

CHAPTER 6 - REFERENCES

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APPENDIX A - CARBIDE DIAMETER MEASUREMENTS

THE MEASURED DIAMETERS OF THIRTEEN CARBIDE PARTICLES IN HEAT 1
AFTER QUENCHING FROM 1000°C, 1050°C, 1075°C AND 1100°C.

MEASURED CARBIDE DIAMETER, μm				
	Austenitised at 1000°C	Austenitised at 1050°C	Austenitised at 1075°C	Austenitised at 1100°C
	1.20	0.80	0.80	0.67
	1.47	1.20	0.80	0.53
	0.80	0.67	0.67	0.53
	0.93	0.67	0.93	0.93
	1.07	1.07	1.20	0.80
	1.47	1.20	0.67	0.80
	1.20	0.93	0.67	0.53
	0.93	0.93	0.93	0.93
	1.33	0.67	0.80	0.93
	3.20	0.93	0.67	1.33
	1.60	0.93	1.60	0.67
	0.67	1.07	1.07	0.53
	0.80	1.07	0.53	1.20
AVERAGE	1.28	0.93	0.87	0.80
Smallest	0.67	0.67	0.53	0.53
Largest	3.20	1.20	1.60	1.33



**THE MEASURED DIAMETERS OF THIRTEEN CARBIDE PARTICLES IN HEAT 2
AFTER QUENCHING FROM 1000°C, 1050°C, 1075°C AND 1100°C.**

MEASURED CARBIDE DIAMETER, μm			
Austenitised at 1000°C	Austenitised at 1050°C	Austenitised at 1075°C	Austenitised at 1100°C
0.40	0.67	0.67	0.67
0.67	0.67	0.53	0.40
0.53	0.40	0.67	0.53
0.93	0.53	0.53	0.67
0.80	0.67	0.53	0.53
1.07	0.40	0.00	0.67
0.67	0.40	0.00	0.67
1.33	0.40	0.00	0.53
0.93	0.40	0.00	0.67
0.53	0.80	0.00	0.00
0.67	0.67	0.00	0.00
0.53	0.67	0.00	0.00
0.67	0.93	0.00	0.00
AVERAGE	0.75	0.58	0.59
Smallest	0.40	0.40	0.40
Largest	1.33	0.93	0.67

APPENDIX B - ASTM GRAIN SIZE NUMBER

ASTM GRAIN SIZE NUMBER (*G*) OF HEAT 1 AS A FUNCTION OF AUSTENITISING TEMPERATURE

AUSTENISED AT 1075°C AND OIL QUENCHED					
Measurements	<i>L_T</i>	<i>P</i>	<i>M</i>	<i>L_L</i>	<i>G</i>
1	122	39	240	0.0130	9.235
2	122	40	240	0.0127	9.309
3	123	34	240	0.0151	8.816
4	122	38	240	0.0134	9.160
5	122	40	240	0.0127	9.309
95% confidence interval					0.25
Average ASTM grain size number, <i>G</i>					9.166
AUSTENISED AT 1100°C AND OIL QUENCHED					
Measurements	<i>L_T</i>	<i>P</i>	<i>M</i>	<i>L_L</i>	<i>G</i>
1	139	14	780	0.0127	9.304
2	139	16	780	0.0111	9.689
3	139	12	780	0.0149	8.859
4	139	13	780	0.0137	9.090
5	139	15	780	0.0119	9.503
95% confidence interval					0.41
Average ASTM grain size number, <i>G</i>					9.289
AUSTENISED AT 1130°C AND OIL QUENCHED					
Measurements	<i>L_T</i>	<i>P</i>	<i>M</i>	<i>L_L</i>	<i>G</i>
1	187	19	600	0.0164	8.572
2	185	19	600	0.0162	8.603
3	185	23	600	0.0134	9.154
4	189	14	600	0.0225	7.660
5	185	21	600	0.0147	8.892
95% confidence interval					0.7
Average ASTM grain size number, <i>G</i>					8.576
AUSTENISED AT 1150°C AND OIL QUENCHED					
Measurements	<i>L_T</i>	<i>P</i>	<i>M</i>	<i>L_L</i>	<i>G</i>
1	139	18	220	0.0351	6.377
2	139	14	220	0.0451	5.652
3	139	18	220	0.0351	6.377
4	139	18	220	0.0351	6.377
5	139	21	220	0.0301	6.822
95% confidence interval					0.52
Average ASTM grain size number, <i>G</i>					6.321
AUSTENISED AT 1175°C AND OIL QUENCHED					
Measurements	<i>L_T</i>	<i>P</i>	<i>M</i>	<i>L_L</i>	<i>G</i>
1	146	8	260	0.0702	4.377
2	140	7	260	0.0769	4.113
3	140	6	260	0.0897	3.668
4	140	6	260	0.0897	3.668
5	140	7	260	0.0769	4.113
95% confidence interval					0.39
Average ASTM grain size number, <i>G</i>					3.988



AUSTENISED AT 1200°C AND OIL QUENCHED					
Measurements	L_T	P	M	L_L	G
1	142	19	60	0.1246	2.722
2	142	21	60	0.1127	3.011
3	142	14	60	0.1690	1.841
4	142	21	60	0.1127	3.011
5	142	23	60	0.1029	3.274
95% confidence interval					0.69
Average ASTM grain size number, G					2.772

**ASTM GRAIN SIZE NUMBER (G) OF HEAT 2 AS A FUNCTION OF
AUSTENITISING TEMPERATURE**

AUSTENISED AT 1075°C AND OIL QUENCHED					
Measurements	L_T	P	M	L_L	G
1	165	52	260	0.0122	9.425
2	165	50	260	0.0127	9.312
3	165	52	260	0.0122	9.425
4	165	53	260	0.0120	9.480
5	165	49	260	0.0130	9.254
95% confidence interval					0.12
Average ASTM grain size number, G					9.379
AUSTENISED AT 1100°C AND OIL QUENCHED					
Measurements	L_T	P	M	L_L	G
1	141	34	320	0.0130	9.252
2	141	29	320	0.0152	8.793
3	141	28	320	0.0157	8.692
4	141	29	320	0.0152	8.793
5	141	27	320	0.0163	8.587
95% confidence interval					0.3
Average ASTM grain size number, G					8.823
AUSTENISED AT 1130°C AND OIL QUENCHED					
Measurements	L_T	P	M	L_L	G
1	148	20	250	0.0296	6.869
2	148	22	250	0.0269	7.144
3	148	23	250	0.0257	7.272
4	148	18	250	0.0329	6.565
5	148	19	250	0.0312	6.721
95% confidence interval					0.4
Average ASTM grain size number, G					6.914
AUSTENISED AT 1150°C AND OIL QUENCHED					
Measurements	L_T	P	M	L_L	G
1	145	10	260	0.0558	5.041
2	145	9	260	0.0620	4.737
3	145	12	260	0.0464	5.567
4	145	9	260	0.0620	4.737
5	145	11	260	0.0507	5.316
95% confidence interval					0.45
Average ASTM grain size number, G					5.080



AUSTENISED AT 1175°C AND OIL QUENCHED					
Measurements	L_T	P	M	L_L	G
1	144	5	240	0.1200	2.830
2	144	6	240	0.1000	3.356
3	144	7	240	0.0857	3.801
4	144	7	240	0.0857	3.801
5	144	6	240	0.1000	3.356
95% confidence interval					0.5
Average ASTM grain size number, G					3.429
AUSTENISED AT 1200°C AND OIL QUENCHED					
Measurements	L_T	P	M	L_L	G
1	145	5	240	0.1208	2.810
2	145	7	240	0.0863	3.781
3	145	5	240	0.1208	2.810
4	145	7	240	0.0863	3.781
5	145	5	240	0.1208	2.810
95% confidence interval					0.7
Average ASTM grain size number, G					3.199

APPENDIX C - VICKERS HARDNESS MEASUREMENTS

MEASURED HARDNESS VALUES OF HEAT 1

HEAT TREATMENT CONDITION	VICKERS HARDNESS WITH A 10 KG LOAD, HV10					AVERAGE	95% CONF. LEVEL
AS-RECEIVED	216	206	214	207	203	209	7
AUSTENITISED AT 1000°C							
Austenitised and oil quenched	660	665	650	670	676	664	12
AUSTENITISED AT 1050°C							
Austenitised and oil quenched	672	688	674	687	669	678	9
AUSTENITISED AT 1075°C							
Austenitised and oil quenched	680	689	675	695	680	684	10
AUSTENITISED AT 1100°C							
Austenitised and oil quenched	658	656	654	642	655	653	8
Austenitised, oil quenched and sub-zero treated	802	800	778	810	793	797	15
AUSTENITISED AT 1130°C							
Austenitised and oil quenched	467	481	477	470	476	474	7
Austenitised, oil quenched and sub-zero treated	737	748	749	727	736	739	11
Austenitised, oil quenched, sub-zero treated and tempered at 550°C	677	665	675	678	672	673	6
Austenitised, oil quenched, sub-zero treated and tempered at 700°C	365	371	380	376	369	372	7
AUSTENITISED AT 1150°C							
Austenitised and oil quenched	308	301	309	314	310	308	6
Austenitised, oil quenched and tempered at 550°C	292	296	308	292	308	299	10
Austenitised, oil quenched and tempered at 650°C	359	350	380	363	360	362	14
Austenitised, oil quenched and tempered at 750°C	550	552	570	569	568	560	10
Austenitised, oil quenched and double tempered at 650°C	492	510	511	498	494	500	9
Austenitised, oil quenched and double tempered at 750°C	315	313	312	320	328	320	7
Austenitised, oil quenched and sub-zero treated	698	695	698	720	689	700	15
Austenitised, oil quenched, sub-zero treated and tempered at 550°C	637	650	653	648	668	651	14
Austenitised, oil quenched, sub-zero treated and tempered at 700°C	380	373	378	381	379	378	4
AUSTENITISED AT 1175°C							
Austenitised and oil quenched	276	281	282	276	280	279	4
Austenitised, oil quenched and tempered at 550°C	292	290	271	294	271	284	14
Austenitised, oil quenched and tempered at 650°C	417	397	415	398	416	409	13
Austenitised, oil quenched and double tempered at 550°C	286	307	293	307	284	295	14
Austenitised, oil quenched and double tempered at 650°C	402	390	384	378	382	388	9
Austenitised, oil quenched and sub-zero treated	713	714	686	690	705	702	16
Austenitised, oil quenched, sub-zero treated and tempered at 550°C	653	641	658	642	653	649	9
Austenitised, oil quenched, sub-zero treated and tempered at 700°C	366	371	374	380	368	372	7
AUSTENITISED AT 1200°C							
Austenitised and oil quenched	278	262	282	260	268	270	12

MEASURED HARDNESS VALUES OF HEAT 2

HEAT TREATMENT CONDITION	VICKERS HARDNESS WITH A 10 KG LOAD, HV10					AVERAGE	95% CONF. LEVEL
AS-RECEIVED	197	191	193	199	193	195	4
AUSTENITISED AT 1000°C							
Austenitised and oil quenched	646	628	647	634	638	639	10
AUSTENITISED AT 1050°C							
Austenitised and oil quenched	674	654	656	670	675	665	9
AUSTENITISED AT 1075°C							
Austenitised and oil quenched	667	666	685	684	666	674	12
AUSTENITISED AT 1100°C							
Austenitised and oil quenched	630	635	647	643	639	639	8
Austenitised, oil quenched and sub-zero treated	791	775	774	794	793	785	12
AUSTENITISED AT 1130°C							
Austenitised and oil quenched	615	622	625	618	616	620	4
Austenitised, oil quenched and sub-zero treated	764	745	739	728	730	741	18
Austenitised, oil quenched, sub-zero treated and tempered at 550°C	624	627	630	626	622	626	4
Austenitised, oil quenched, sub-zero treated and tempered at 700°C	332	334	333	330	334	333	2
AUSTENITISED AT 1150°C							
Austenitised and oil quenched	599	620	612	603	611	609	10
Austenitised, oil quenched and tempered at 550°C	505	520	506	518	510	513	9
Austenitised, oil quenched and tempered at 650°C	471	480	495	473	492	482	14
Austenitised, oil quenched and tempered at 750°C	398	402	412	390	400	400	10
Austenitised, oil quenched and double tempered at 650°C	366	357	357	360	362	360	5
Austenitised, oil quenched and double tempered at 750°C	296	297	286	290	299	294	7
Austenitised, oil quenched and sub-zero treated	764	757	758	756	745	756	9
Austenitised, oil quenched, sub-zero treated and tempered at 550°C	635	642	642	655	644	644	9
Austenitised, oil quenched, sub-zero treated and tempered at 700°C	329	330	328	329	334	330	3
AUSTENITISED AT 1175°C							
Austenitised and oil quenched	485	491	485	486	489	488	3
Austenitised, oil quenched and tempered at 550°C	440	447	448	452	445	446	5
Austenitised, oil quenched and tempered at 650°C	465	447	456	446	455	455	8
Austenitised, oil quenched and double tempered at 550°C	517	528	521	525	520	522	5
Austenitised, oil quenched and double tempered at 650°C	334	345	352	342	348	344	6
Austenitised, oil quenched and sub-zero treated	761	729	749	755	759	751	16
Austenitised, oil quenched, sub-zero treated and tempered at 550°C	640	644	630	650	660	647	12
Austenitised, oil quenched, sub-zero treated and tempered at 700°C	323	319	329	330	328	326	6
AUSTENITISED AT 1200°C							
Austenitised and oil quenched	460	457	458	461	460	459	2

APPENDIX D – ADDITIONAL MICROGRAPHS

THE EFFECT OF AUSTENITISING TEMPERATURE ON MICROSTRUCTURE

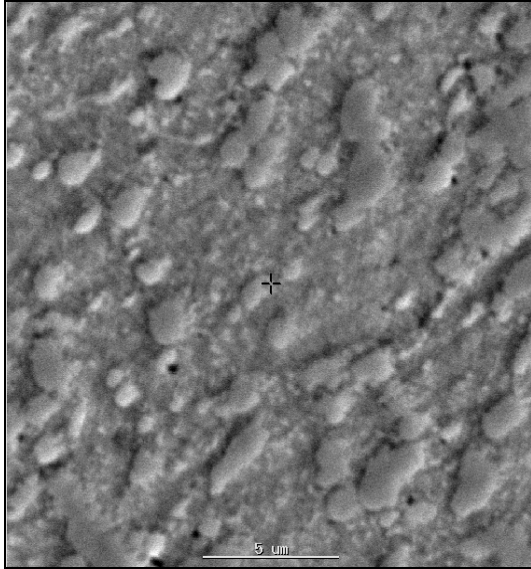


Figure D.1: Scanning electron micrograph of HEAT 1, austenitised at 1000°C for 15 minutes and oil quenched. The microstructure consists of coarse $M_{23}C_6$ carbides in a martensite matrix. (Hardness: 664 ± 12 HV). (Magnification: 500x).

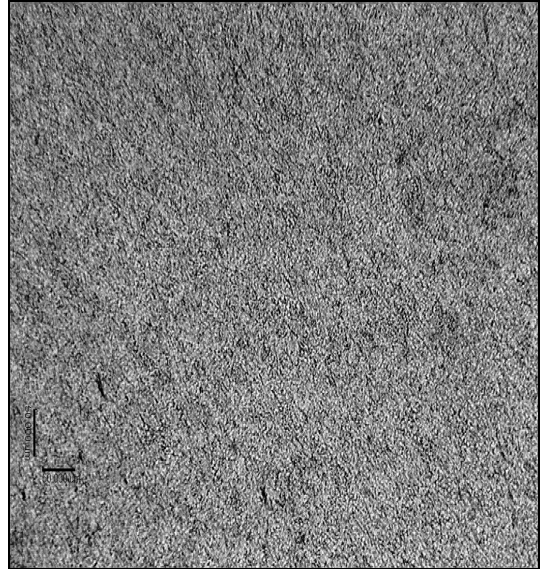


Figure D.2: Optical micrograph of HEAT 2, austenitised at 1000°C for 15 minutes and oil quenched. The microstructure consists of coarse $M_{23}C_6$ carbides in a martensite matrix. (Hardness: 639 ± 10 HV). (Magnification: 100x).

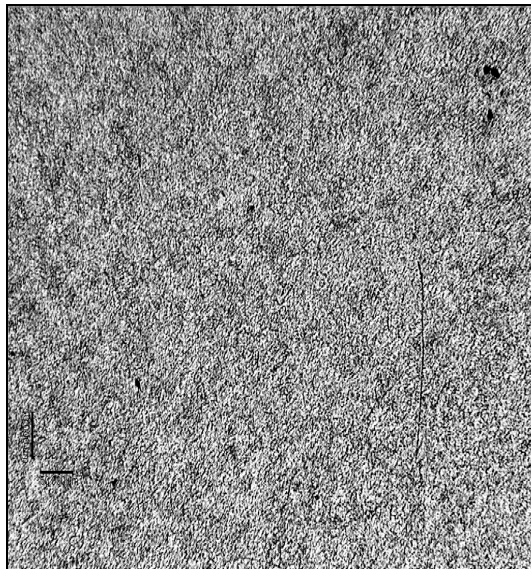


Figure D.3: Optical micrograph of HEAT 2, austenitised at 1050°C for 15 minutes and oil quenched. The microstructure consists of coarse $M_{23}C_6$ carbides in a martensite matrix. (Hardness: 665 ± 19 HV). (Magnification: 100x).

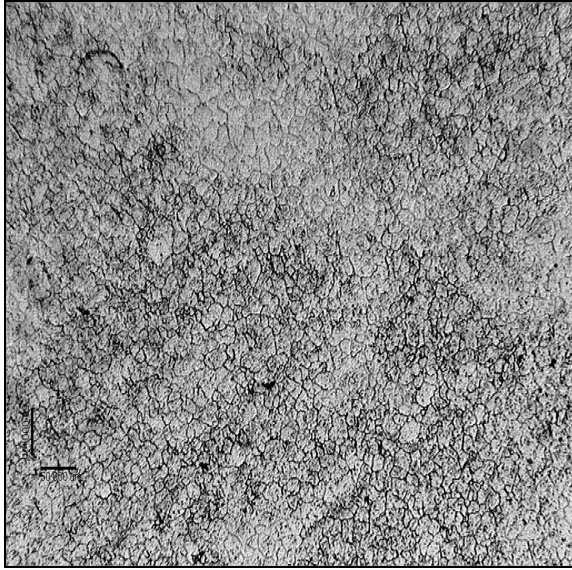


Figure D.4: Optical micrograph of HEAT 1, austenitised at 1075°C for 60 minutes and oil quenched. The microstructure consists of $M_{23}C_6$ carbides and retained austenite in a martensite matrix. (Hardness: 665 ± 16 HV). (Magnification: 100x).

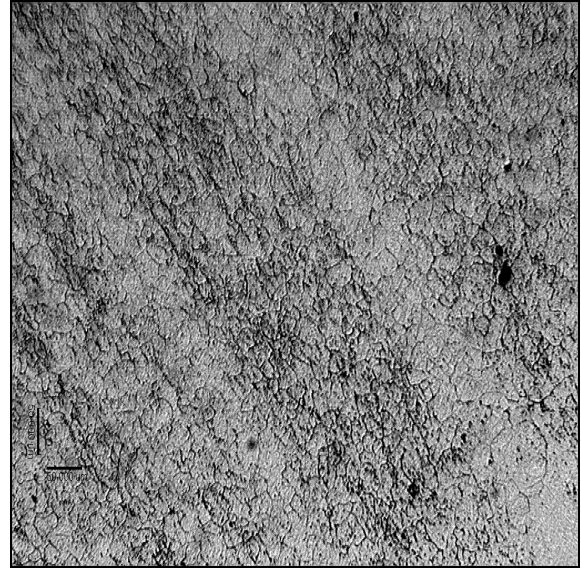


Figure D.5: Optical micrograph of HEAT 2, austenitised at 1075°C for 120 minutes and oil quenched. The microstructure consists of $M_{23}C_6$ carbides and retained austenite in a martensite matrix. (Hardness: 681 ± 9 HV). (Magnification: 100x).

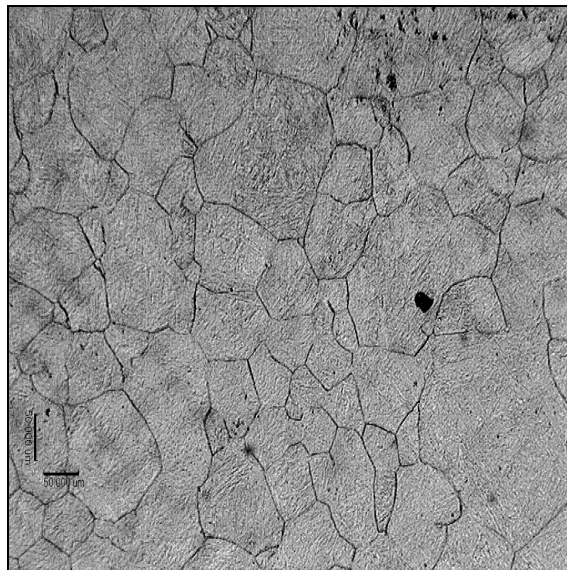


Figure D.6: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes and oil quenched. The microstructure consists of coarse $M_{23}C_6$ carbides in a martensite matrix. (Hardness: 609 ± 15 HV). (Magnification: 100x).

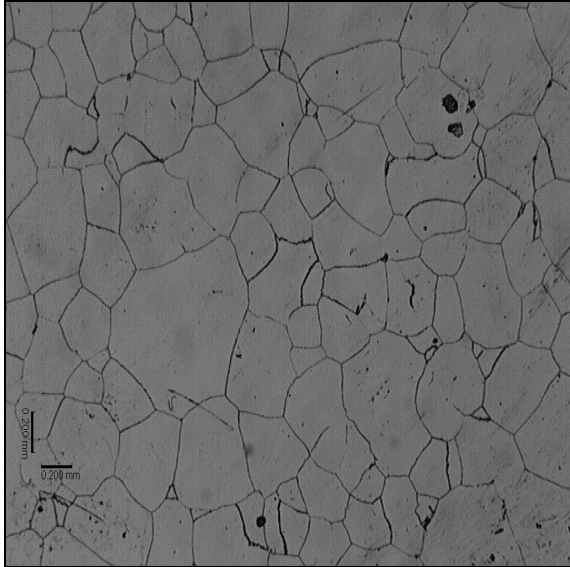


Figure D.7: Optical micrograph of HEAT 1, austenitised at 1175°C for 15 minutes and oil quenched. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 279±4 HV). (Magnification: 50x).

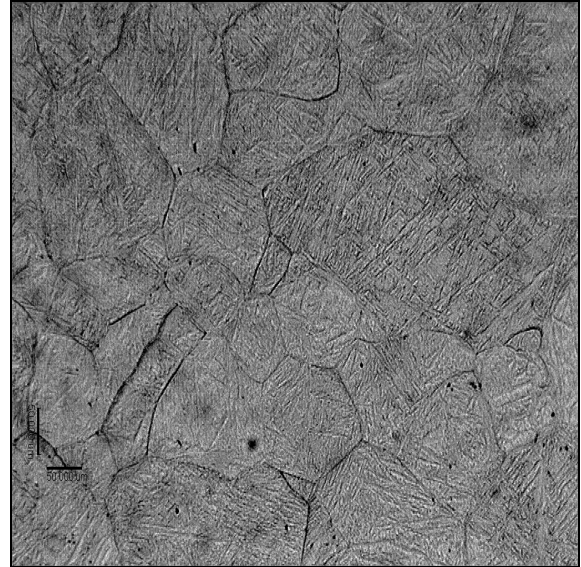


Figure D.8: Optical micrograph of HEAT 2, austenitised at 1175°C for 15 minutes and oil quenched. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 488±63 HV). (Magnification: 100x).

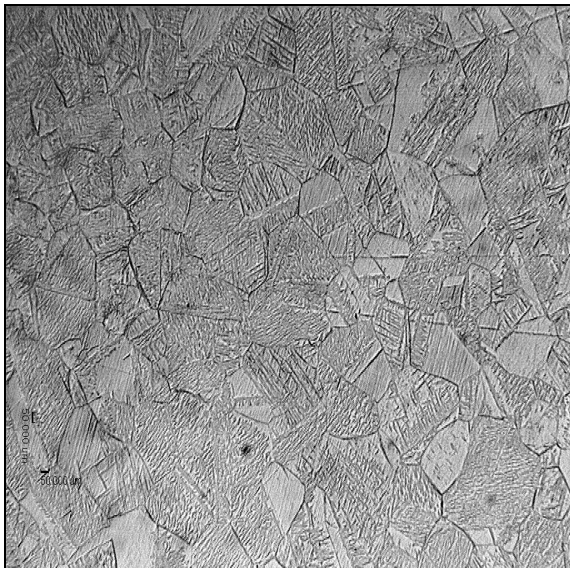


Figure D.9: Optical micrograph of HEAT 1, austenitised at 1200°C for 15 minutes and oil quenched. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 270±12 HV). (Magnification: 50x).

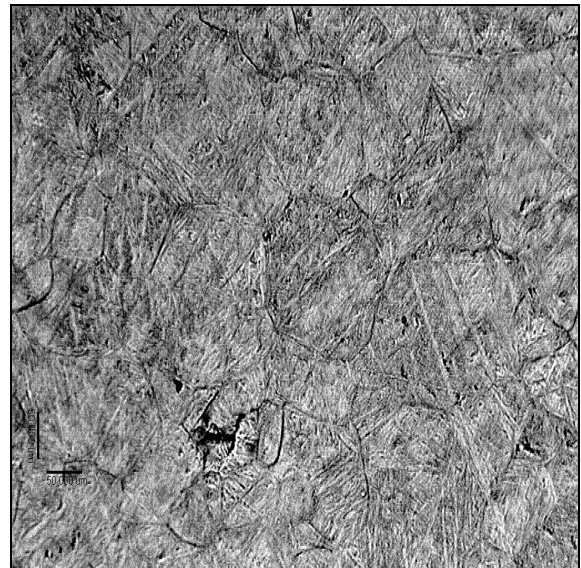


Figure D.10: Optical micrograph of HEAT 2, austenitised at 1200°C for 15 minutes and oil quenched. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 459±2 HV). (Magnification: 100x).

THE EFFECT OF TEMPERING TEMPERATURE ON MICROSTRUCTURE

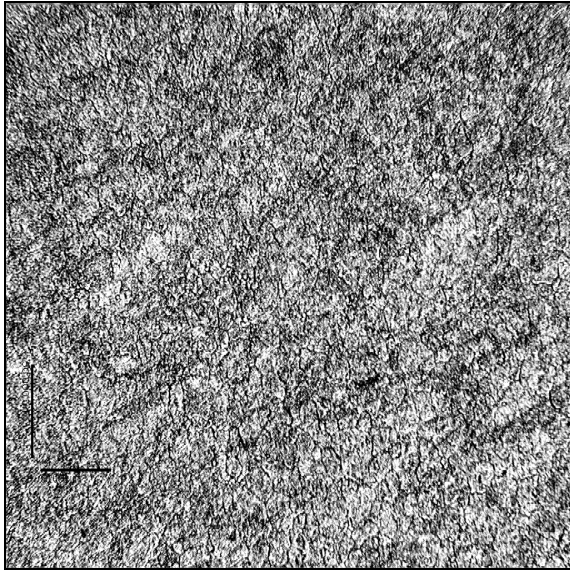


Figure D.11: Optical micrograph of HEAT 1, austenitised at 1075°C for 15 minutes, oil quenched and tempered at 400°C for 120 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 589±9 HV). (Magnification: 100x).

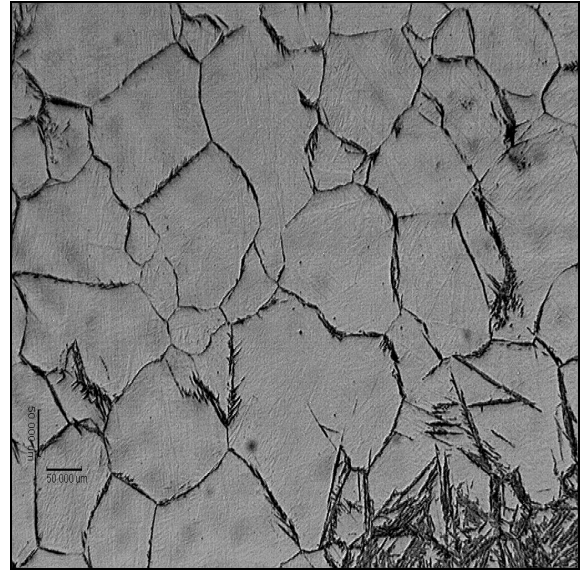


Figure D.12: Optical micrograph of HEAT 1, austenitised at 1150°C for 15 minutes, oil quenched and tempered at 550°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 299±10 HV). (Magnification: 100x).

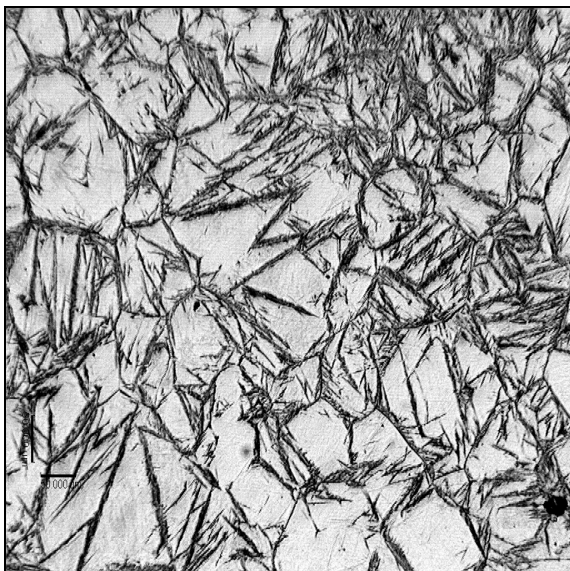


Figure D.13: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes, oil quenched and tempered at 550°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 513±9 HV). (Magnification: 100x).

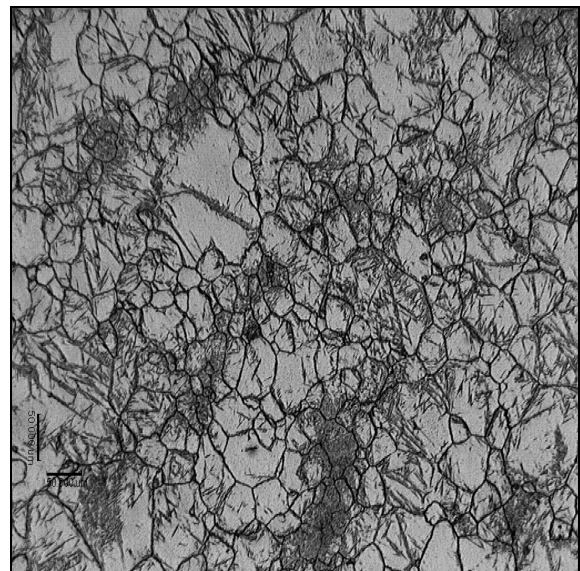


Figure D.14: Optical micrograph of HEAT 2, austenitised at 1175°C for 15 minutes, oil quenched and tempered at 550°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 446±5 HV). (Magnification: 100x).

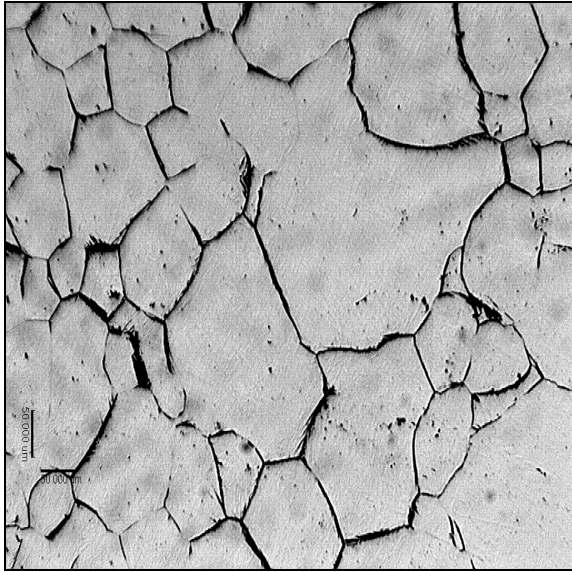


Figure D.15: Optical micrograph of HEAT 1, austenitised at 1150°C for 15 minutes, oil quenched and tempered at 650°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 362 ± 14 HV). (Magnification: 100x).

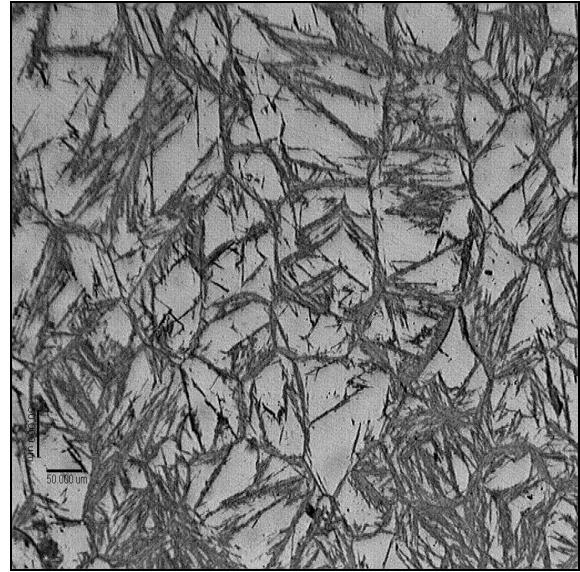


Figure D.16: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes, oil quenched and tempered at 650°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 482 ± 14 HV). (Magnification: 100x).

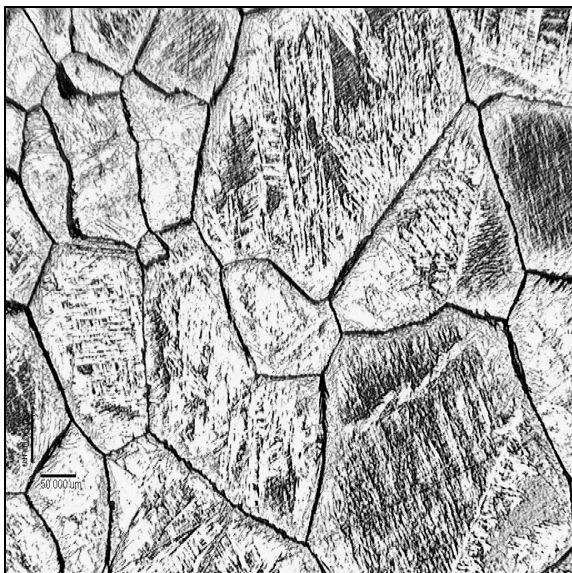


Figure D.17: Optical micrograph of HEAT 1, austenitised at 1175°C for 15 minutes, oil quenched and tempered at 650°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 409 ± 13 HV). (Magnification: 100x).

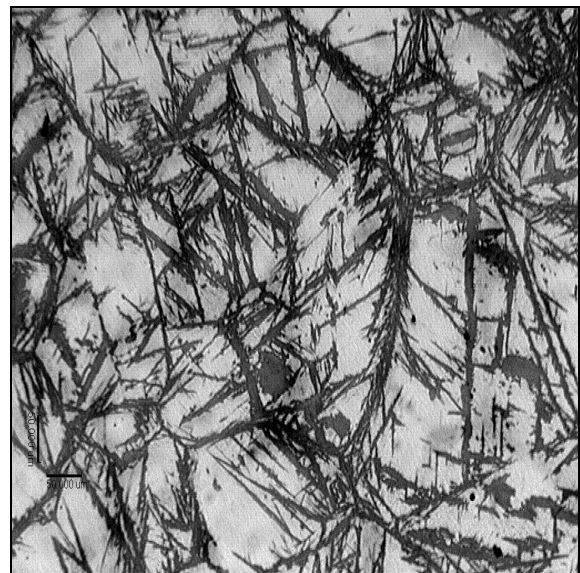


Figure D.18: Optical micrograph of HEAT 2, austenitised at 1175°C for 15 minutes, oil quenched and tempered at 650°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 455 ± 8 HV). (Magnification: 100x).

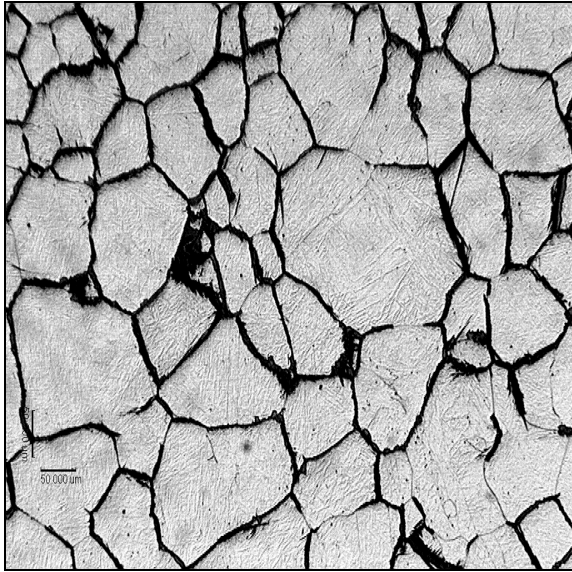


Figure D.19: Optical micrograph of HEAT 1, austenitised at 1150°C for 15 minutes, oil quenched and tempered at 750°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 560 ± 10 HV). (Magnification: 100x).

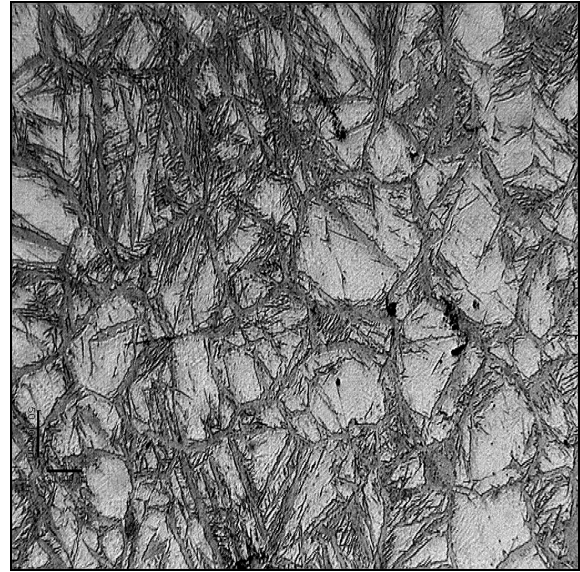


Figure D.20: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes, oil quenched and tempered at 750°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 400 ± 10 HV). (Magnification: 100x).

THE EFFECT OF DOUBLE TEMPERING ON MICROSTRUCTURE

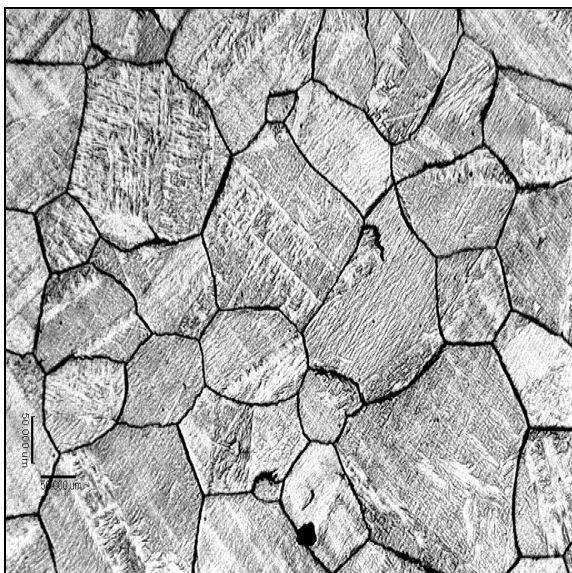


Figure D.21: Optical micrograph of HEAT 1, austenitised at 1175°C for 15 minutes, oil quenched, and double tempered at 550°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 295 ± 14 HV). (Magnification: 100x).

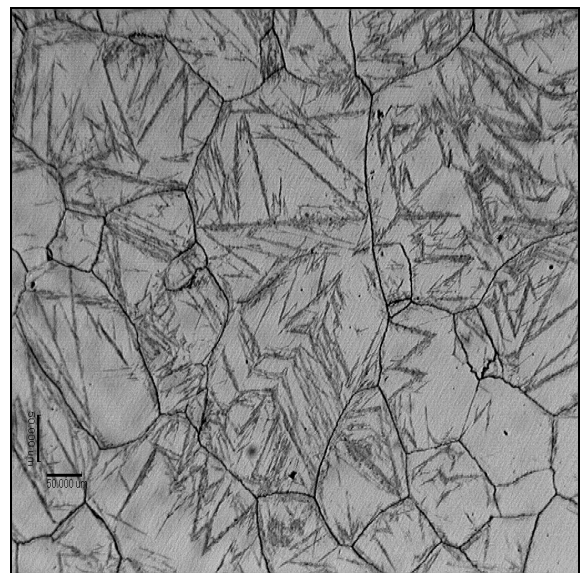


Figure D.22: Optical micrograph of HEAT 2, austenitised at 1175°C for 15 minutes, oil quenched and double tempered at 550°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 522 ± 5 HV). (Magnification: 100x).

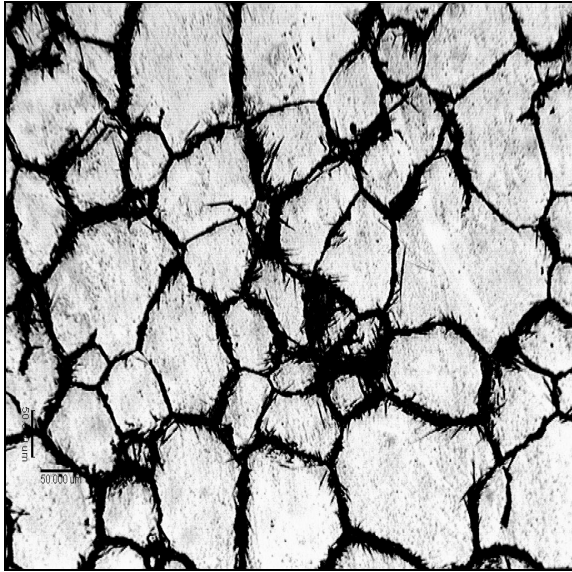


Figure D.23: Optical micrograph of HEAT 1, austenitised at 1150°C for 15 minutes, oil quenched, and double tempered at 650°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 500±9 HV). (Magnification: 100x).

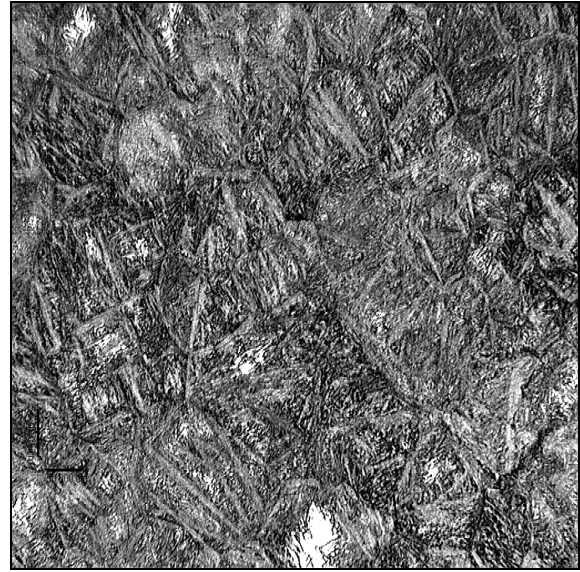


Figure D.24: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes, oil quenched and double tempered at 650°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 360±5 HV). (Magnification: 100x).

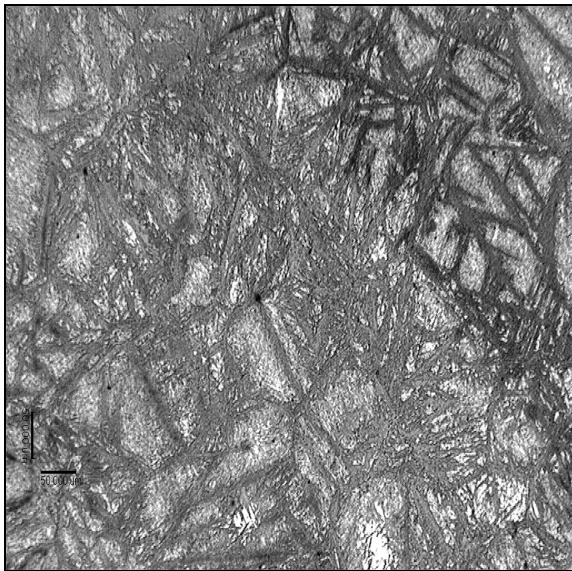


Figure D.25: Optical micrograph of HEAT 2, austenitised at 1175°C for 15 minutes, oil quenched, and double tempered at 650°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 344±6 HV). (Magnification: 100x).

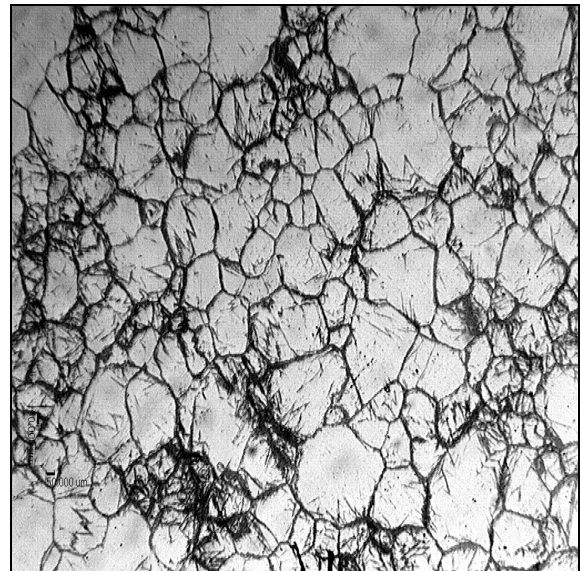


Figure D.26: Optical micrograph of HEAT 1, austenitised at 1150°C for 15 minutes, oil quenched and double tempered at 750°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 320±7 HV). (Magnification: 100x).

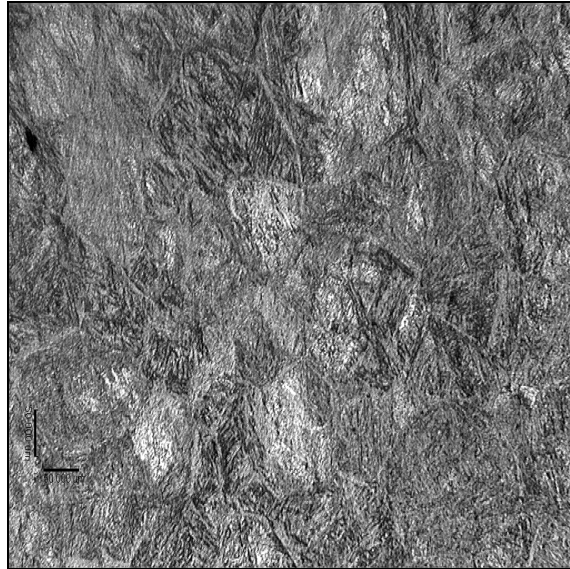


Figure D.27: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes, oil quenched and double tempered at 750°C for 30 minutes. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 294±7 HV). (Magnification: 100x).

THE EFFECT OF SUB-ZERO TEMPERING ON MICROSTRUCTURE

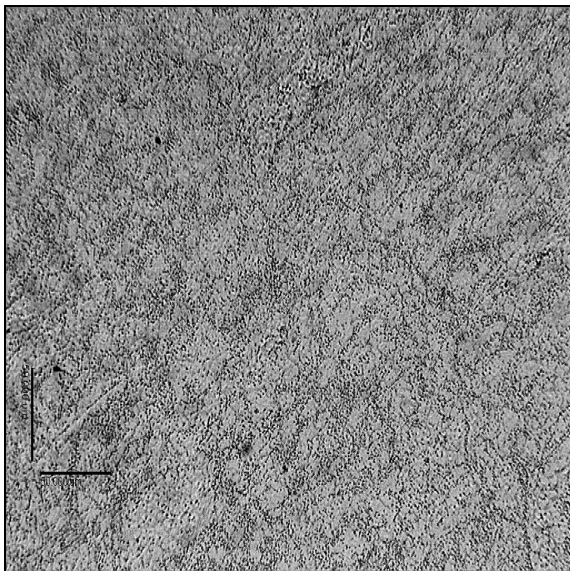


Figure D.28: Optical micrograph of HEAT 1, austenitised at 1050°C for 15 minutes, oil quenched, and sub-zero treated at -75°C. The microstructure consists of $M_{23}C_6$ carbides and retained austenite in a martensite matrix. (Hardness: 660±8 HV). (Magnification: 200x).

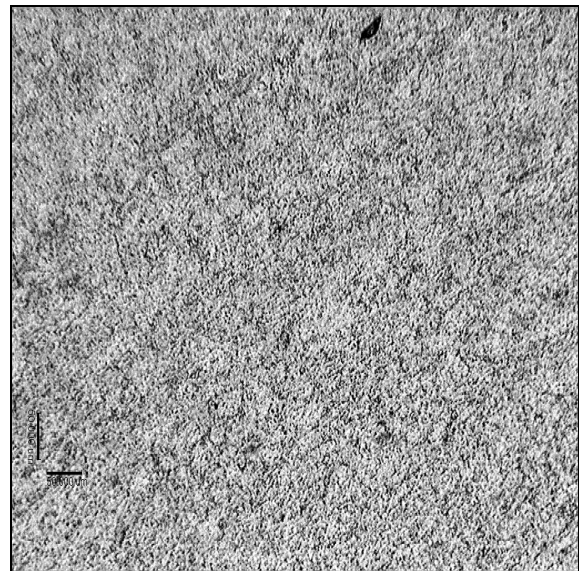


Figure D.29: Optical micrograph of HEAT 2, austenitised at 1050°C for 15 minutes, oil quenched and sub-zero treated at -75°C. The microstructure consists of $M_{23}C_6$ carbides and retained austenite in a martensite matrix. (Hardness: 673±8 HV). (Magnification: 100x).

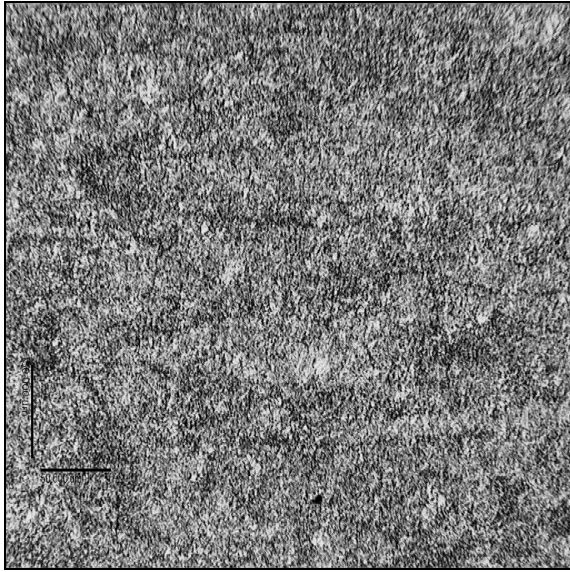


Figure D.30: Optical micrograph of HEAT 1, austenitised at 1100°C for 15 minutes, oil quenched, and sub-zero treated at -196°C. The microstructure consists of $M_{23}C_6$ carbides and retained austenite in a martensite matrix. (Hardness: 797 ± 15 HV). (Magnification: 200x).

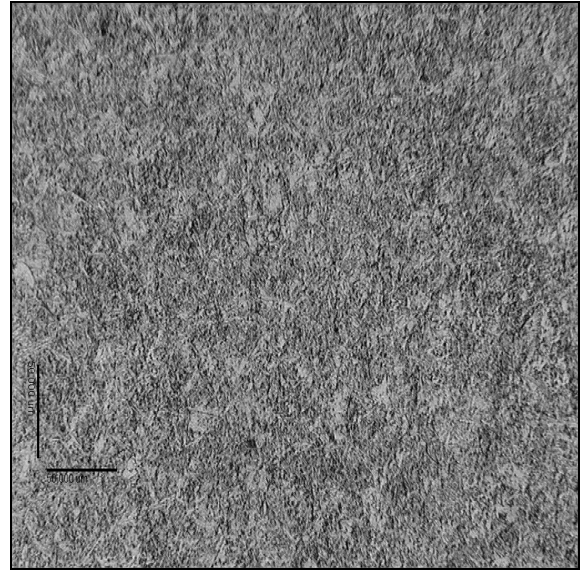


Figure D.31: Optical micrograph of HEAT 2, austenitised at 1100°C for 15 minutes, oil quenched, and sub-zero treated at -196°C. The microstructure consists of $M_{23}C_6$ carbides and retained austenite in a martensite matrix. (Hardness: 785 ± 12 HV). (Magnification: 200x).

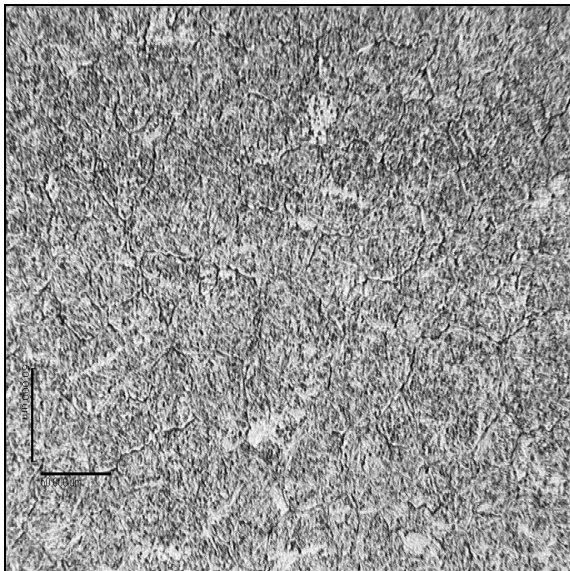


Figure D.32: Optical micrograph of HEAT 1, austenitised at 1130°C for 15 minutes, oil quenched, and sub-zero treated at -196°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 739 ± 11 HV). (Magnification: 200x).



Figure D.33: Optical micrograph of HEAT 1, austenitised at 1150°C for 15 minutes, oil quenched, and sub-zero treated at -196°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 700 ± 15 HV). (Magnification: 200x).

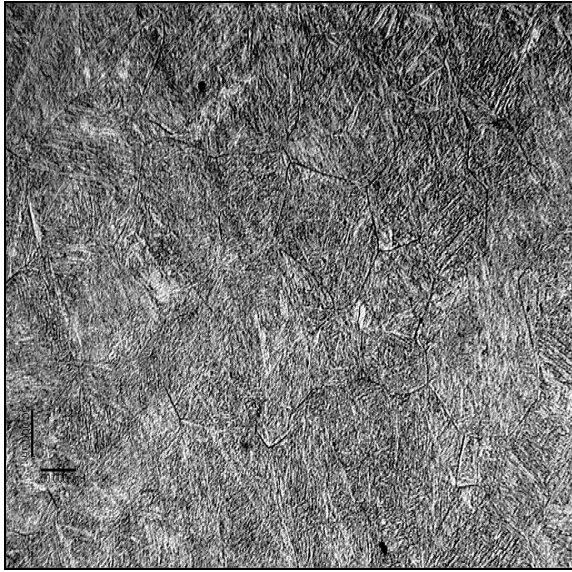


Figure D.34: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes, oil quenched, and sub-zero treated at -196°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 756±9 HV). (Magnification: 100x).

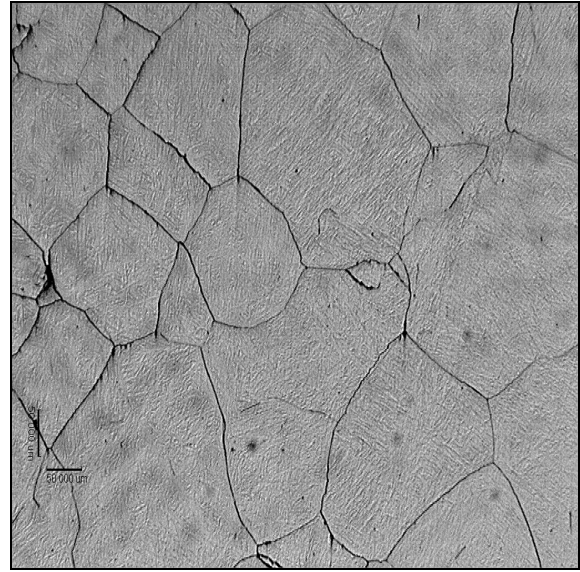


Figure D.35: Optical micrograph of HEAT 1, austenitised at 11750°C for 15 minutes, oil quenched and sub-zero treated at -196°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 702±16 HV). (Magnification: 100x).

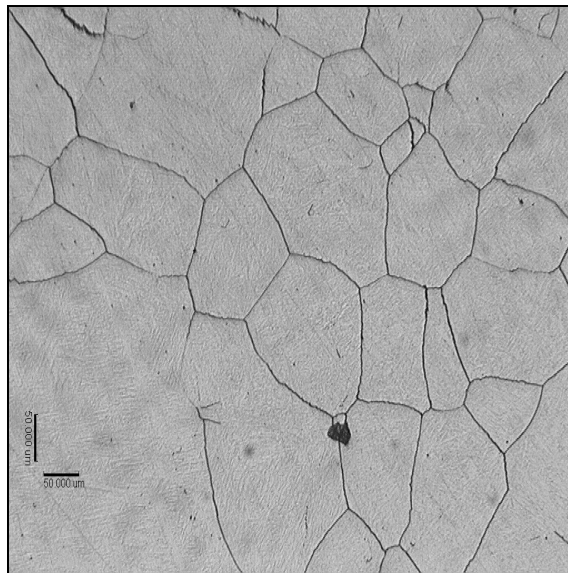


Figure D.36: Optical micrograph of HEAT 2, austenitised at 1175°C for 15 minutes, oil quenched, and sub-zero treated at -196°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 751±16 HV). (Magnification: 100x).

SUB-ZERO TEMPERING FOLLOWED BY TEMPERING

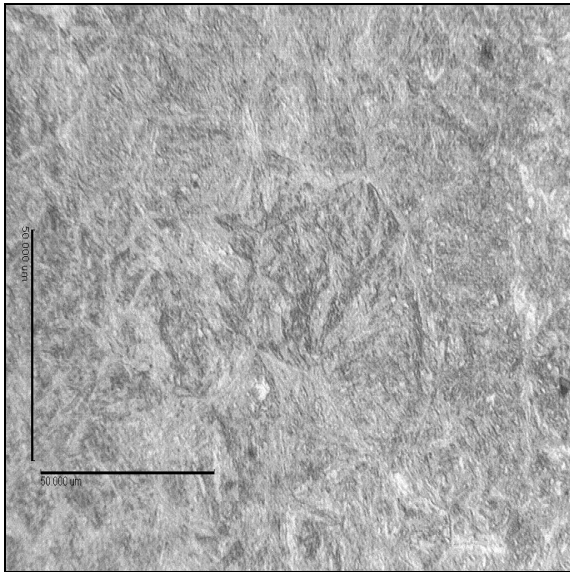


Figure D.37: Optical micrograph of HEAT 1, austenitised at 1130°C for 15 minutes, oil quenched, sub-zero treated at -196°C and tempered at 700°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 327 ± 7 HV). (Magnification: 500x).

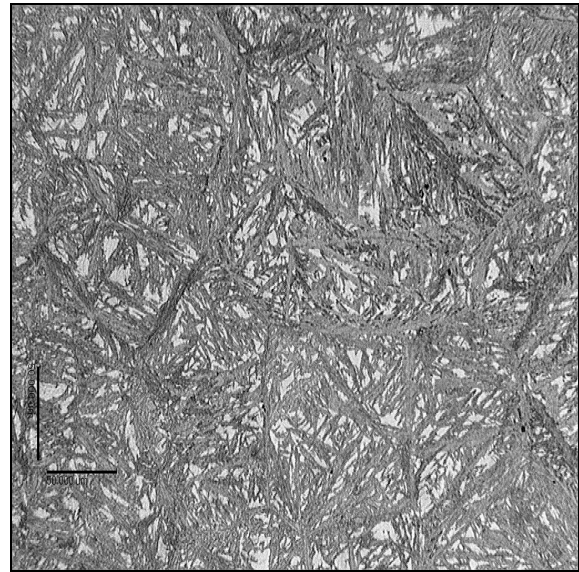


Figure D.38: Optical micrograph of HEAT 1, austenitised at 1150°C for 15 minutes, oil quenched, sub-zero treated at -196°C and tempered at 700°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 380 ± 4 HV). (Magnification: 200x).

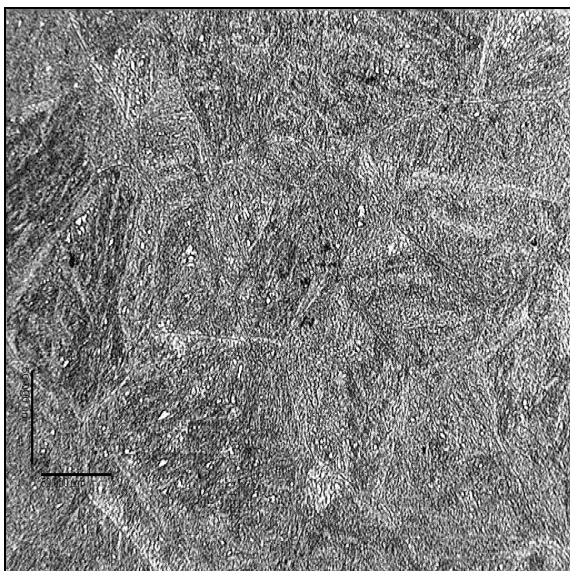


Figure D.39: Optical micrograph of HEAT 2, austenitised at 1150°C for 15 minutes, oil quenched, sub-zero treated at -196°C and tempered at 700°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 330 ± 3 HV). (Magnification: 200x).

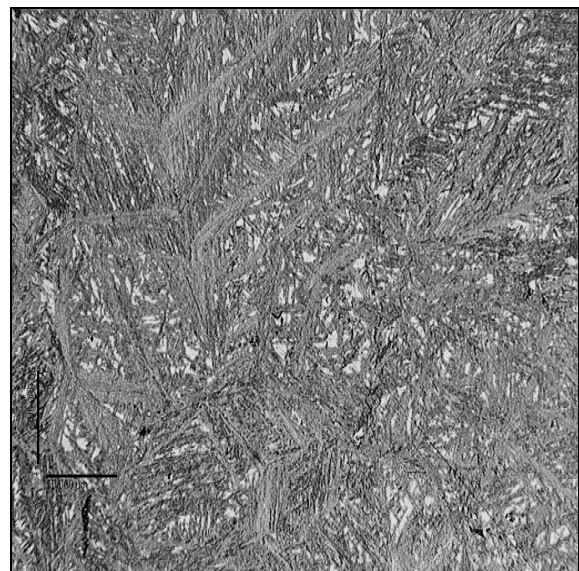


Figure D.40: Optical micrograph of HEAT 1, austenitised at 1175°C for 15 minutes, oil quenched, sub-zero treated at -196°C and tempered at 700°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 327 ± 7 HV). (Magnification: 200x).

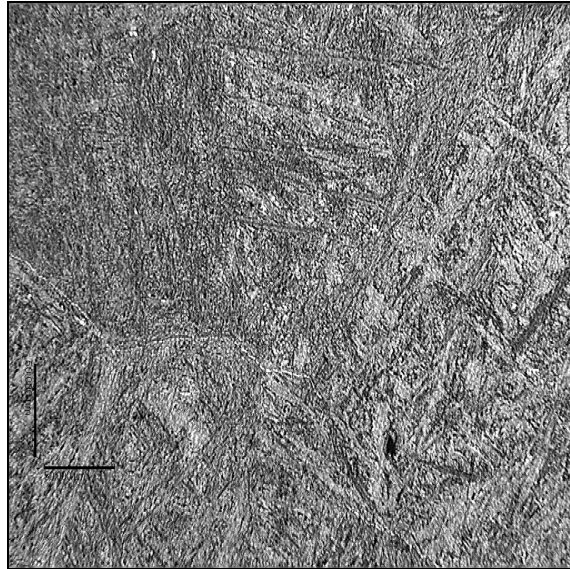


Figure D.41: Optical micrograph of HEAT 2, austenitised at 1175°C for 15 minutes, oil quenched, sub-zero treated at -196°C and tempered at 700°C. The microstructure consists of retained austenite in a martensite matrix. (Hardness: 326 ± 6 HV). (Magnification: 200x).