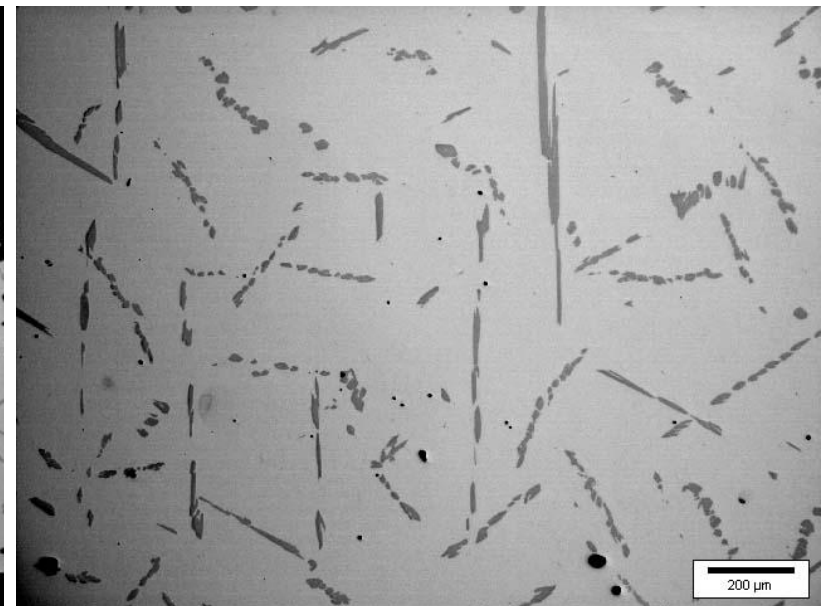
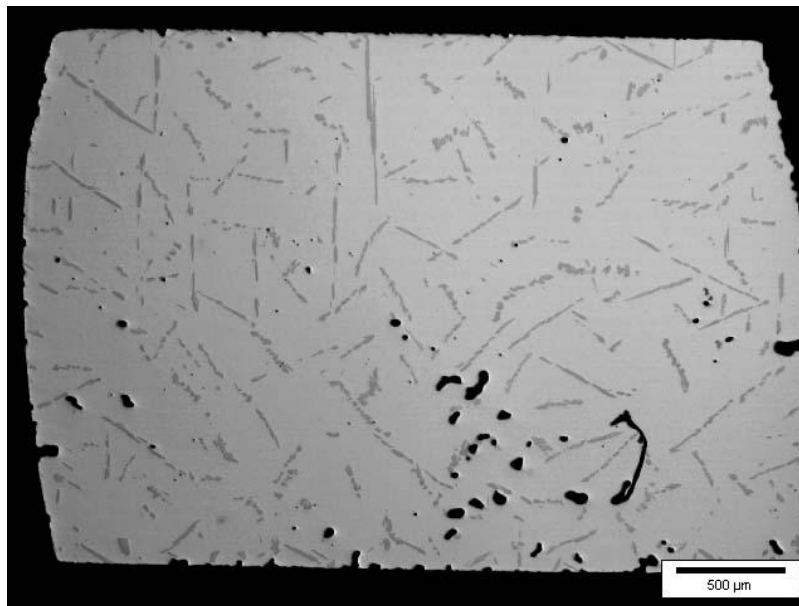


- DTA experiments

Alloy D – heating up to 1575°C



D



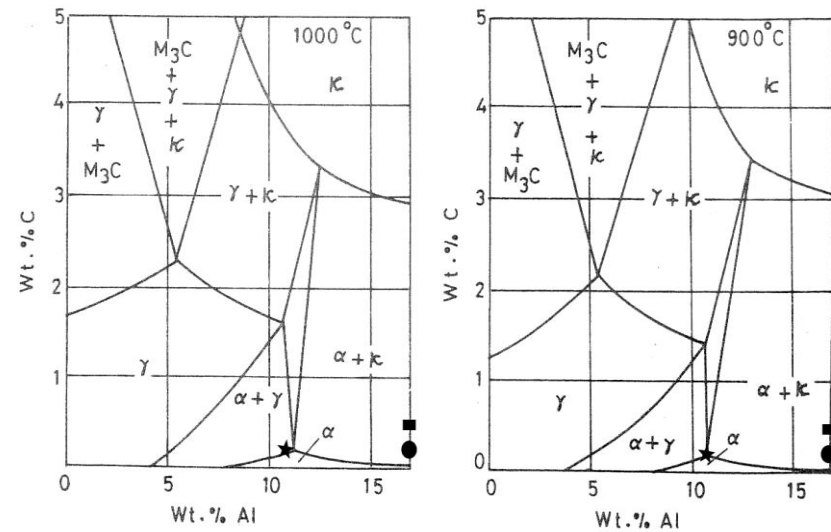
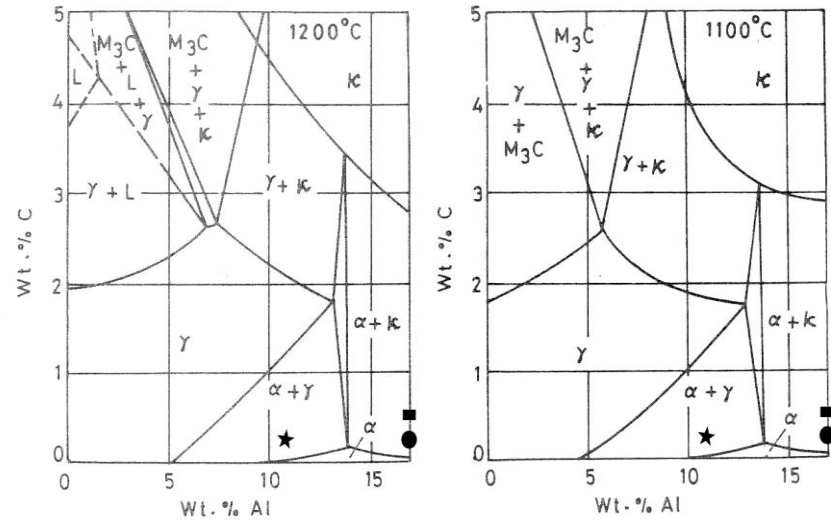


Figure 6 Al-C-Fe-Mn Isothermal Sections at 20 Wt.% Mn

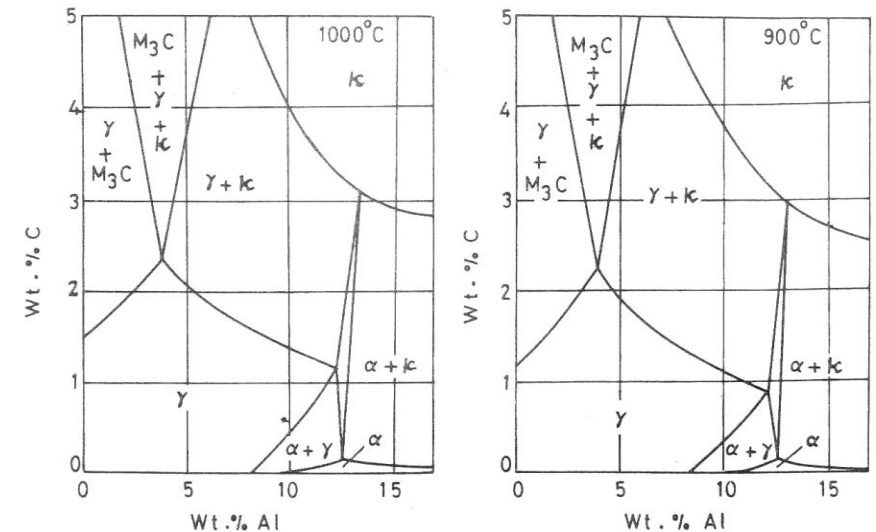
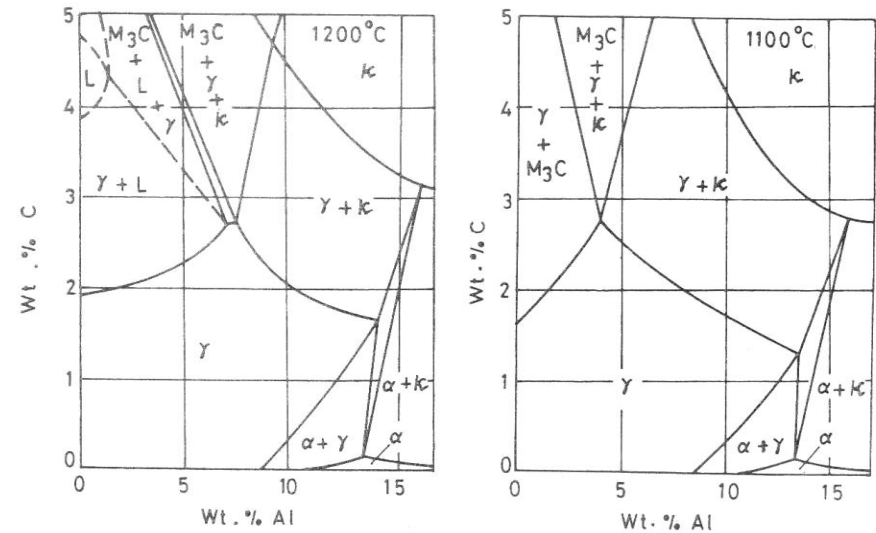
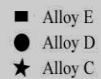
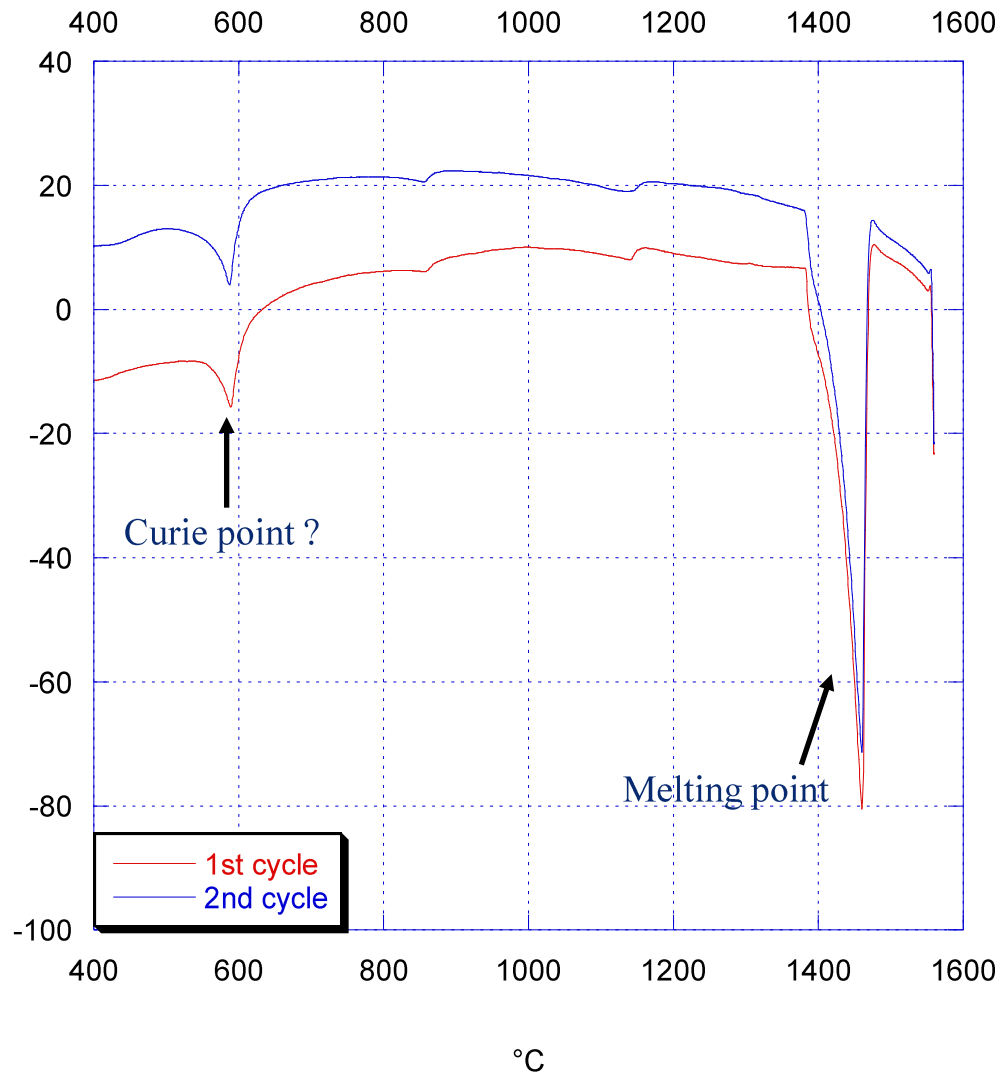


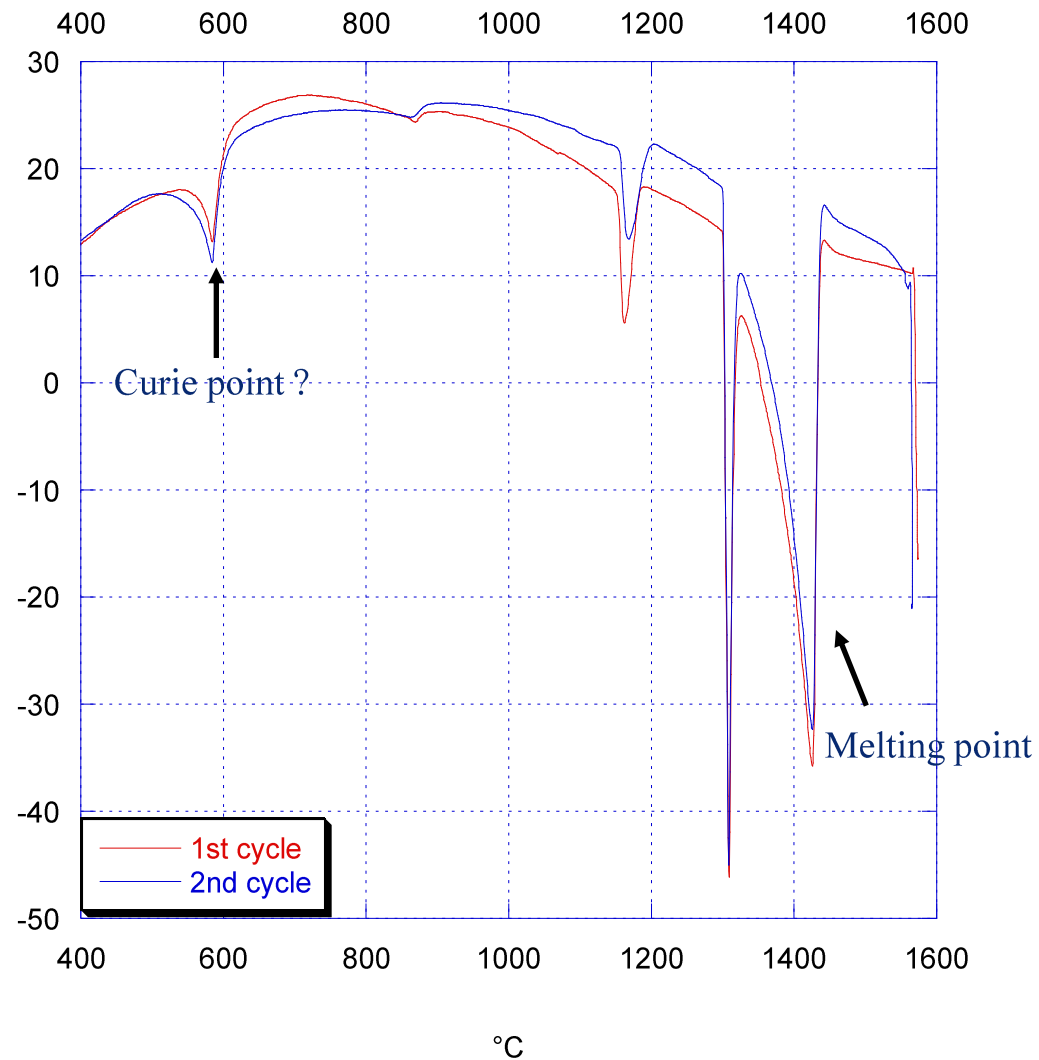
Figure 7 Al-C-Fe-Mn Isothermal Sections at 30 Wt.% Mn

- DTA experiments

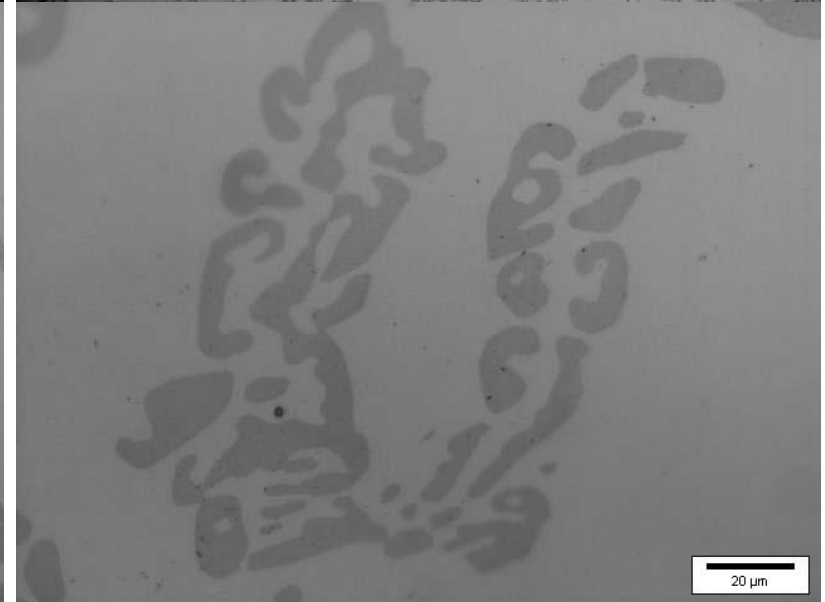
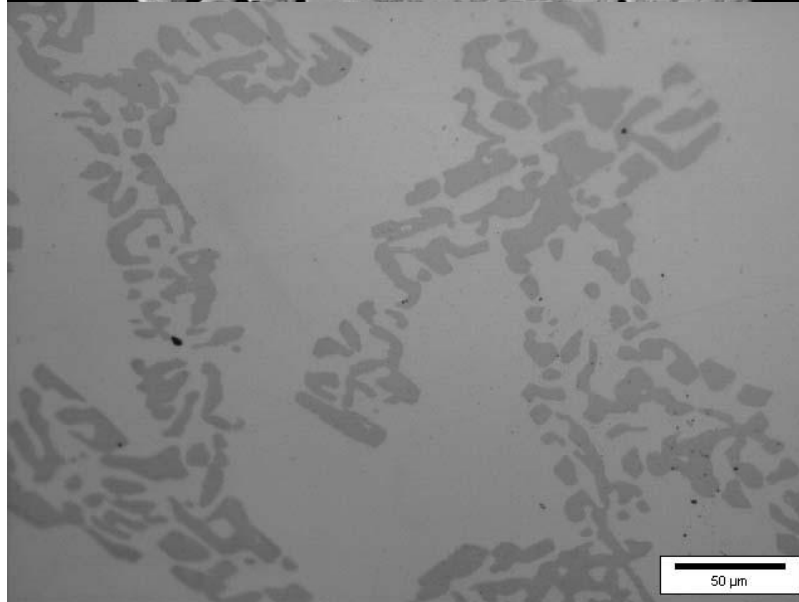
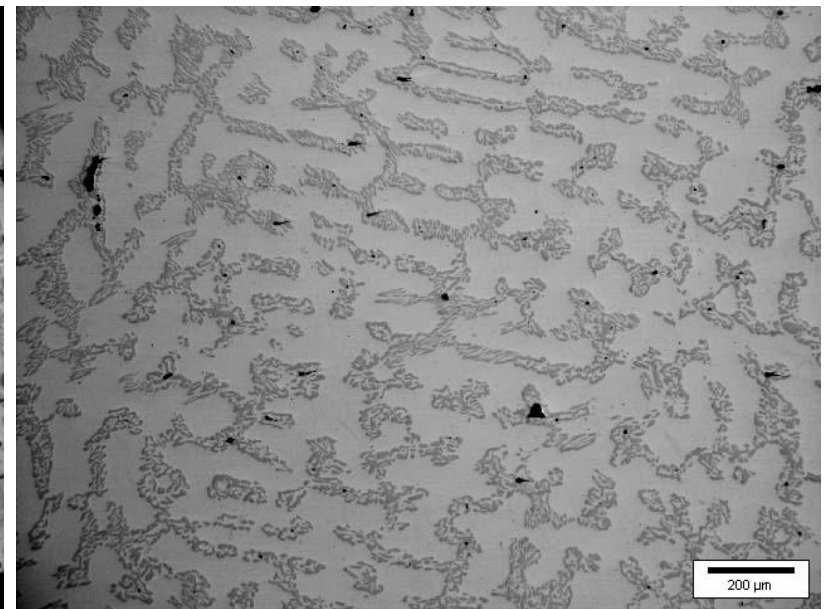
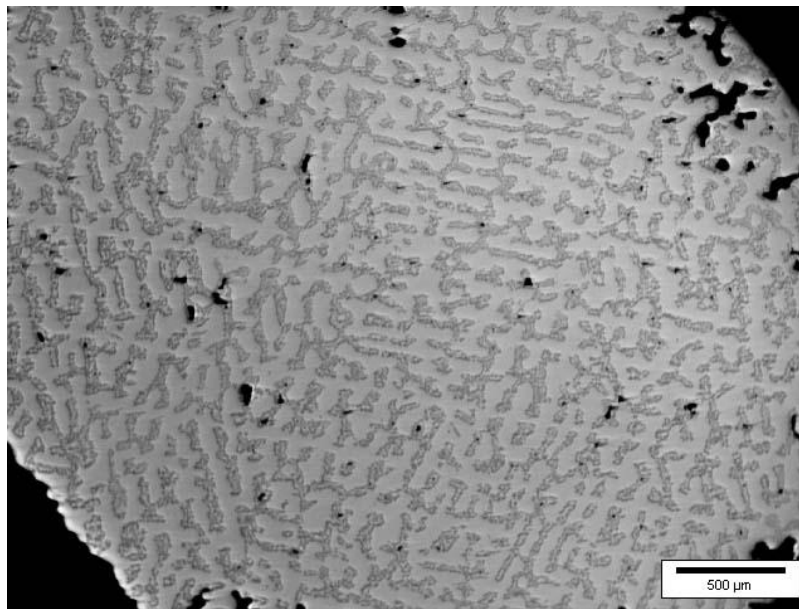
Alloy D – heating up to 1575°C



- DTA experiments Alloy E – heating up to 1575°C)



E



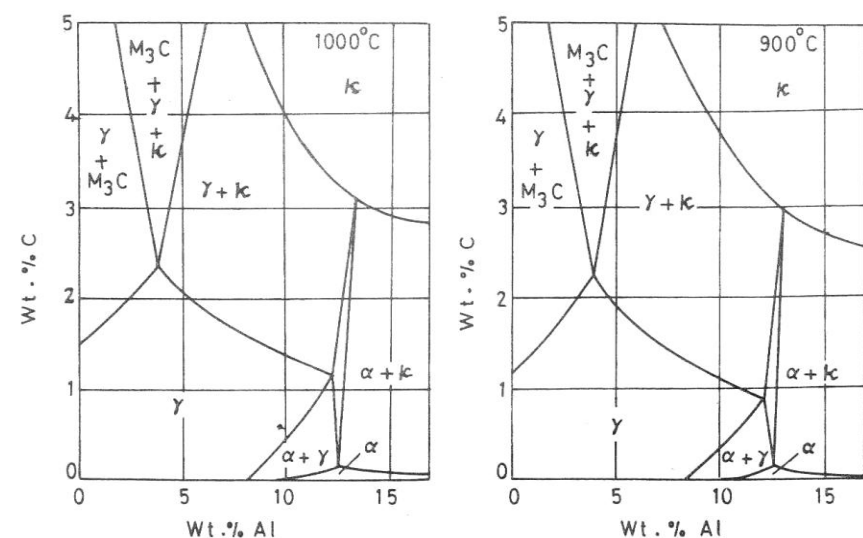
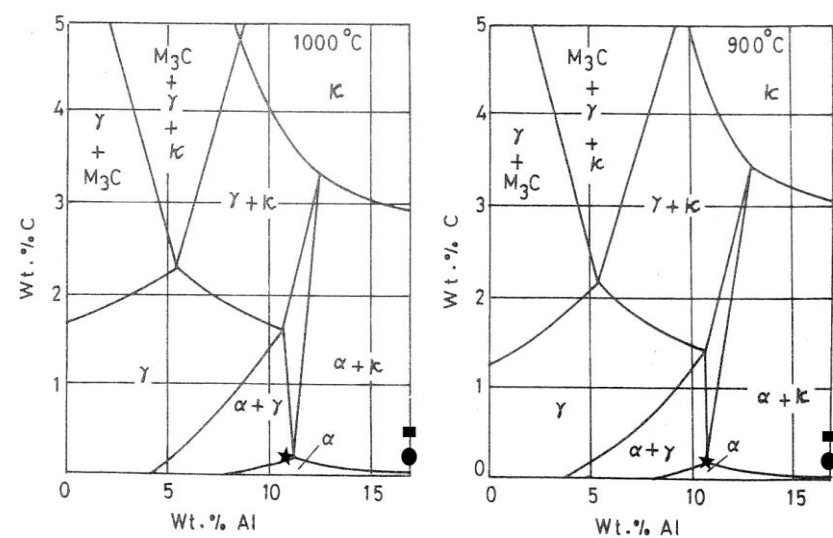
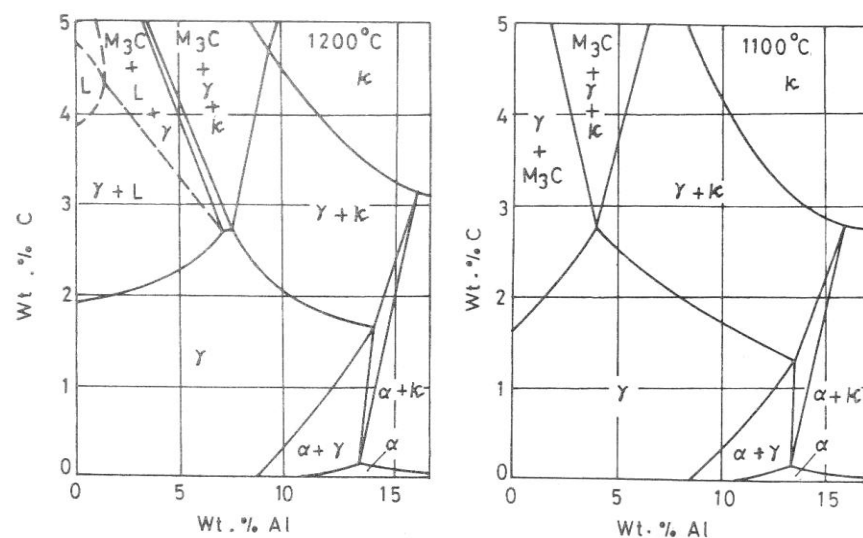
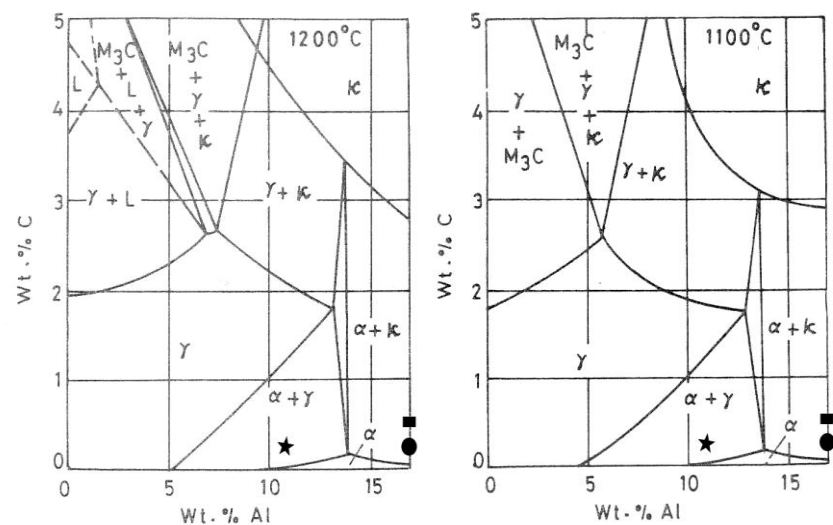
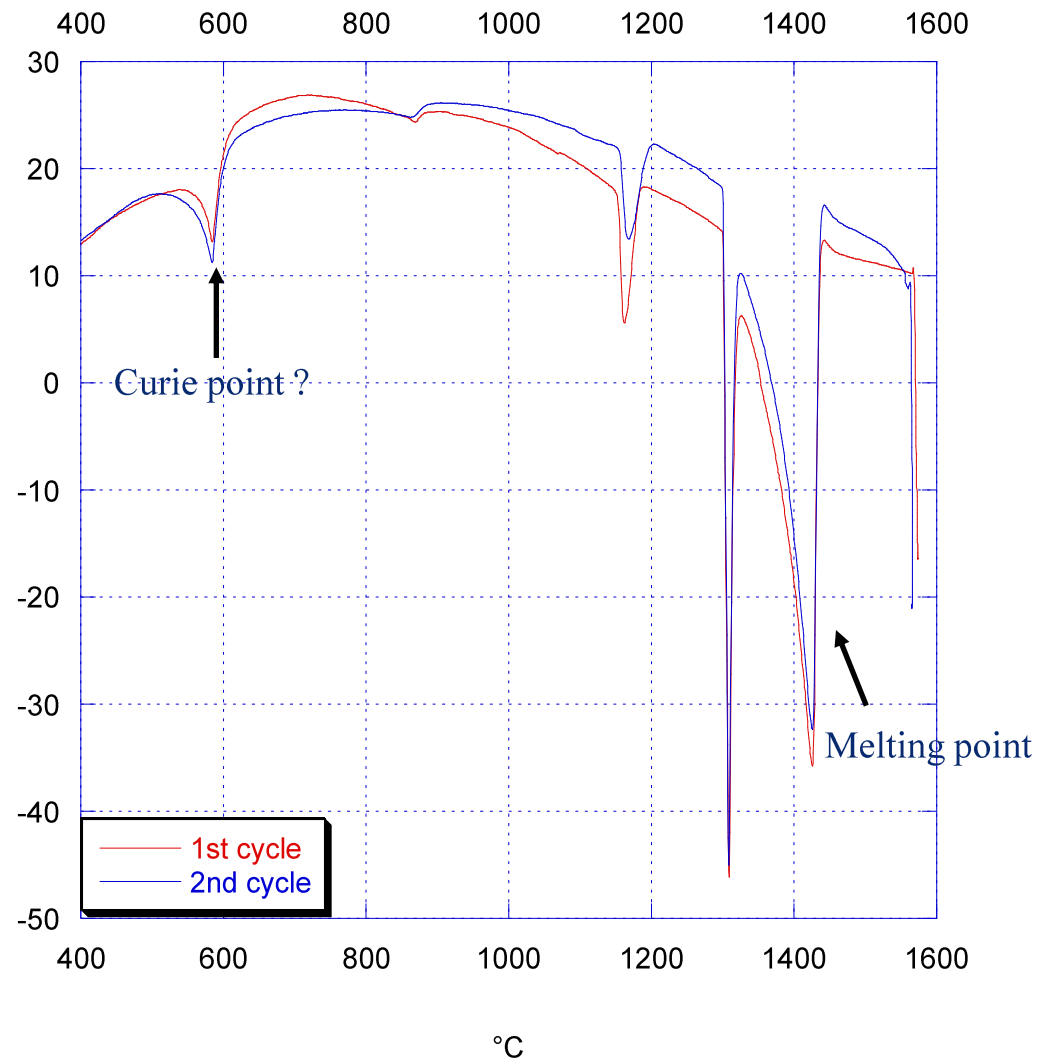


Figure 6 Al-C-Fe-Mn Isothermal Sections at 20 Wt.% Mn

Figure 7 Al-C-Fe-Mn Isothermal Sections at 30 Wt.% Mn

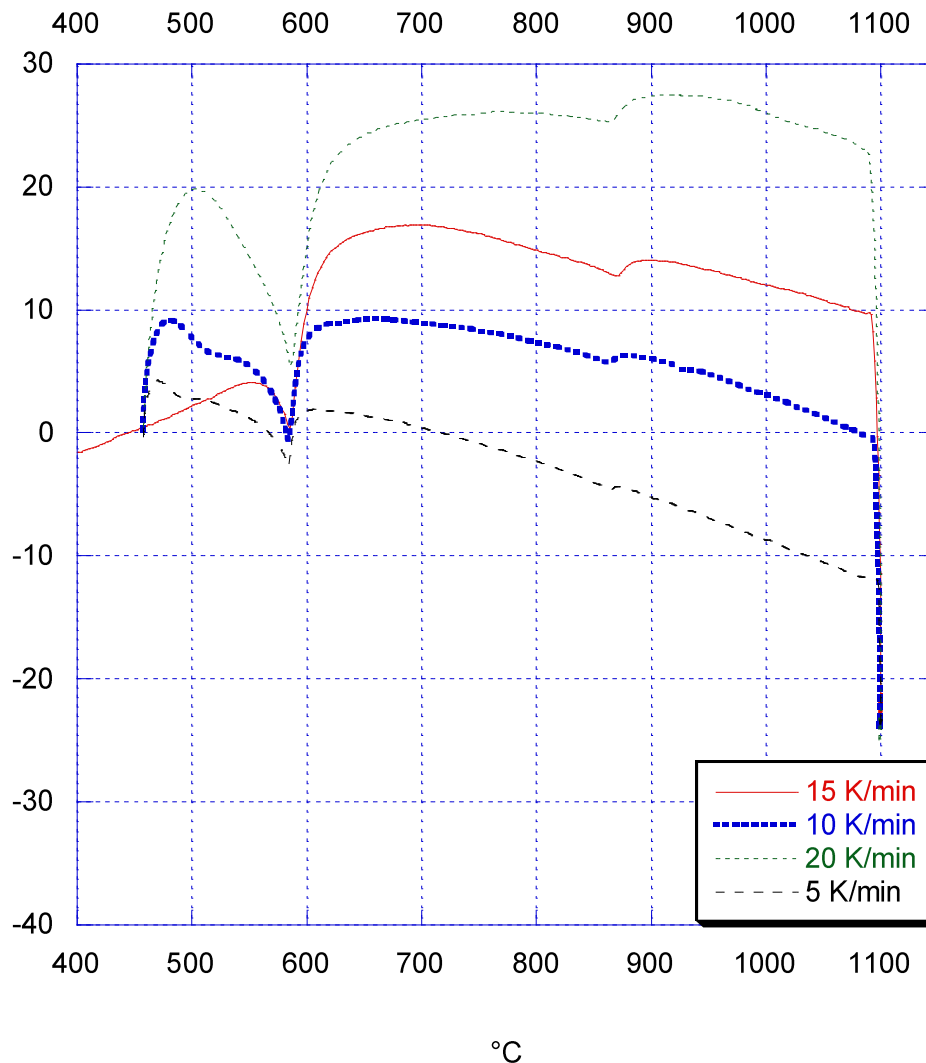
■ Alloy E
 ● Alloy D
 ★ Alloy C

- DTA experiments Alloy E – heating up to 1575°C)

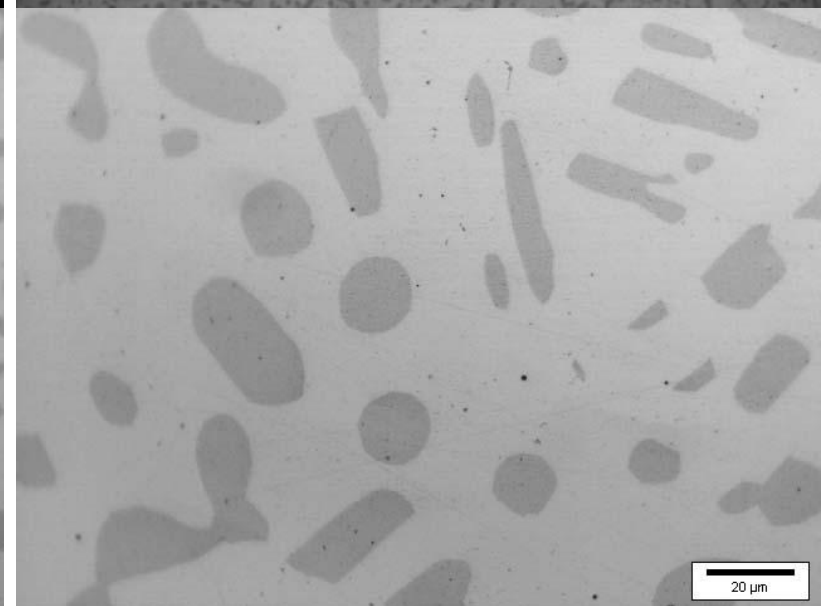
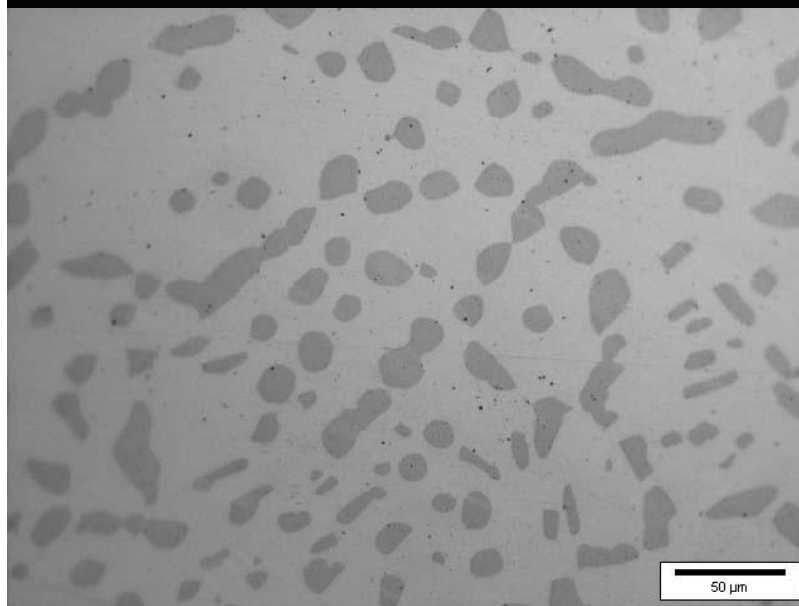
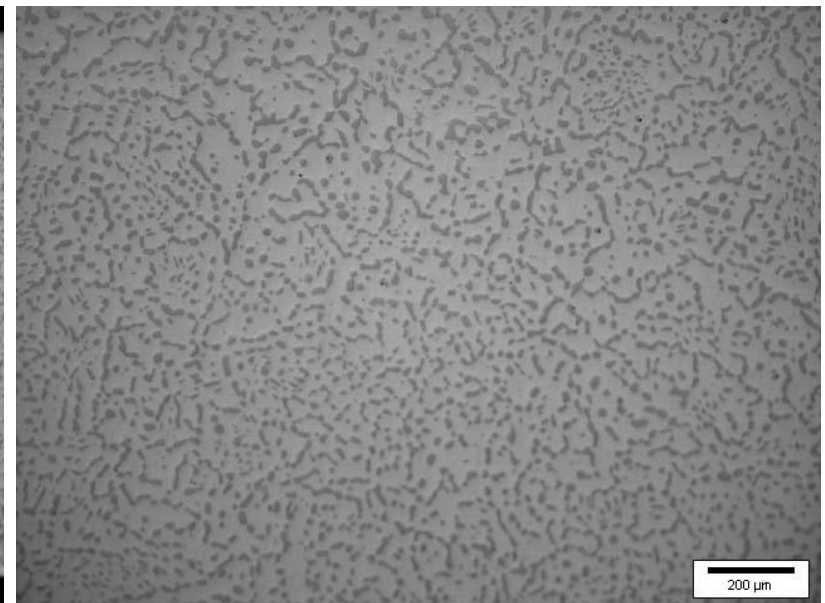
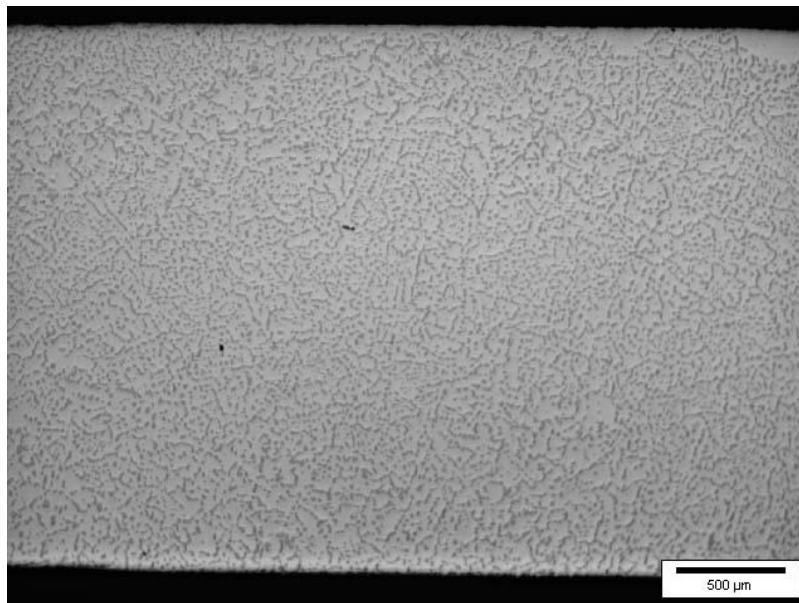


- DTA experiments

Specimen E 4 cycles – heating
(between 450 – 1100°C)



E



- Future work

Heat treatments → Identification of phases

Electron Probe Microanalysis → Identification of phases

Optical Microscopy → Different etchants (GB)

Transmission Electron Microscopy → Order-disorder

Differential Thermal Analysis → Different cooling rates