

Selective carbide etching of 25 wt% Cr white cast iron for wear application



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Introduction and Background

- HCWCI - used in mining industry as lining material
 - ASTM A532 Class III
 - Crushers and Ball Mills
- High abrasion wear and corrosion resistance
 - high amount of eutectic and precipitated carbides
- Size, type and distribution of the carbides – contribute to the properties





- Liner high wear rates
- Breaking and Cracking



- Costs in downtime, repair and relining costs
- Affect milling and energy efficiency
- This prompt need to extend the liner life
 - Parameters : overheating temperature and pouring temperature, holding time, chemical composition
 - Introduction of carbide forming elements : Nb and V
 - Charge materials, refining treatment, and wall thickness of the casting



Aim

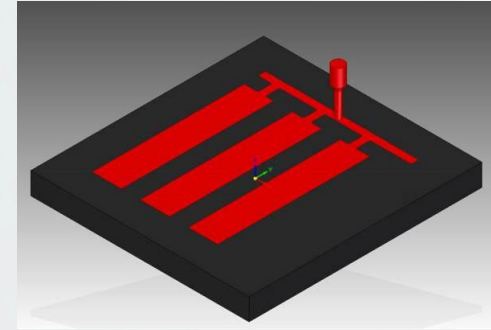
- To investigate the effect of vanadium (1.5 - 2.0 wt% V) and niobium (0.3 - 0.35 wt% Nb) on the microstructure of 25 wt% Cr high chromium white cast iron
- To analyse and compare the hardness and wear resistance of V & Nb alloyed HCWCI with the 25 wt% Cr industrial reference white cast iron

Assess the ability of selective colour etchant to clearly reveal the carbides in the HCWCI alloys

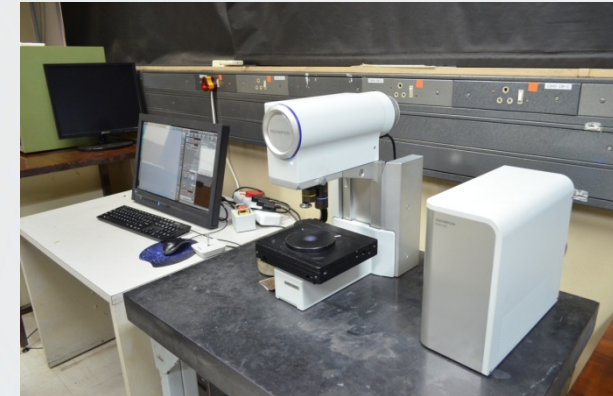
Experimental Procedure



Alloy	C	Si	Mn	Cr	Nb	V
HCWCI	2.5 - 2.9	1.0 - 1.60	0.5 - 0.8	25.0 - 28.0	0.10	0.10
HCWCI + Nb	2.5 - 2.9	1.0 - 1.60	0.5 - 0.8	25.0 - 28.0	0.30 - 0.35	-
HCWCI + V	2.5 - 2.9	1.0 - 1.60	0.5 - 0.8	25.0 - 28.0	-	1.5 - 2.0

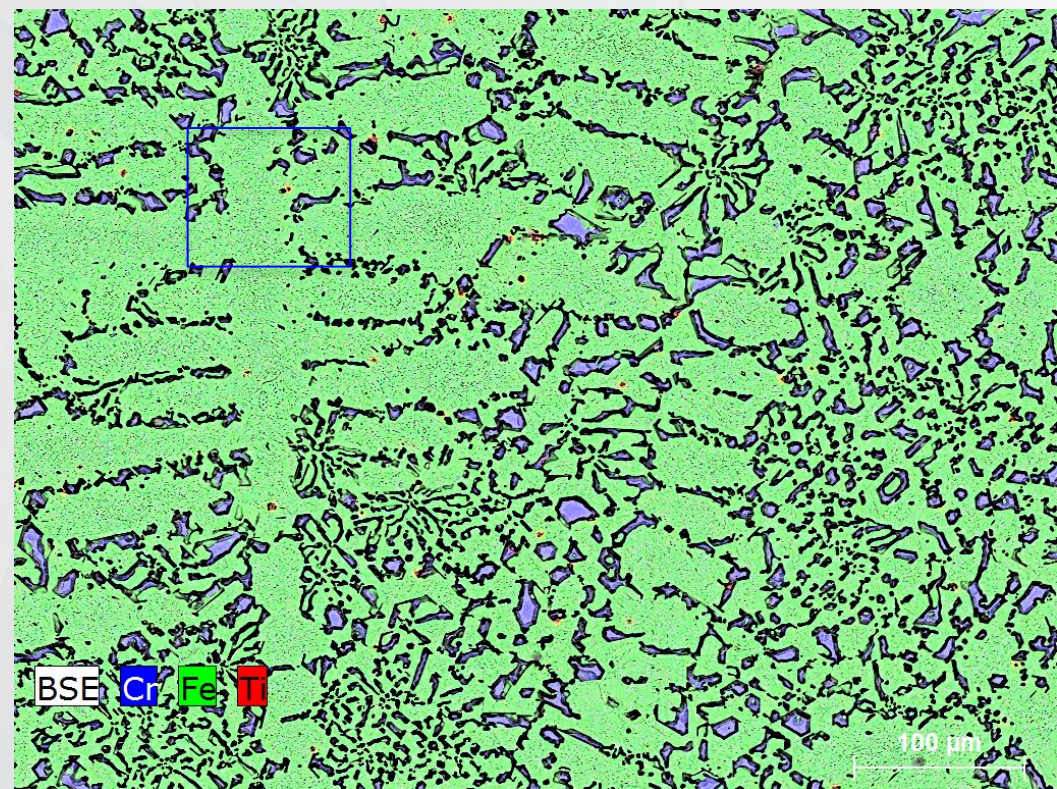
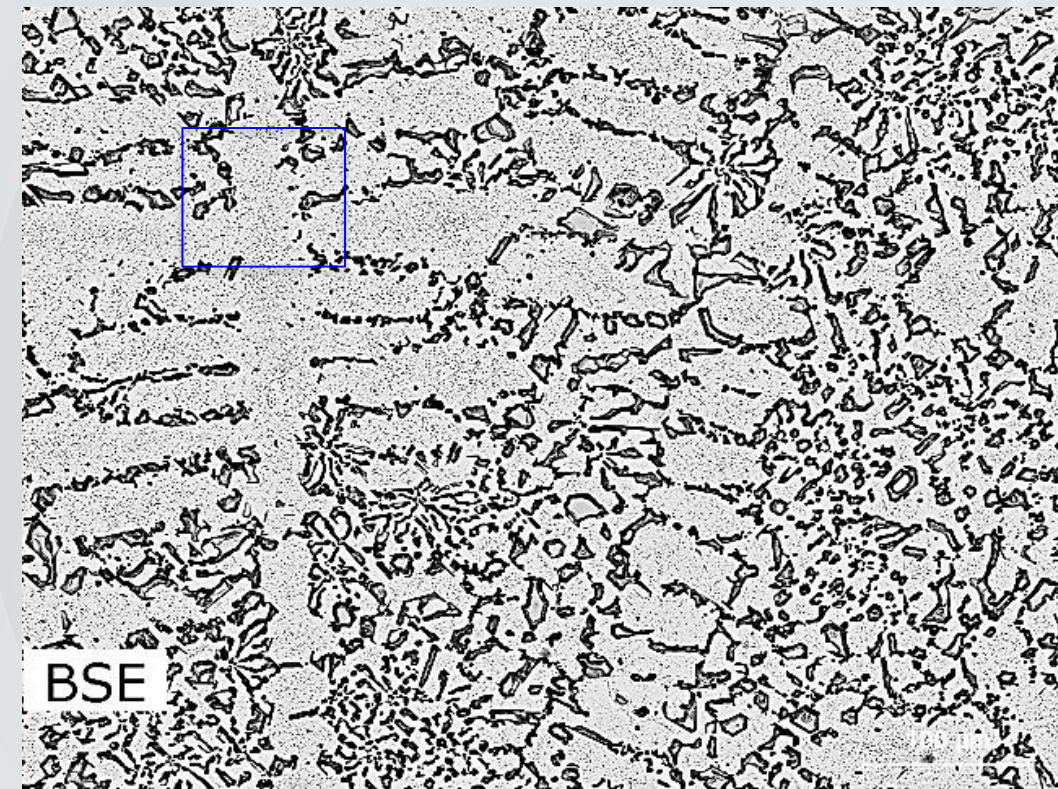


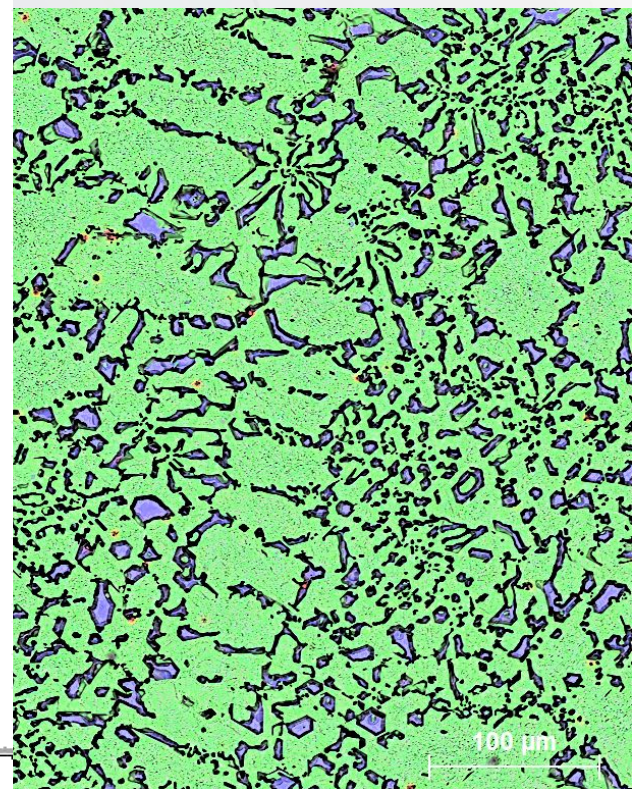
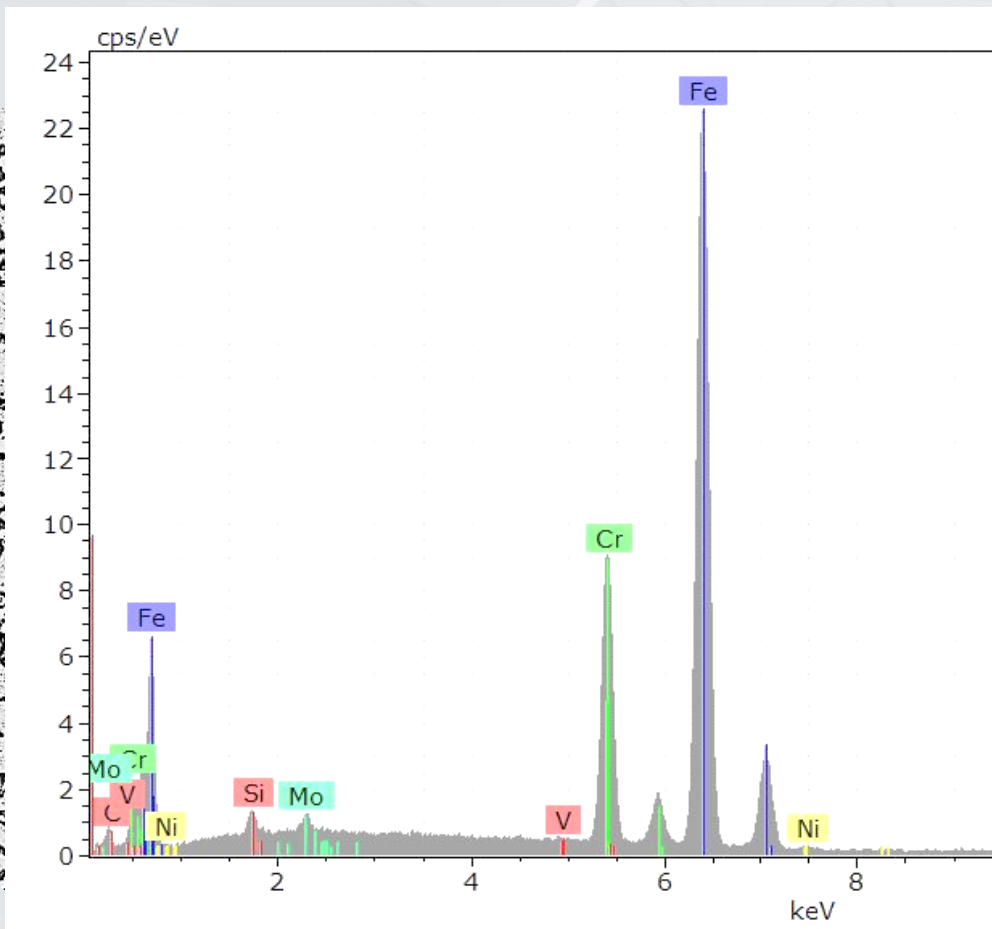
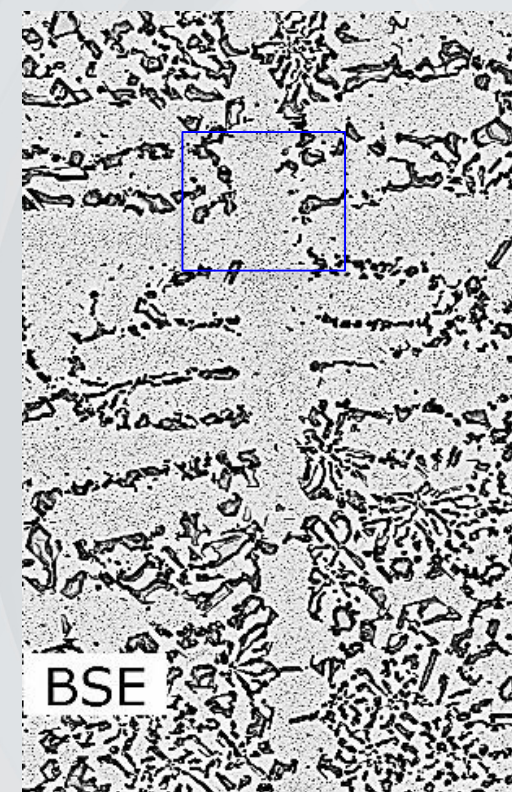
- Casting
- Ground
- Polished
- SEM analysis
 - Zeiss EVO-MA15 SEM
- Microstructure
 - Olympus DSX 510

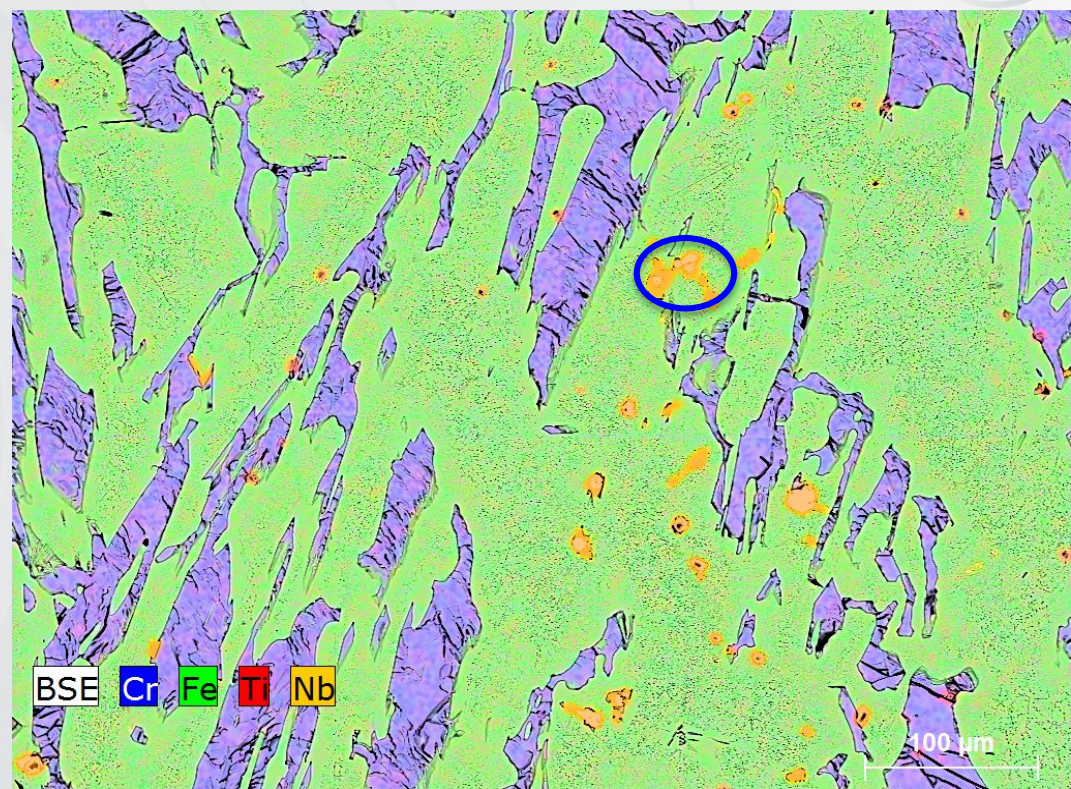




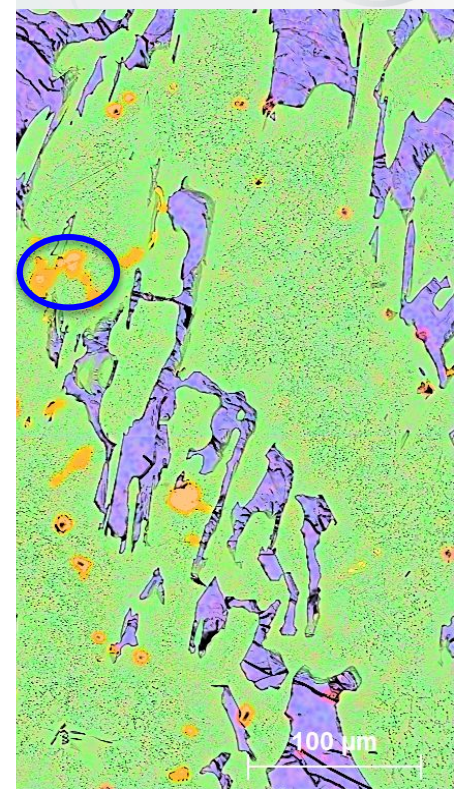
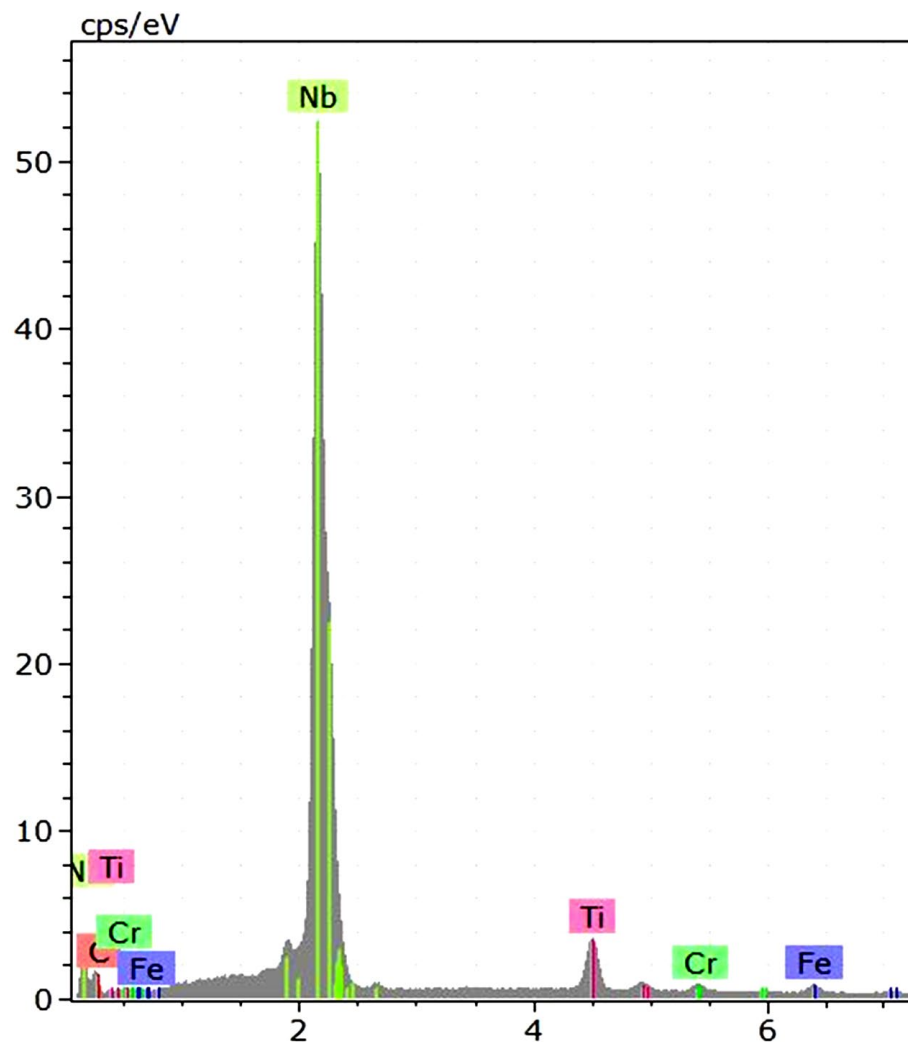
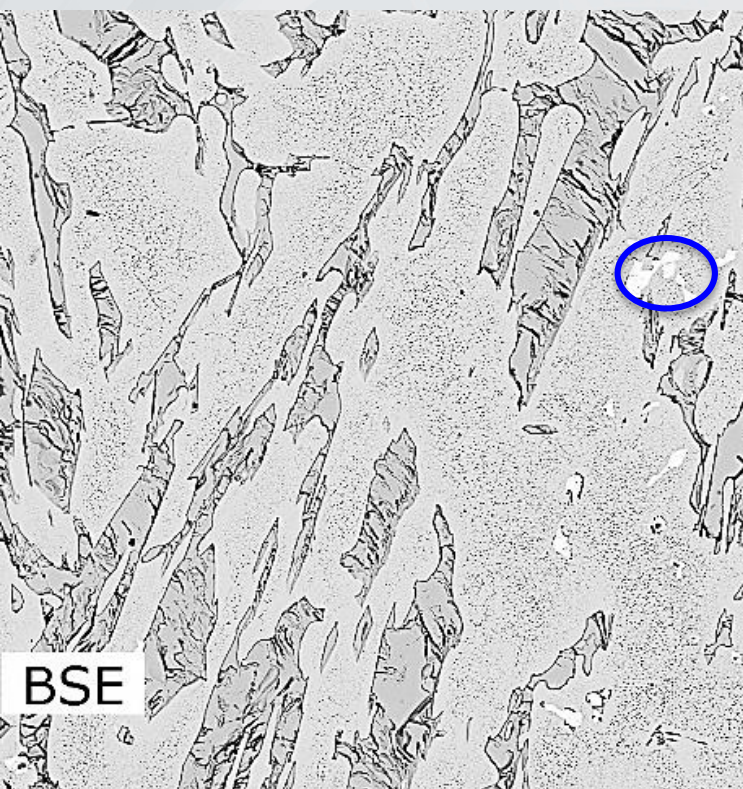
- Alkaline Sodium Picrate (APS): 100ml water, 2g Picric acid, 25g NaOH; use at 90-100°C or at 6V DC for 10s
- Groesbeck's : 100ml water, 4g NaOH, 4g KMnO_4 use at 20°C
- Murakami's : 100ml water, 10g NaOH, 10g $\text{K}_3\text{Fe}(\text{CN})_6$ use at 20°C
- 10% Ammonium Persulfate (ASP): 100ml water, 10g $(\text{NH}_4)_2\text{S}_2\text{O}_8$ at 6V DC for 10s
- 1% CrO_3 : 100ml water and 1g CrO_3 at 6V DC for 10s

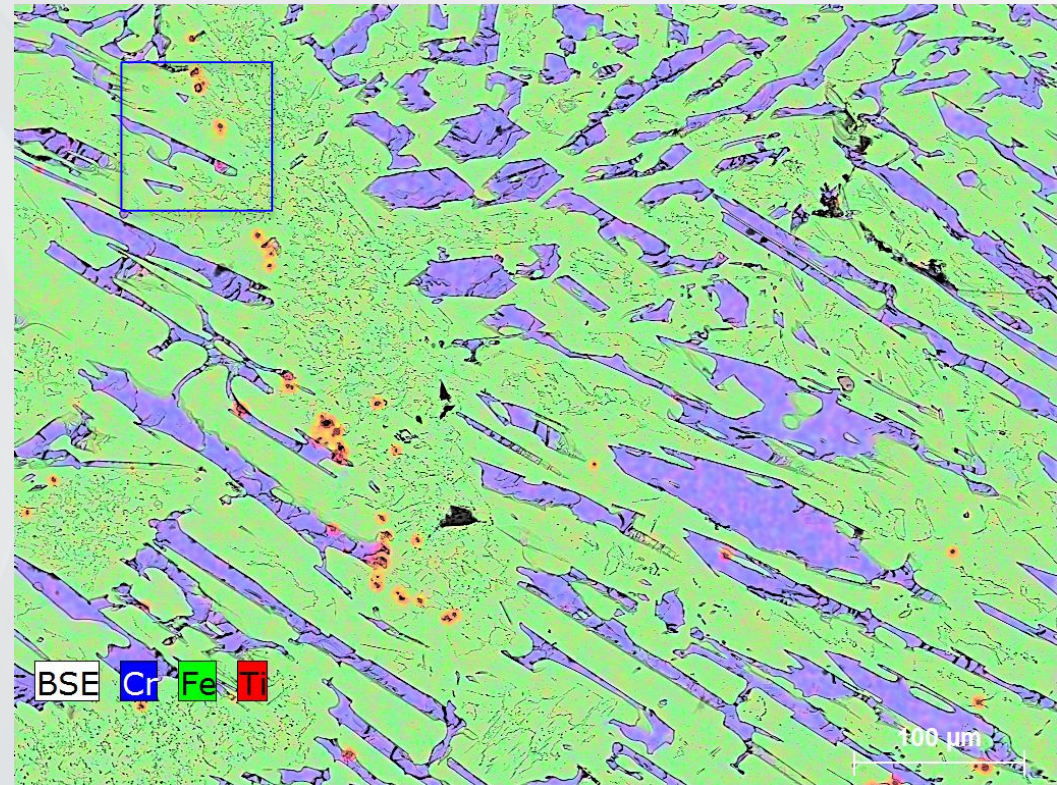
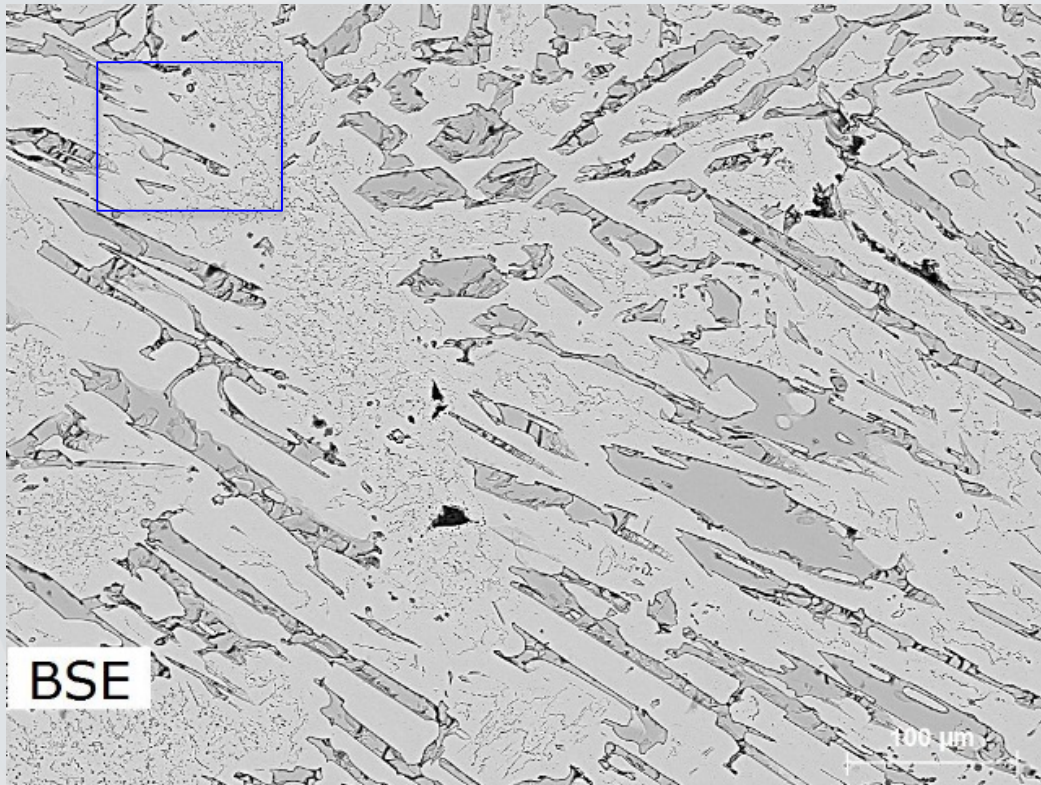


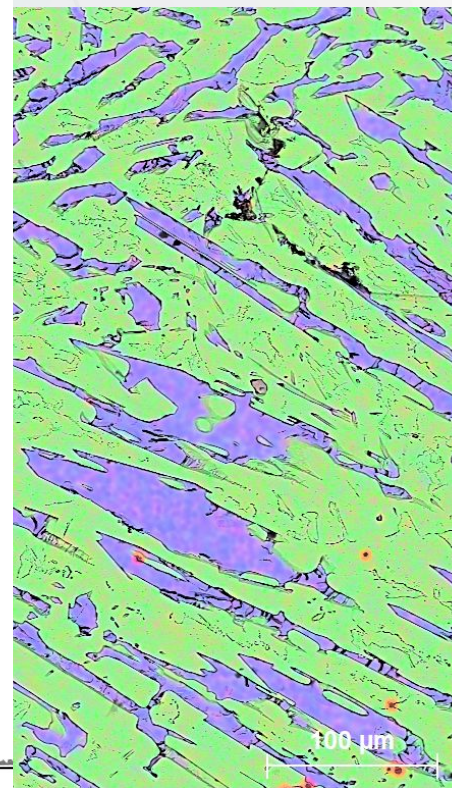
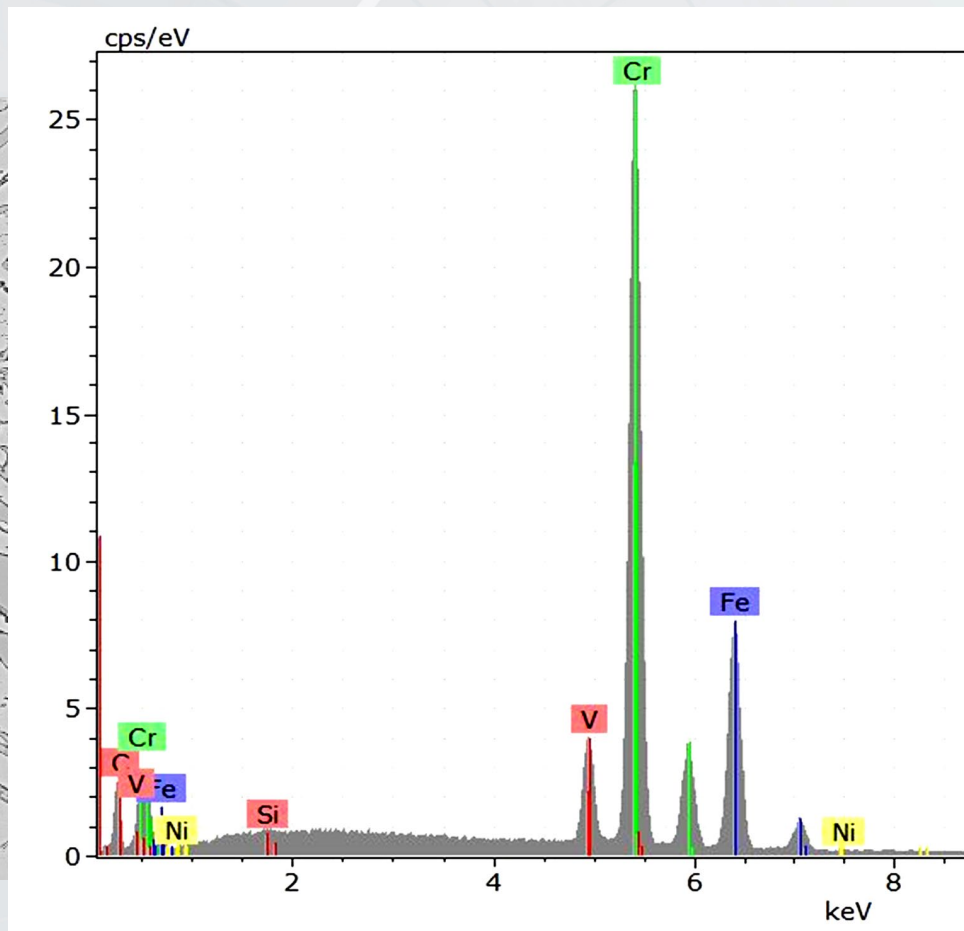
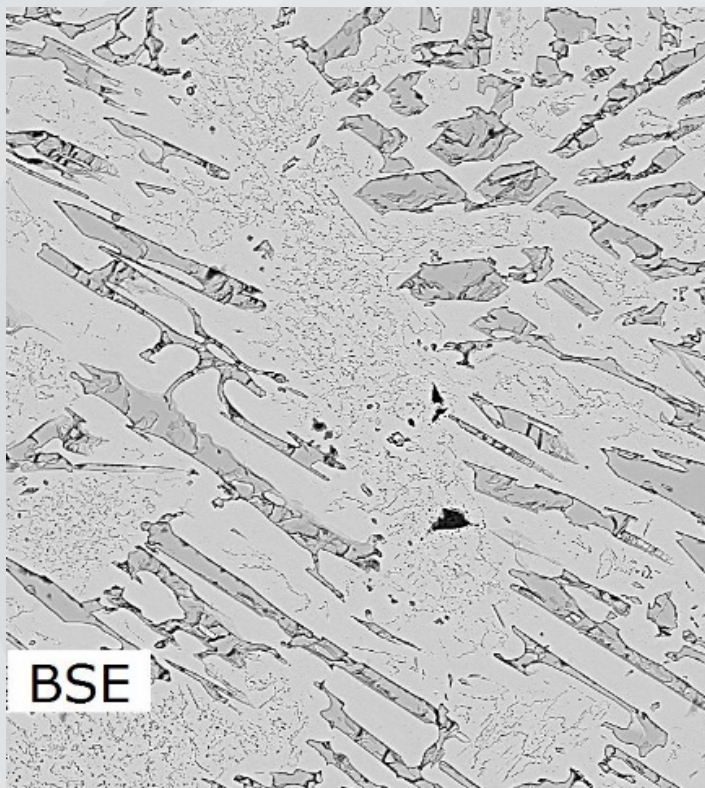


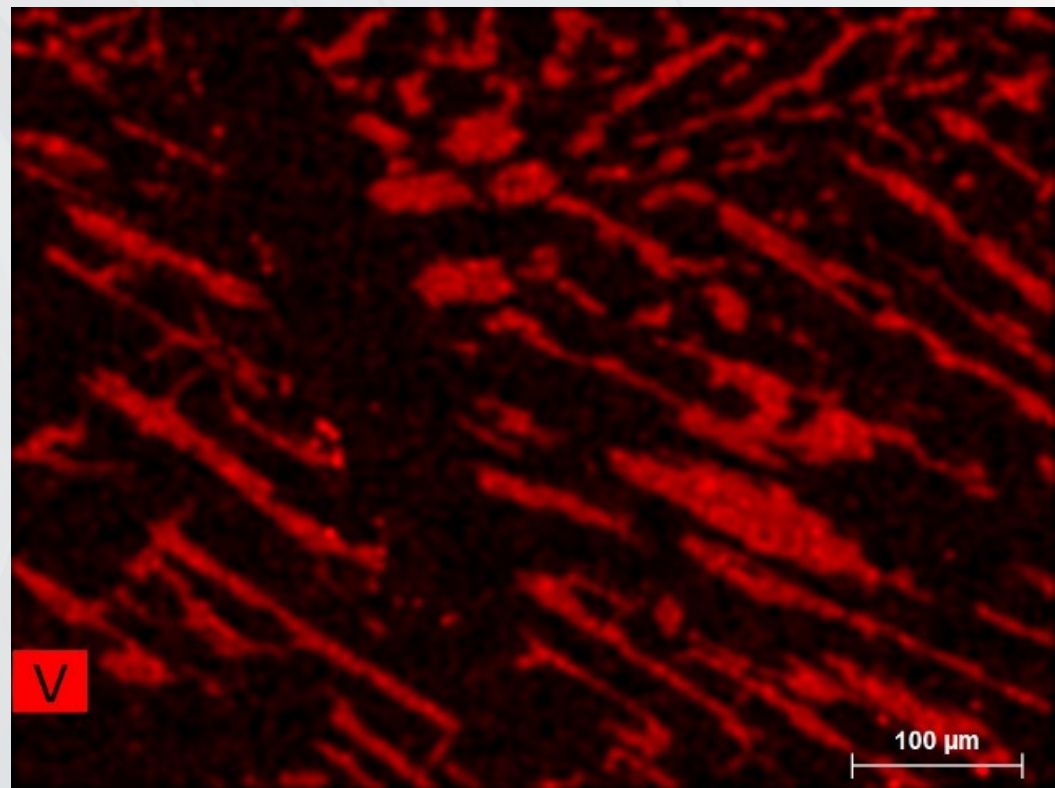
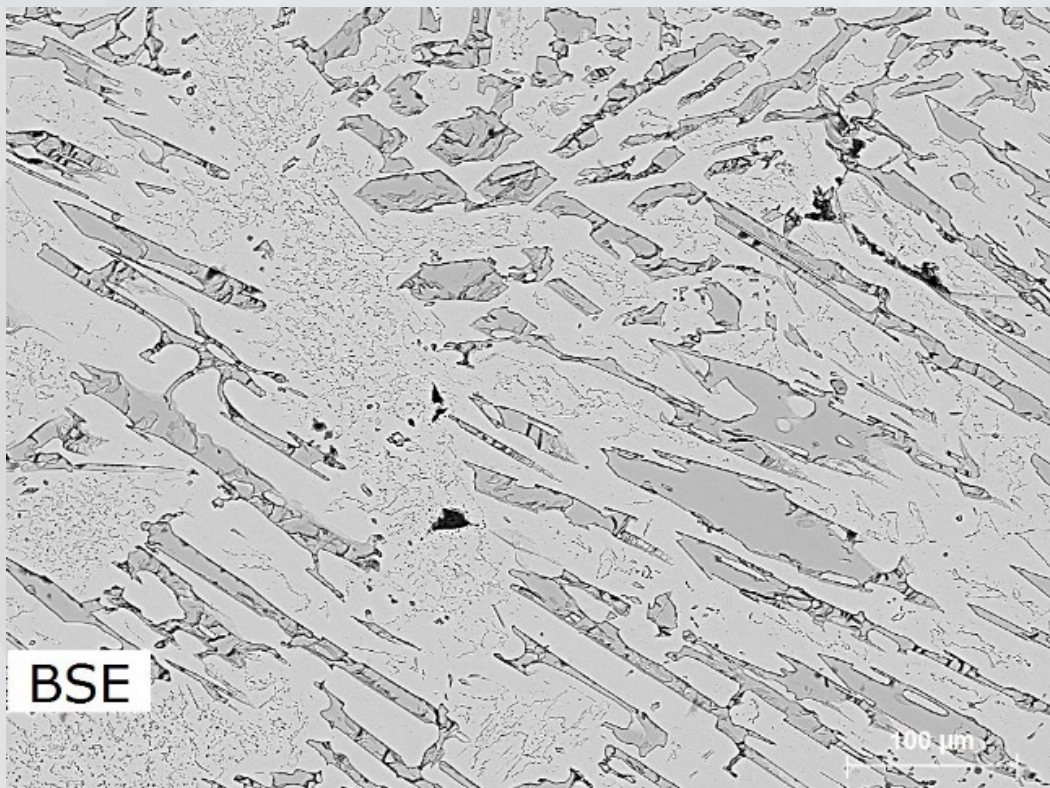


SEM of HCWC + Nb





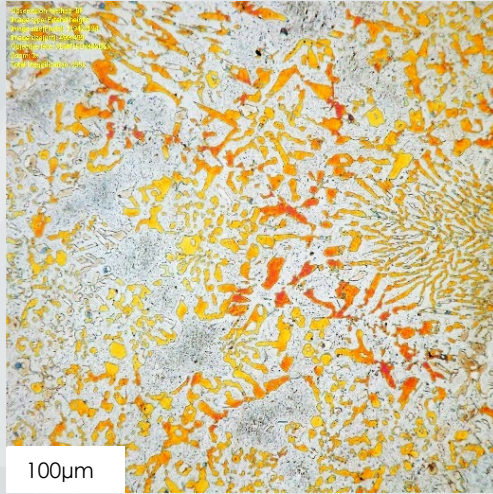




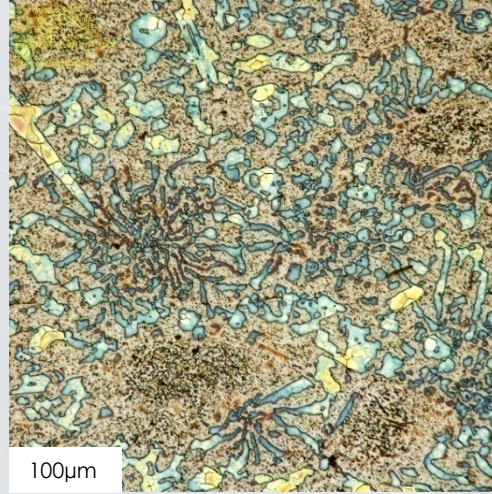
Selective Colour etching of HCWCI



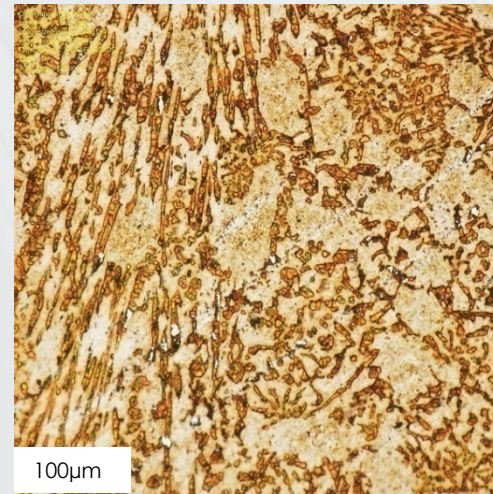
Groesbeck's



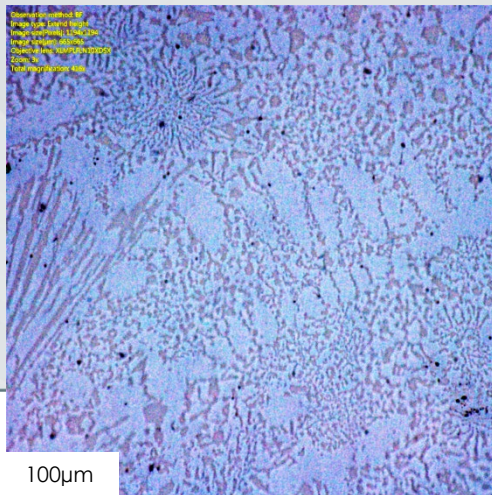
Murakami's



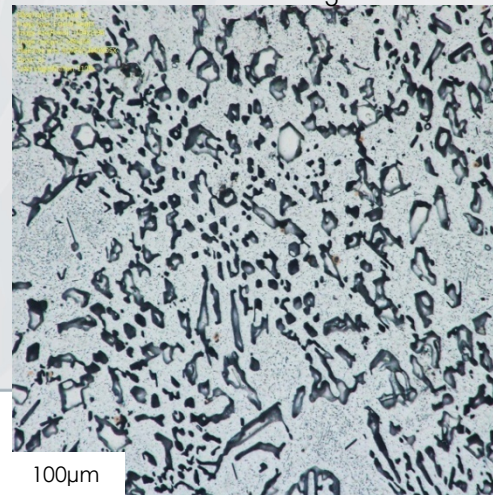
ASP



10%APS



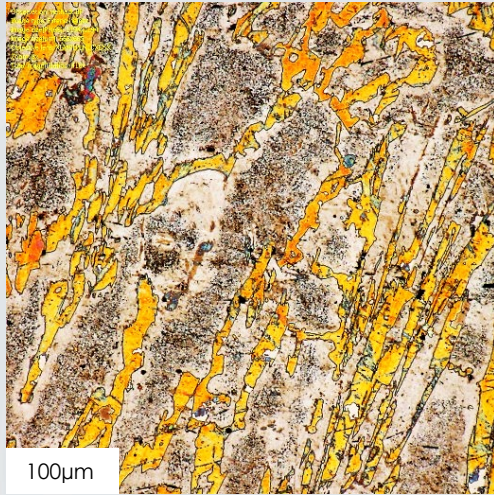
1%CrO₃



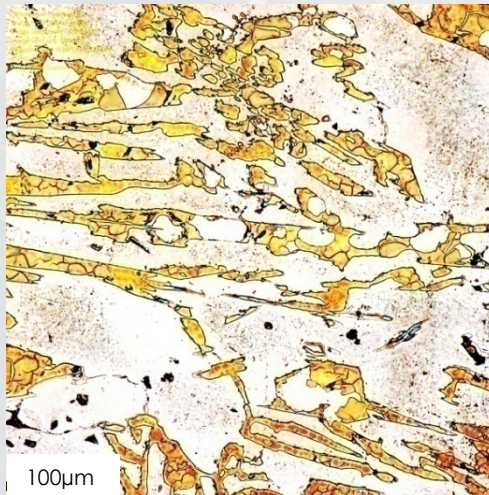
Selective Colour etching of HCWCI + Nb



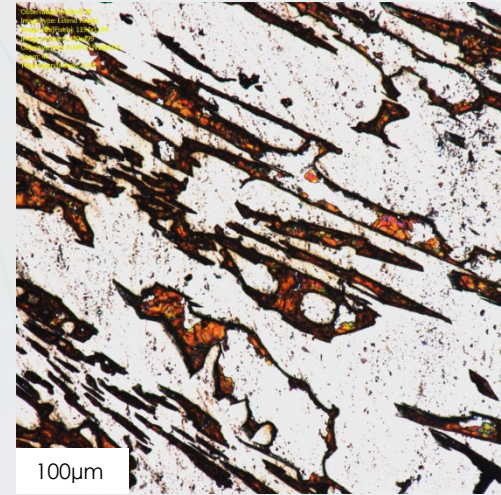
Groesbeck's



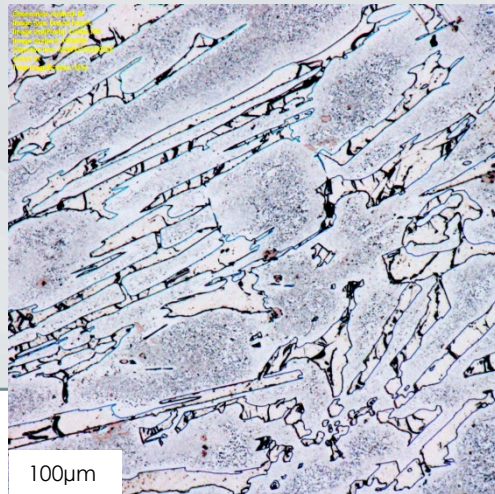
Murakami's



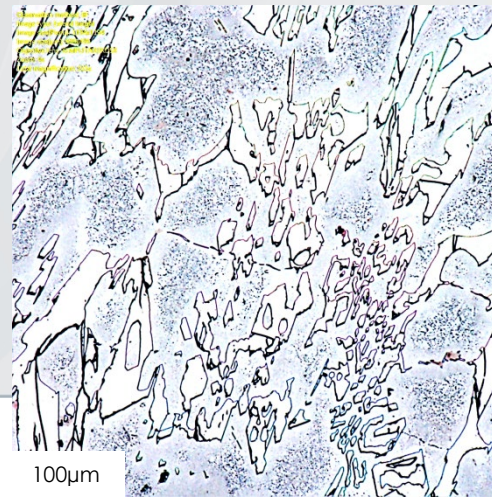
ASP



10%APS



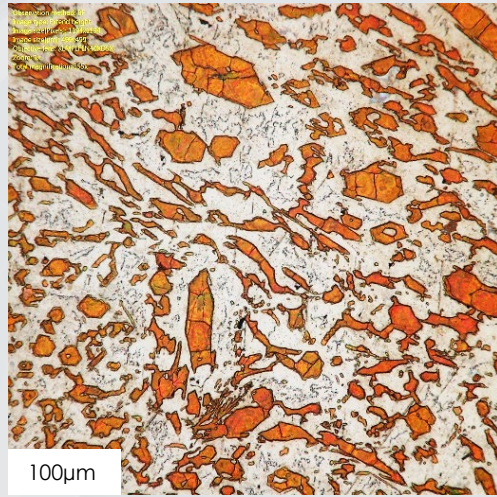
1%CrO₃



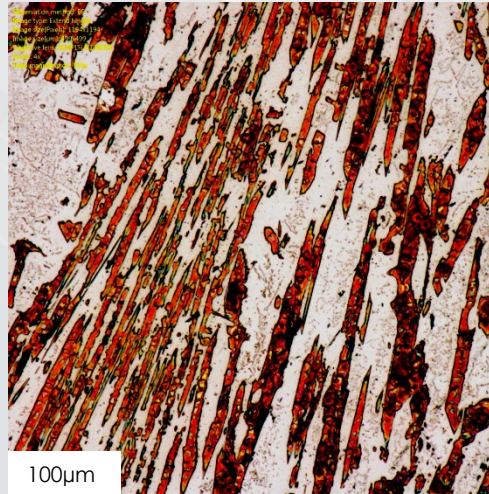
Selective Colour etching of HCWCI + V



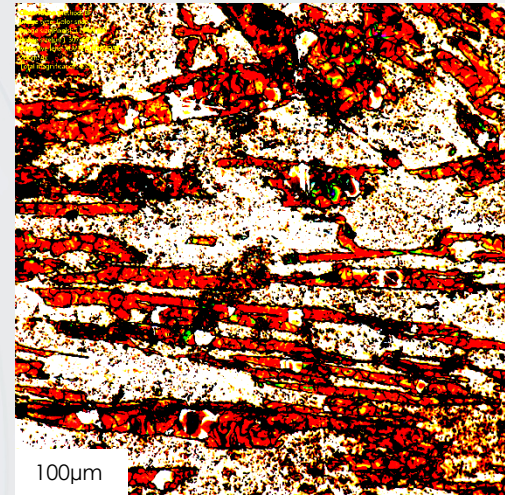
Groesbeck's



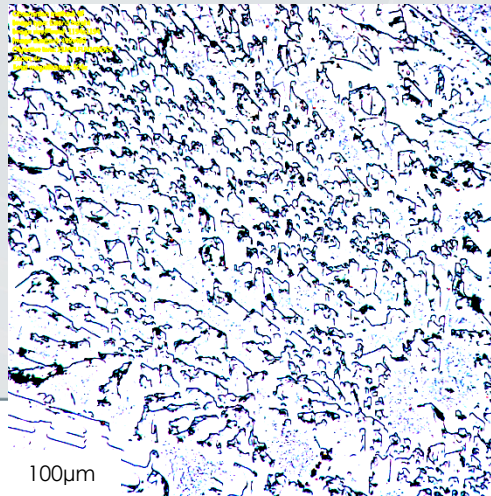
Murakami's



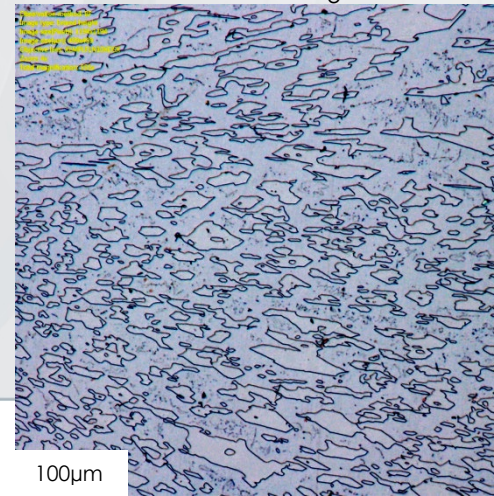
ASP



10%APS



1%CrO₃



Summary of the effects of each etchant on the carbides



Etchant	Primary carbides and Secondary carbides		
	HCWCI	HCWCI+ Nb	HCWCI+V
Groesbeck's	Colour	Colour	Colour
Murakami's	Colour	Colour	Colour
ASP	Colour	Colour	Colour
10%APS	Outlined	Outlined	Outlined
1%CrO ₃	Outlined	Outlined	Outlined



- Groesbeck's and Murakami's showed strong colouring effect of the carbides in all the alloys. Best for colouring carbides
- Though ASP showed strong colouring effect of the carbides in all the alloys, there were sections that were faint coloured
- 10% APS and 1% CrO_3 outlined the carbides in all the alloys. Best for outlining carbides



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Thank You



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