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DESIGN AND DILATOMETRIC PROCESSING OF NANOBAINITIC STRUCTURES IN AL-ALLOYED 3MN MULTIPHASE STEEL

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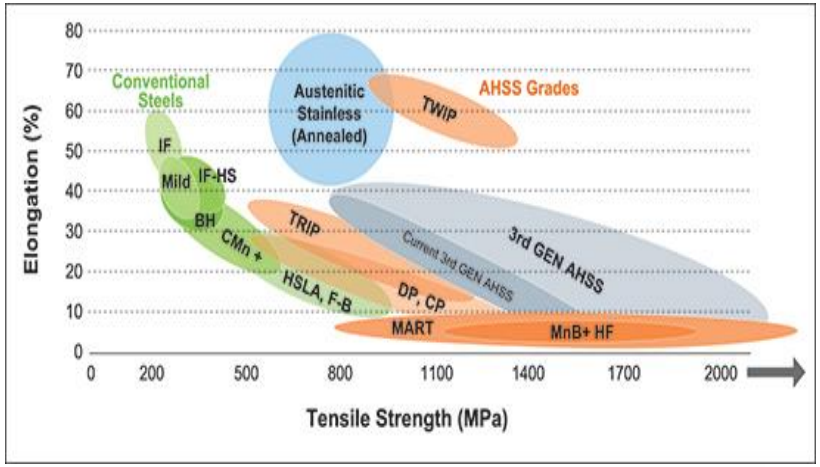
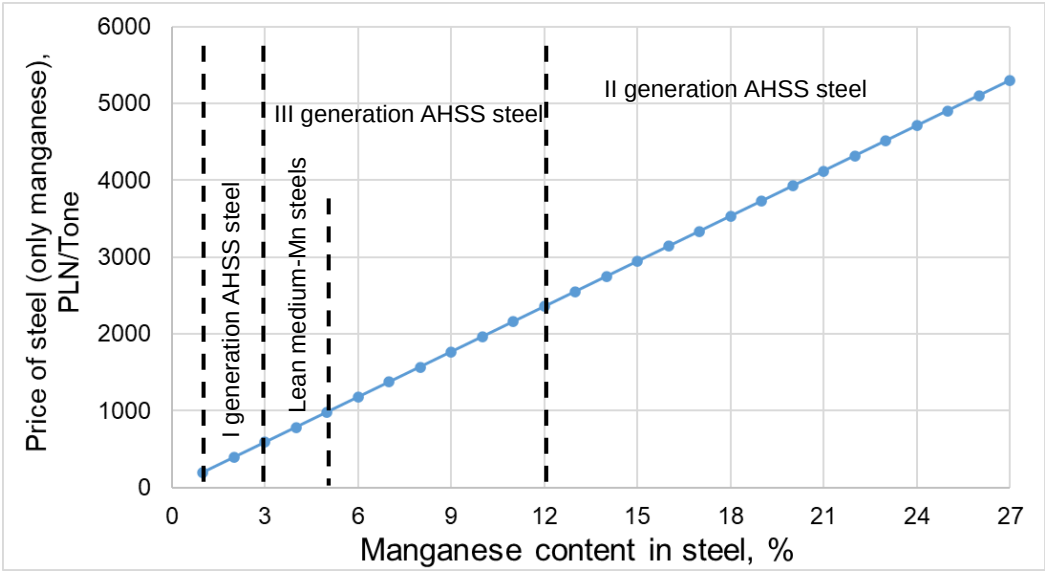
INTRODUCTION



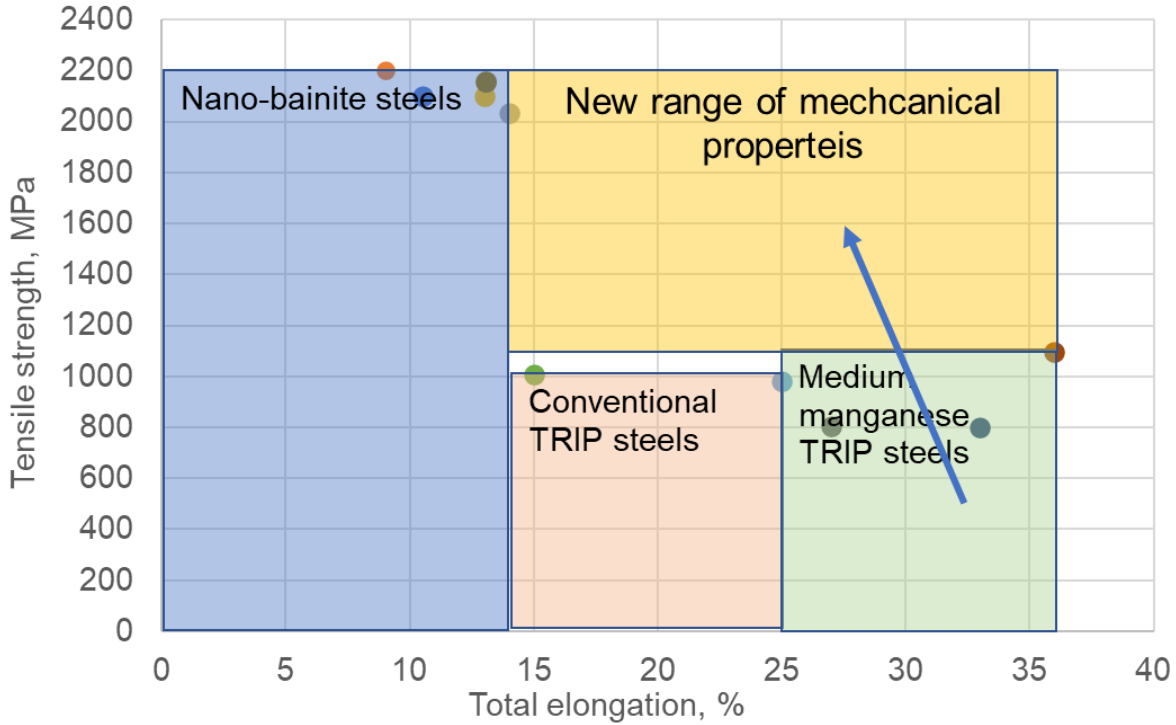
	Mid-Range CO_2e	Estimated Part Weight (kg)	kg CO_2e
Mild Steel	1.9	100	190
AHSS	1.9	75	143
Aluminum	8.9	67	596
Magnesium	46	50	2300
CFRP	22	45	990

Figure 9. LCA Emissions from Material Production



The price of 1 ton of steel increase 5 times, when the Mn content is increased from 5 to 24%

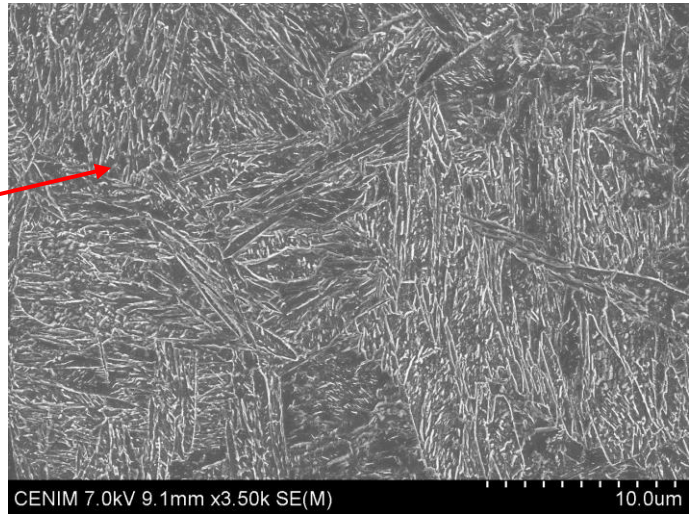
INTRODUCTION



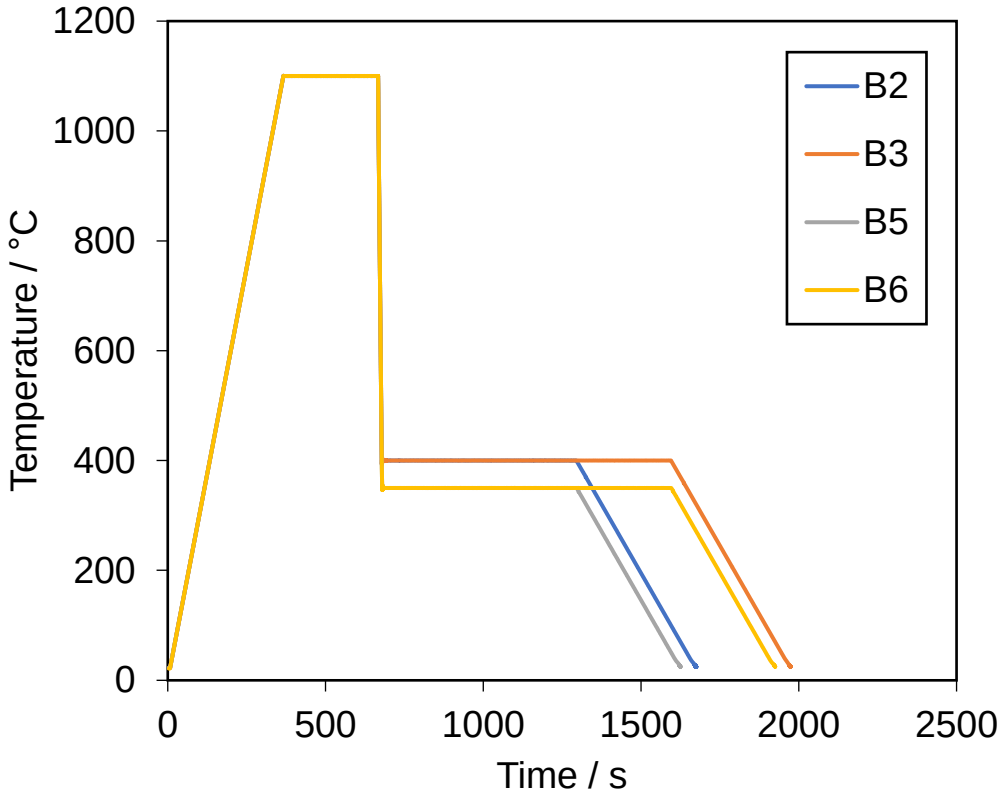
MATERIAL

Steel grade	C	Mn	Al	Si	Mo	Nb
3MnNb steel	0.17	3.1	1.6	0.20	0.20	0.04

100% Martensite structure



INITIAL RESEARCH - AUSTEMPERING



Ms MUCG (ºC)	Ms Exp (ºC)	Bs MUCG (ºC)
407	389	547

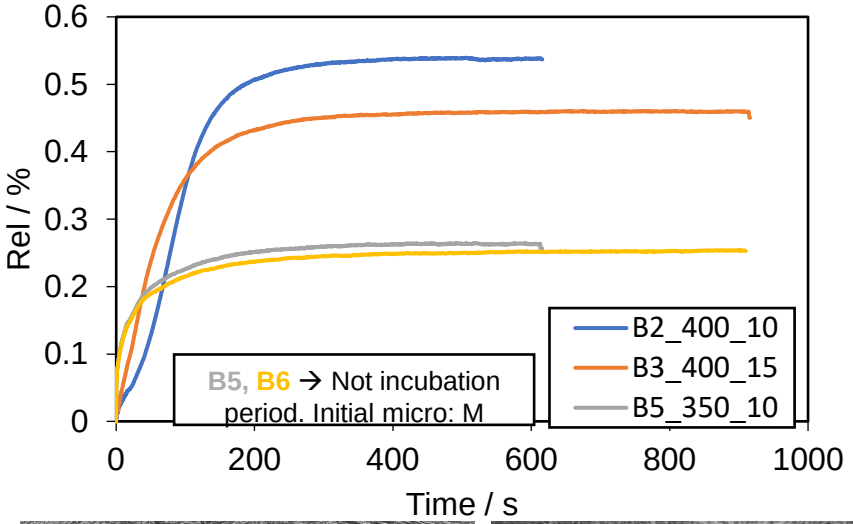
Heating: 3°C/s

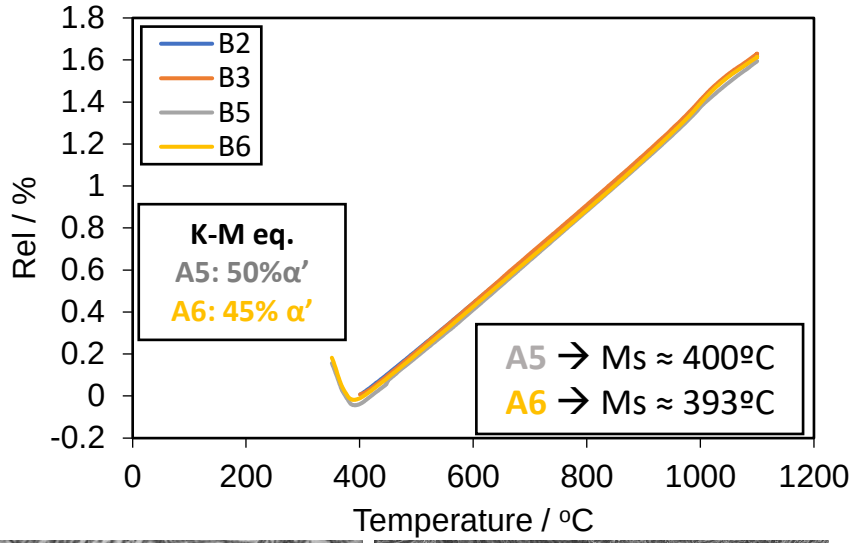
Austenitization : 1100°C, 300s

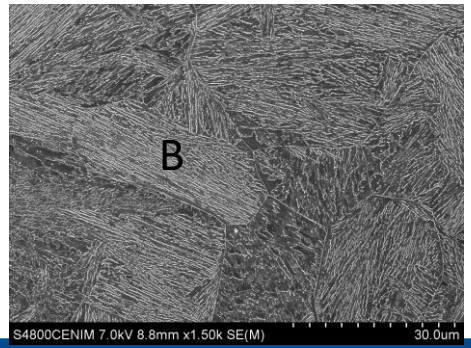
Cooling: 60°C/s

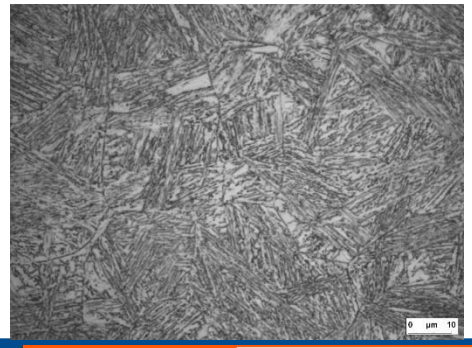
ISO: 400 / 350°C, 600 / 900s

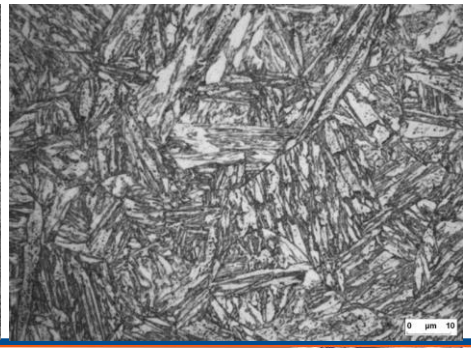
INITIAL RESEARCH - AUSTEMPERING

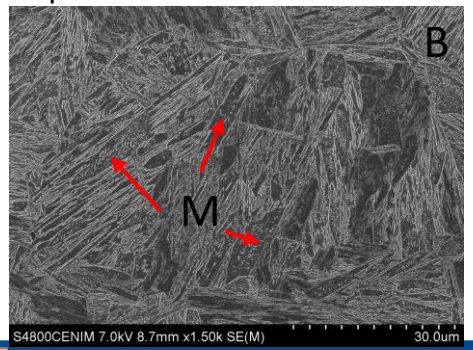




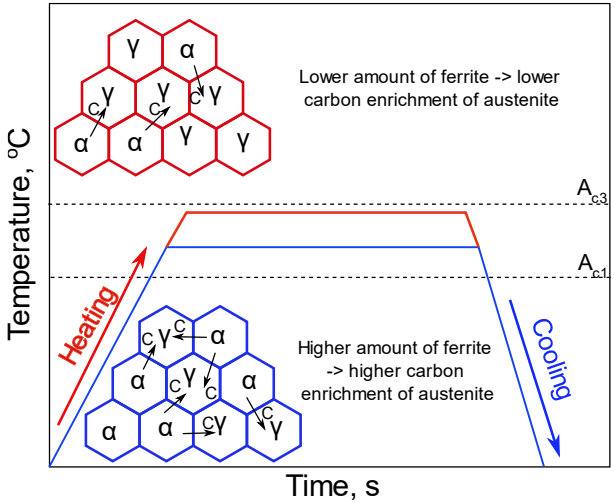


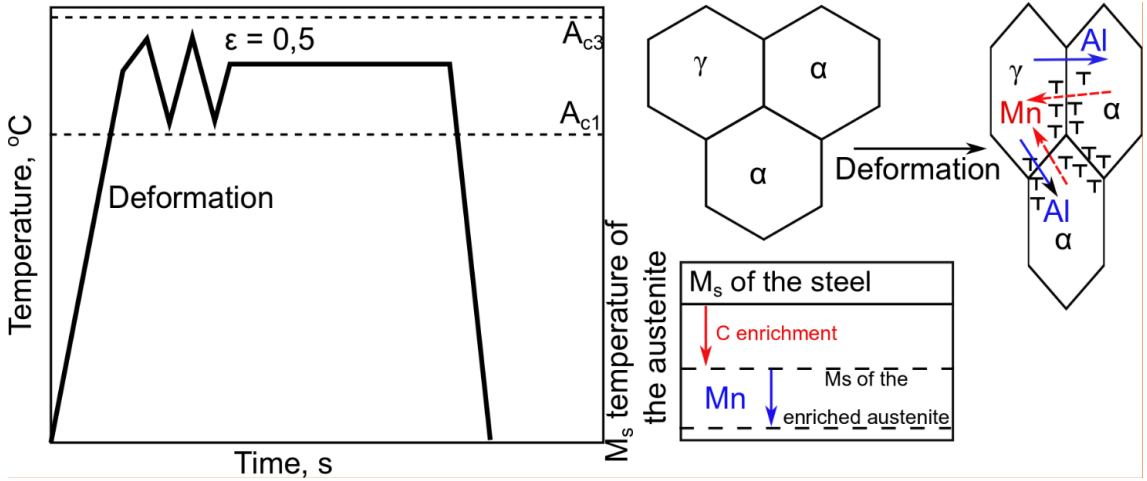






WAYS TO INCREASE THE THERMAL STABILITY OF AUSTENITE

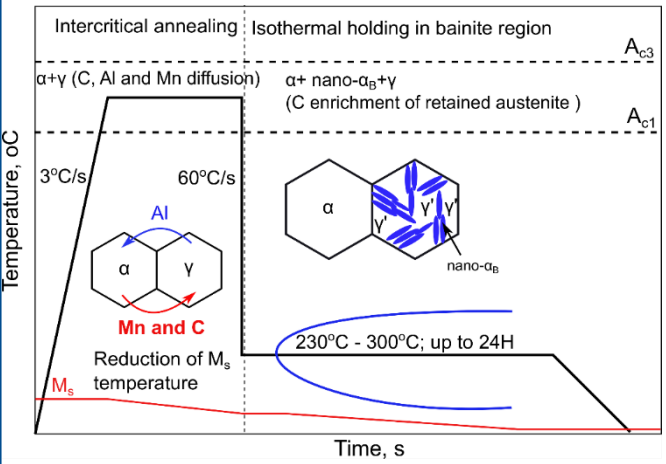


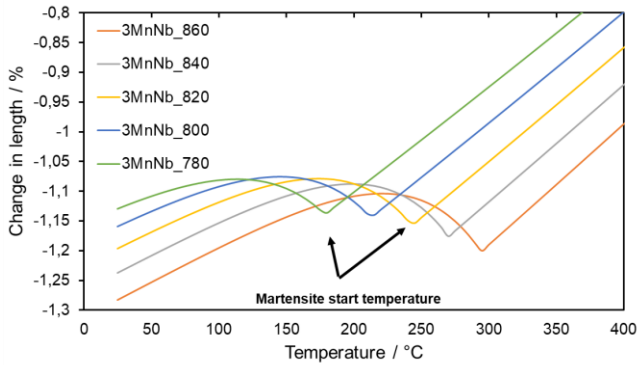


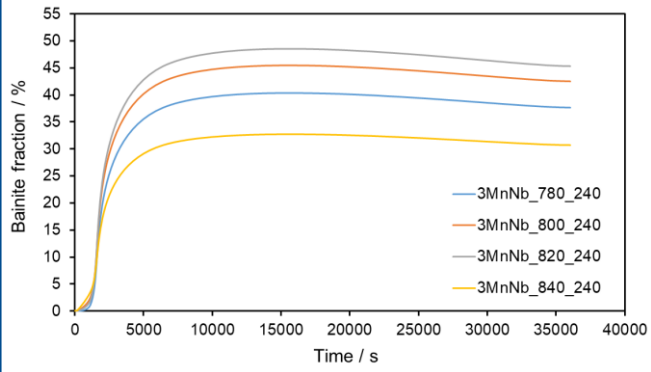
Austenite thermal stability controlled by the chemical composition

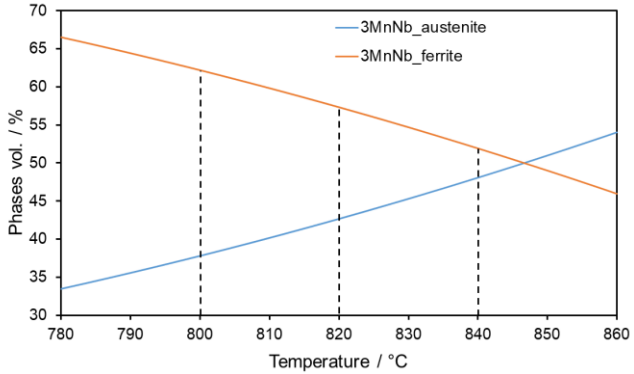
Austenite thermal stability controlled by the plastic deformation and grain refinement

THEORETICAL CALCULATIONS

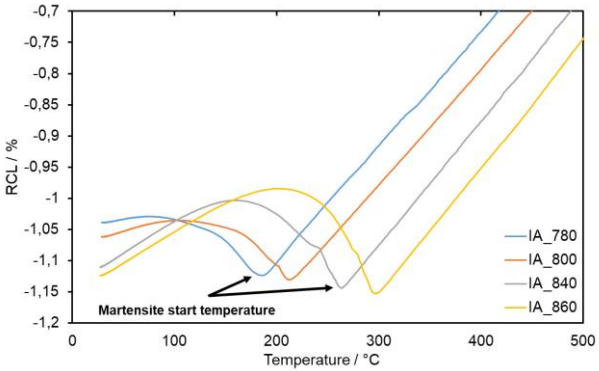


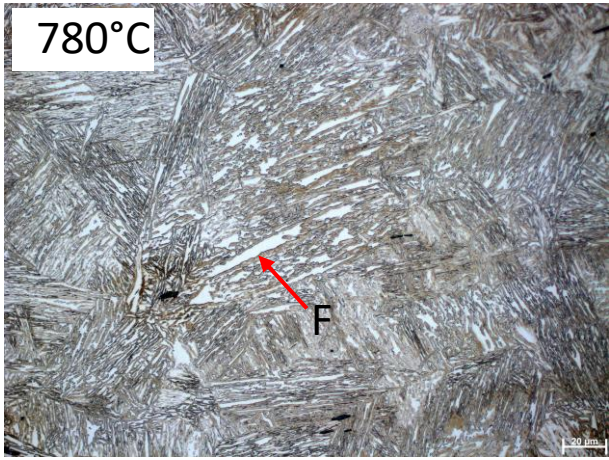


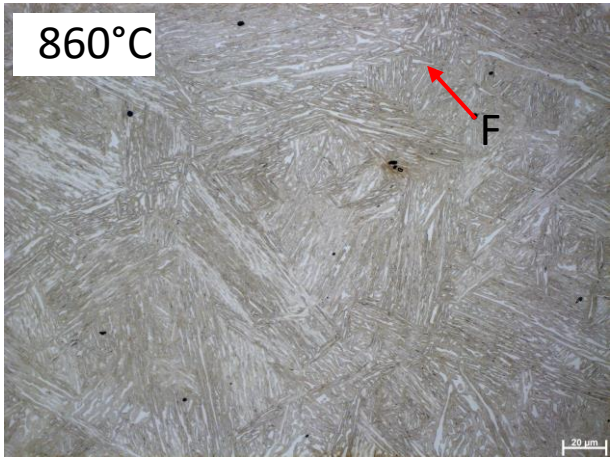


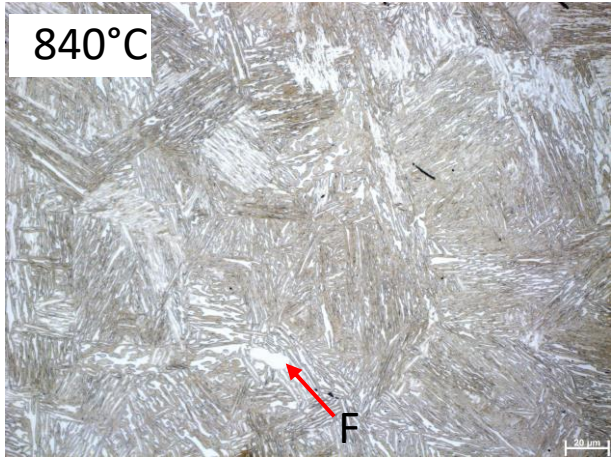


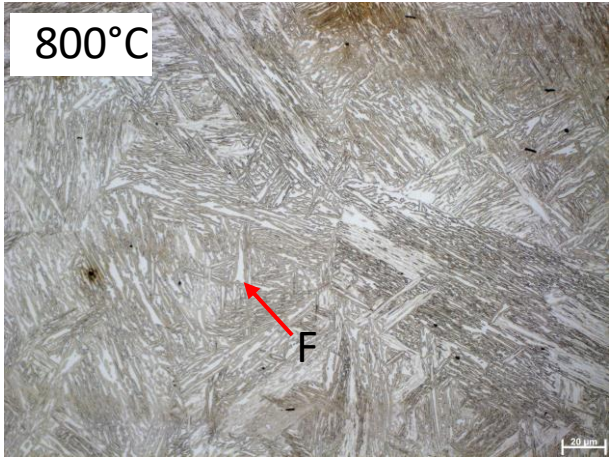
DILATOMETRY STUDY - IA



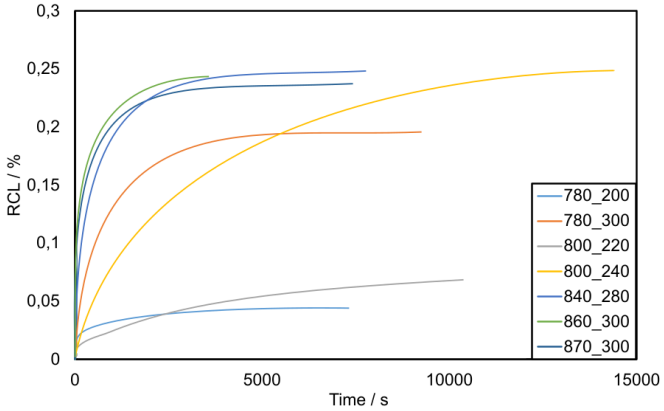


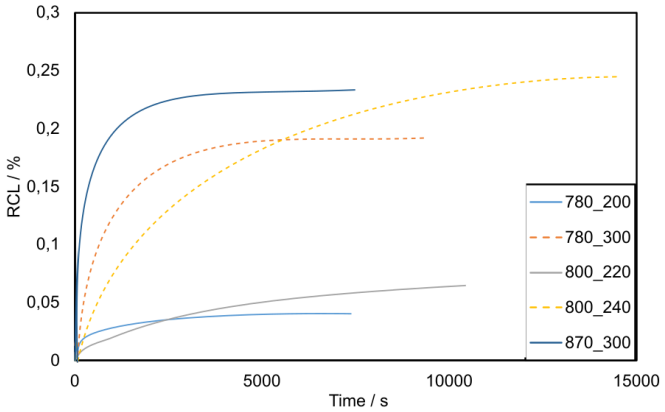


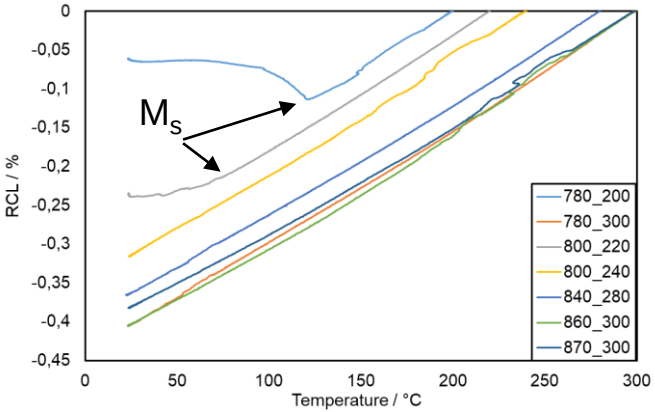




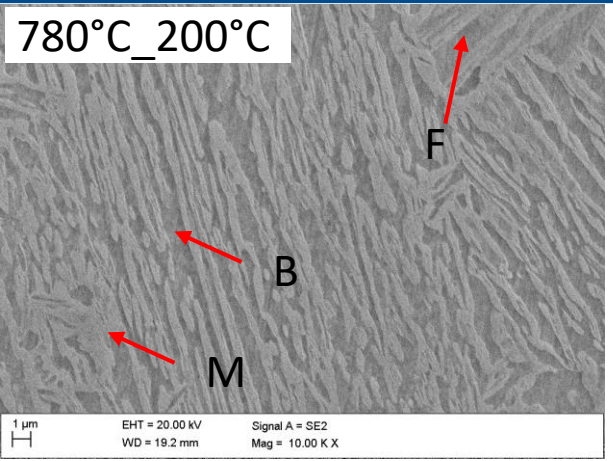
DILATOMETRIC STUDY – NANOBAINITE FORMATION



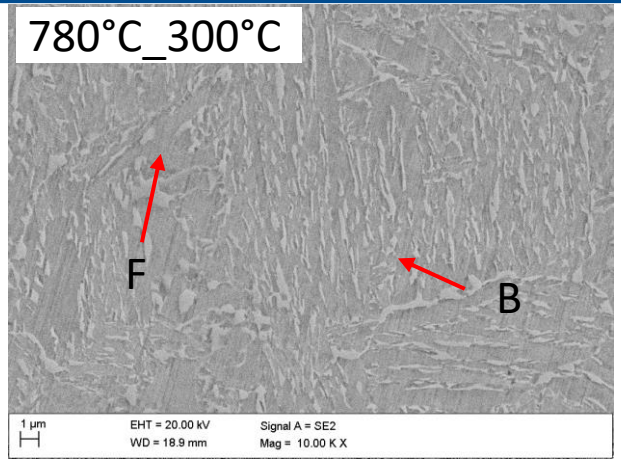




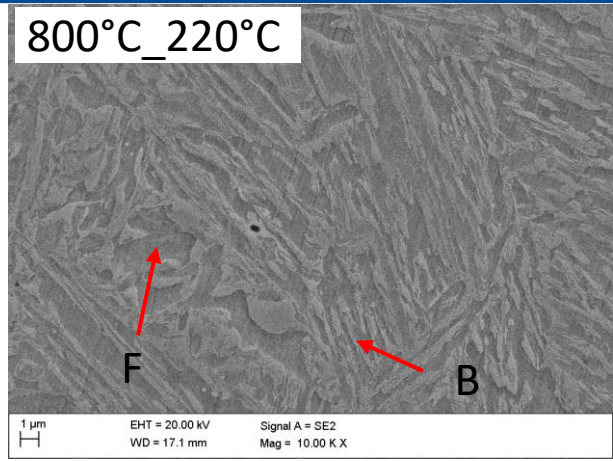
780°C_200°C



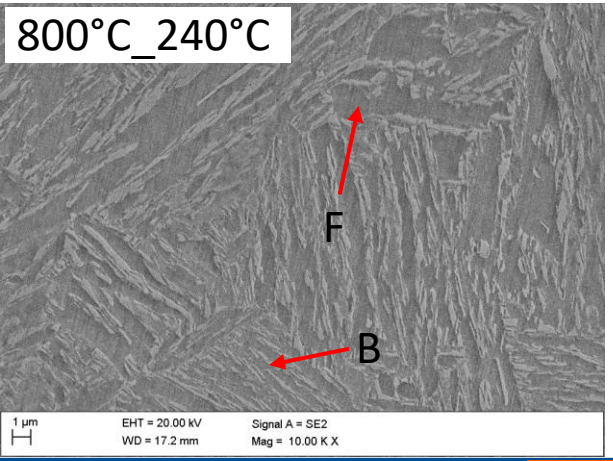
780°C_300°C



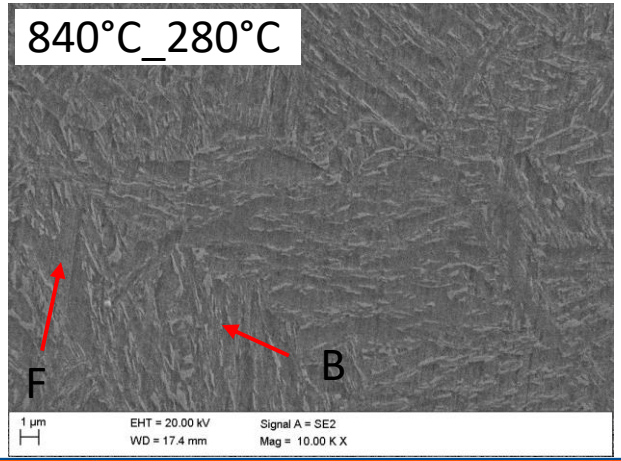
800°C_220°C



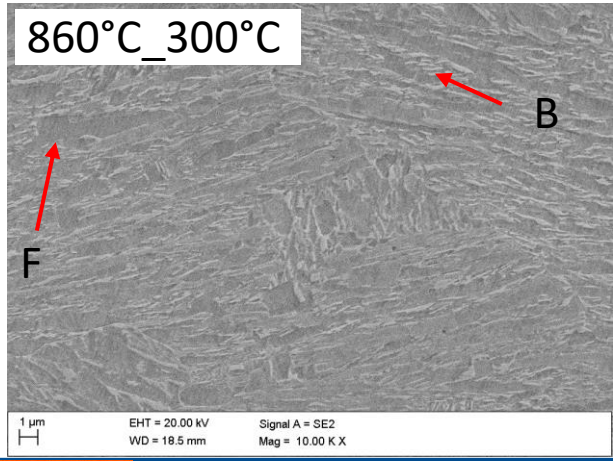
800°C_240°C



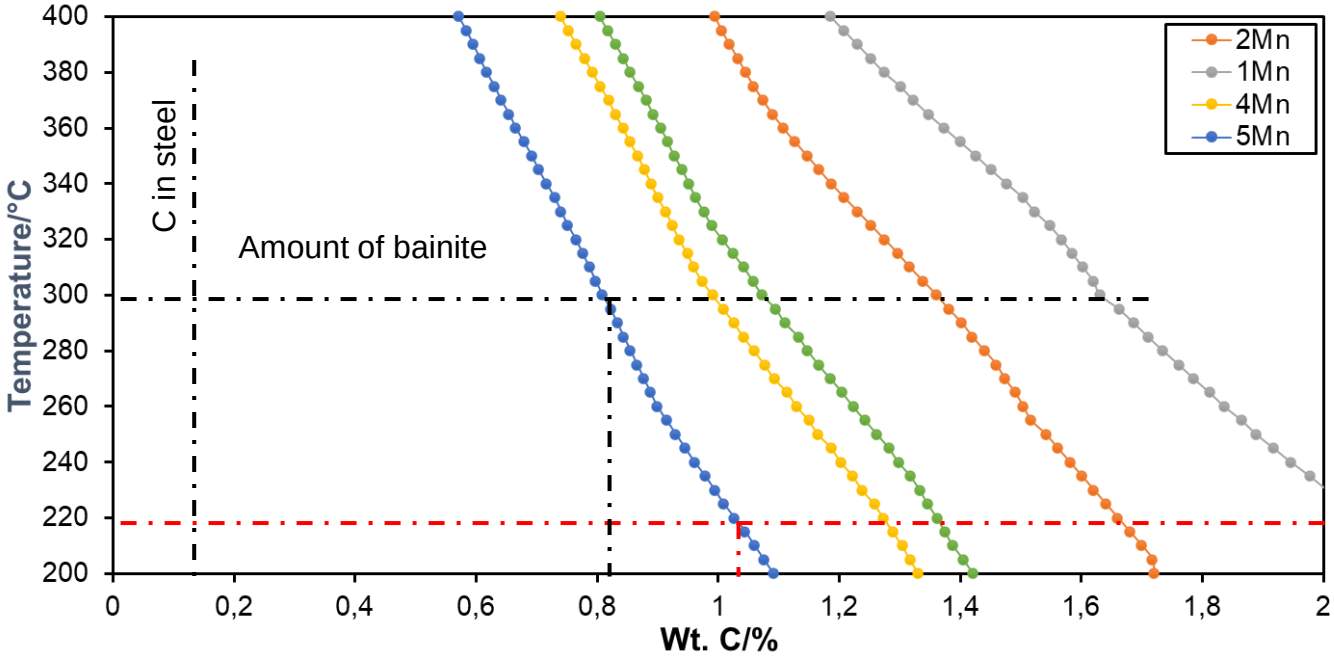
840°C_280°C



860°C_300°C



MANGANESE INFLUENCE ON BAINITE FORMATION KINETIC

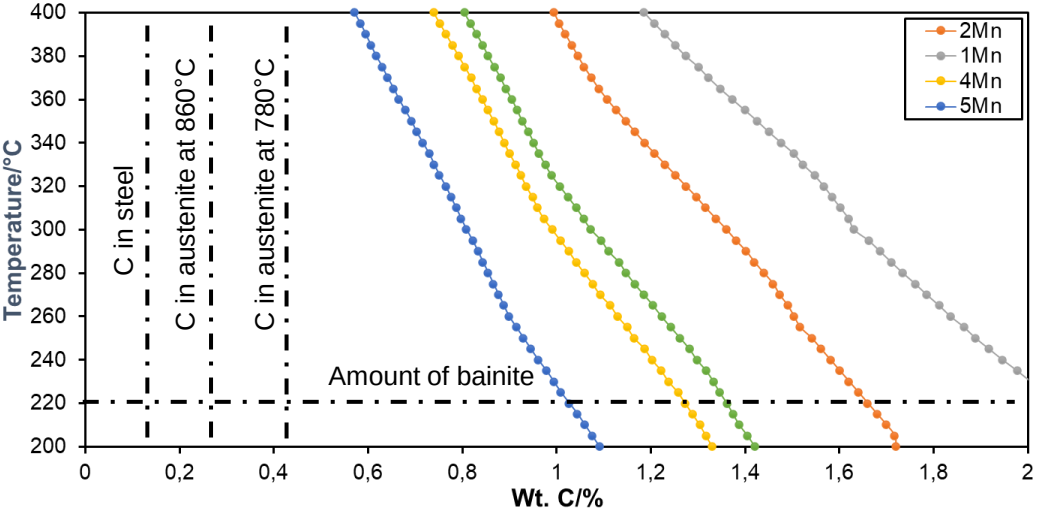


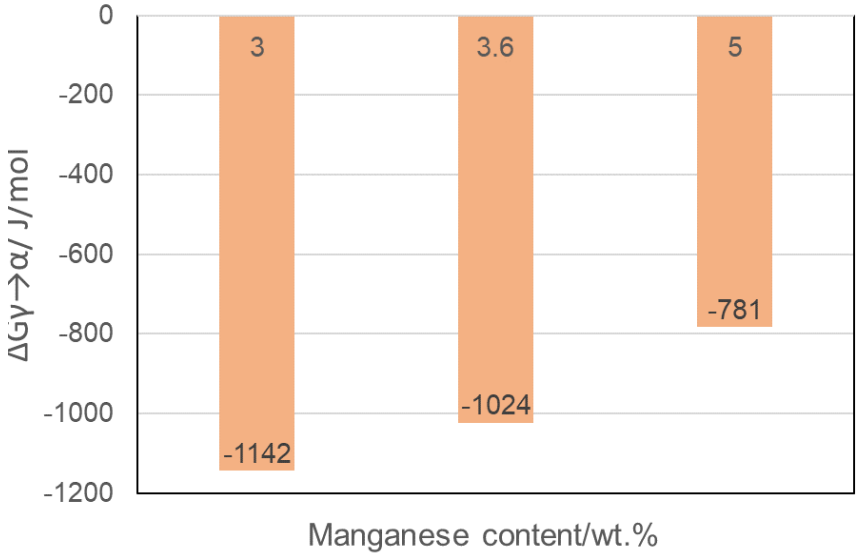
Manganese decreases the amount of bainite, by decreasing the equilibrium carbon concentration in austenite

A decrease of isothermal holding temperature results in the increase of equilibrium carbon concentration in austenite

Temp. [°C]	Fe [wt.%]	Al [wt.%]	Mn [wt.%]	Mo [wt.%]	Nb [wt.%]	Si [wt.%]	C [wt.%]
860	94,153087	1,363202	3,826821	0,184148	0,000197	0,205275	0,26727
840	93,950813	1,319163	4,04244	0,182759	0,000125	0,206326	0,298374
820	93,707943	1,277219	4,29103	0,18213	0,000078	0,207366	0,334234
800	93,416821	1,237621	4,579343	0,182343	0,000048	0,208423	0,375401
780	93,067285	1,200506	4,916719	0,183479	0,000029	0,209568	0,422414

CARBON INFLUENCE ON BAINITE FORMATION KINETIC





Carbon concentration in austenite after IA, strongly influences the amount of bainite

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Conclusions

1. Two step heat treatment allows for the formation of bainite at lower isothermal holding temperatures without martensite (in most cases). It is possible to form bainite at the temperatures from 200 to 300°C,
2. Decreasing the IA temperature, results in the lower bainite amount after isothermal holding. This correspond to the amount of austenite and its chemical composition prior to the isothermal holding,
3. As the IA temperature increase, the bainite transformation kinetics accelerate too. The fastest transformation occurs at the IA temperatures of 840, 860 and 870°C,
4. The microstructure of the steel exhibits a mixture of large regular ferritic grains together with bainitic laths of different size from 50 nm up to 200 nm.

Thank you for your attention!

ACKNOWLEDGEMENTS

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NARODOWE CENTRUM NAUKI