Institut für Eisenhüttenkunde
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Diffusion controlled bainitic phase transformation

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Introduction

➢**Bainite structure is of considerable importance in the design of high strength steels due to its excellent balance of strength and toughness.**

➢**In order to deeper understand the mechanisms of bainite reaction, Local field Electrode Atom Probe (LEAP) investigations and High Resolution TEM analysis were performed in high carbon steel 100Cr6.**

➢**2D phase-field simulations coupling with CALPHAD method were applied to simulate the microstructure evolution of bainitic phase transformation.**

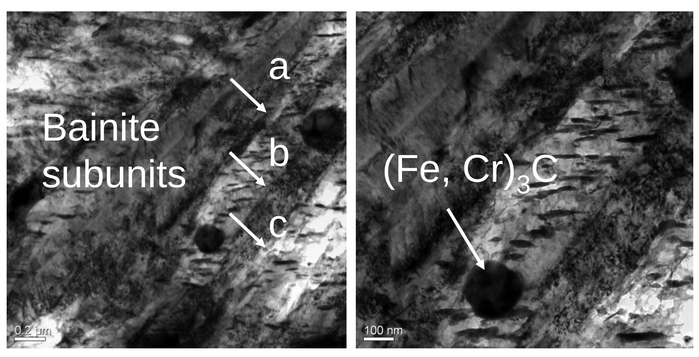
Research Material

High carbon bearing steel 100Cr6

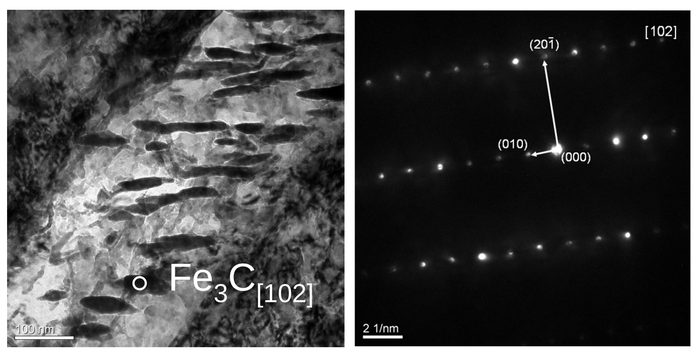
Element	C	Si	Mn	P	S
wt.%	0.967	0.30	0.23	0.003	<0.001
Element	Cr	Mo	Ni	Cu	Al
wt.%	1.38	0.05	0.07	0.05	0.026

Characterization of bainitic microstructure

HRTEM

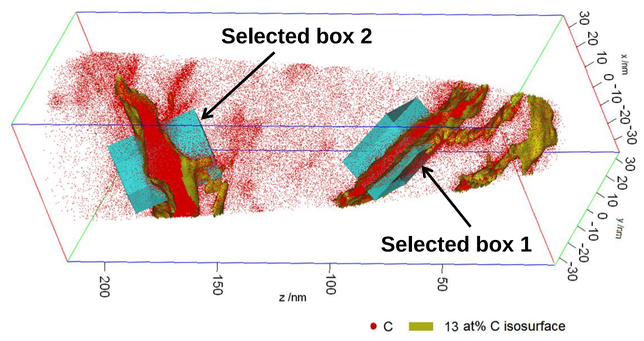


High Resolution Transmission Electron Microscopy (HRTEM) bright field image showing bainite subunits a, b, c and secondary carbide $(Fe, Cr)_3C$ in 100Cr6 isothermally heat treated at 260 °C for 2500 s

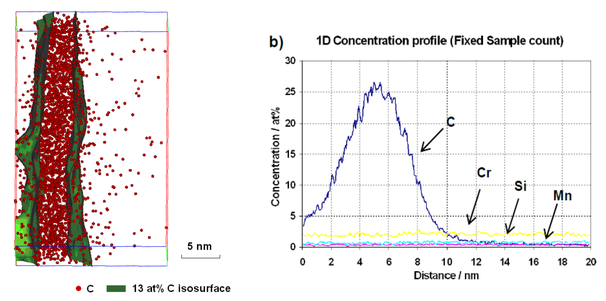


HRTEM bright field image showing the elongated precipitation within bainitic ferrite in 100Cr6 isothermally heat treated at 260 °C for 2500 s and CBED pattern proving it to be Fe_3C with the direction of [102]

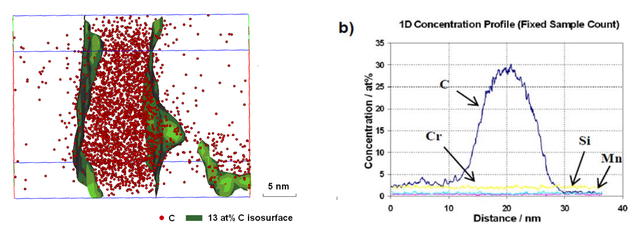
3D Atom Probe



Carbon atom map and 13 at% isoconcentration surface in lower bainite in 100Cr6 isothermally heat treated at 260 °C for 2500 s



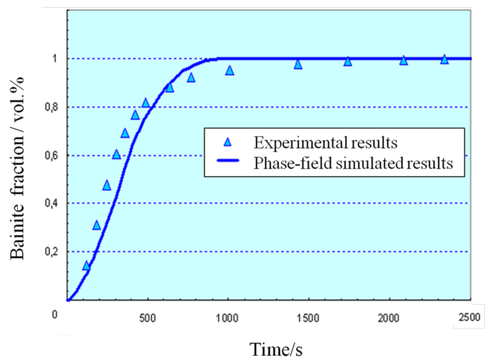
Carbon atom map and 1D concentration profile showing the elements distribution in cementite



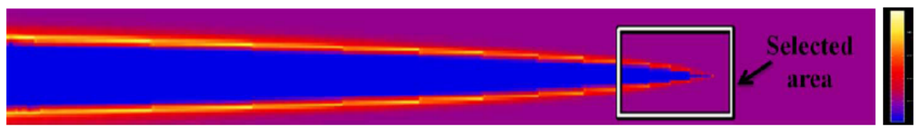
Carbon atom map and 1D concentration profile showing the elements distribution in ε- carbide

Phase-field Modelling

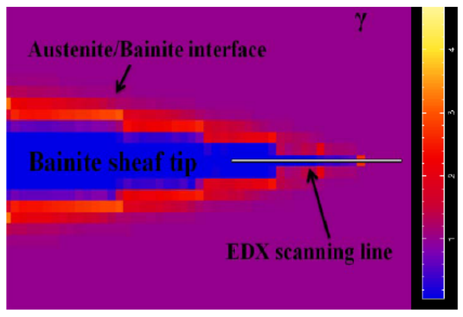
Phase-field simulation of single bainite sheaf development in 100Cr6 during 260 °C isothermal transformation by means of MICRESS®



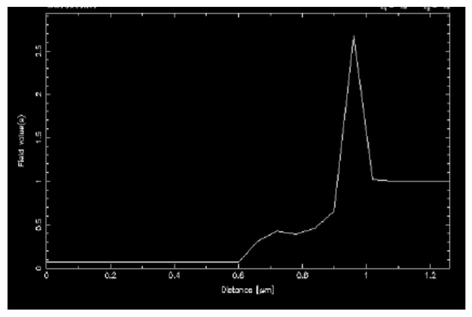
Comparison of experimental results and phase-field simulated results of bainitic phase transformation kinetics in 100Cr6 during 260 °C isothermal transformation



Carbon profile of 40 vol. % transformed bainite sheaf in 100Cr6 during 260 °C isothermal transformation simulated with phase-field software MICRESS®



Carbon profile of selected area bainite sheaf tip



Virtual EDX showing the carbon concentration along the EDX scanning line

Conclusions

➢**3 Dimensional Atom Probe (3DAP) analysis reveal the existence of cementite and ε-carbide in lower bainite. The detection of ε-carbide in lower bainite implies a large excess of carbon trapped in bainitic ferrite when it first forms.**

➢**A single bainite sheaf development during isothermal transformation is successfully simulated by means of phase-field method.**

➢**The experimental and phase-field simulated results of bainitic phase transformation kinetics have a satisfactory agreement.**

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