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Slow Bainite: an Opportunity to Determine the Carbon Content of the Bainitic Ferrite during Growth

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Mechanisms Controlling Bainitic Ferrite Growth

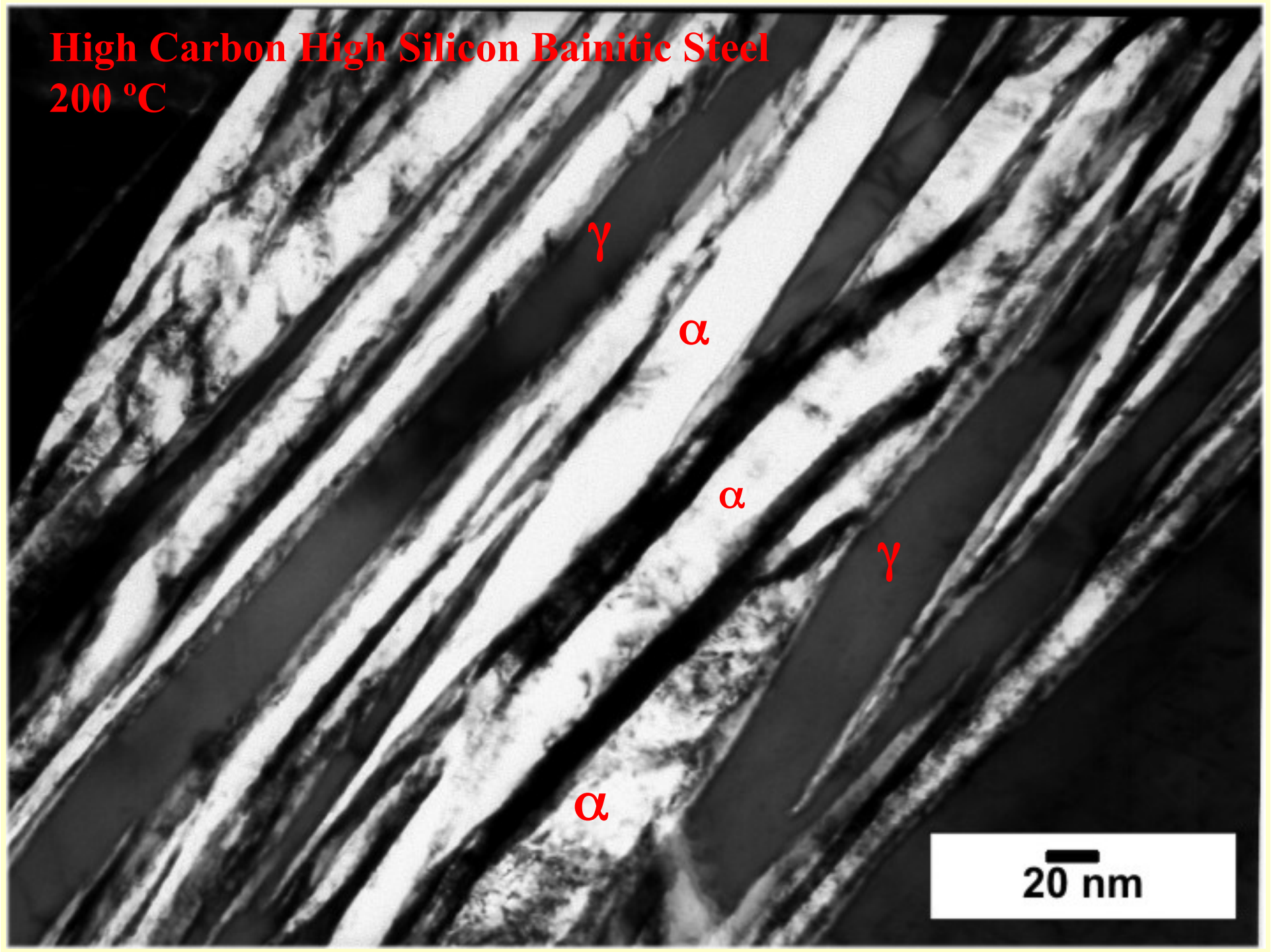
Diffusional vs. Diffusionless

Has the newly formed bainitic ferrite the para-equilibrium carbon content (~0.12 at.%)?

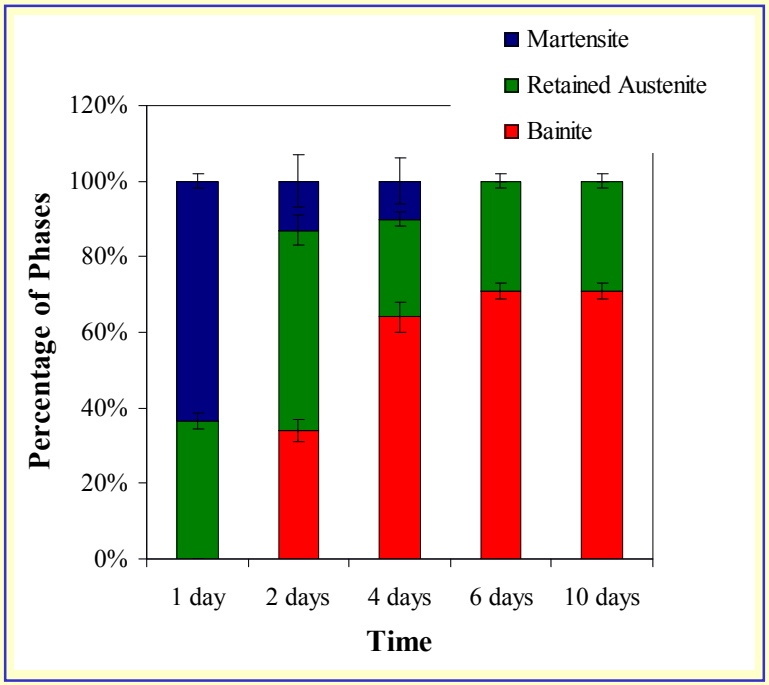
or is it supersaturated with carbon?.

In most alloys, it is impossible to experimentally estimate the initial carbon content of bainitic ferrite because the time taken for any carbon to diffuse into austenite can be extremely short.

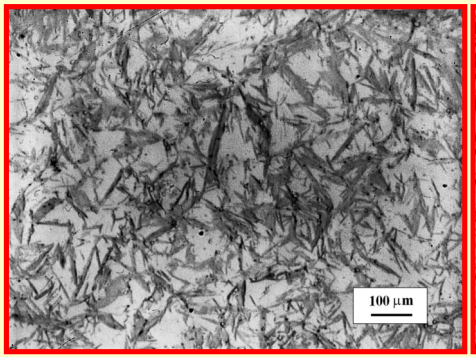
Carbon can be very mobile at temperatures as low as -60ºC.


High Carbon High Silicon Bainitic Steel
200 °C
γ
α
α
γ
α
20 nm

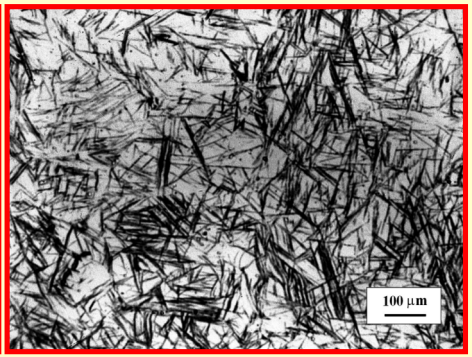
Slow Bainite Transformation Kinetics



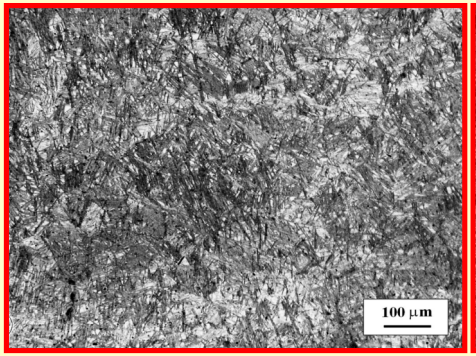
Fe-1.0C-1.5Si-2Mn - 200ºC



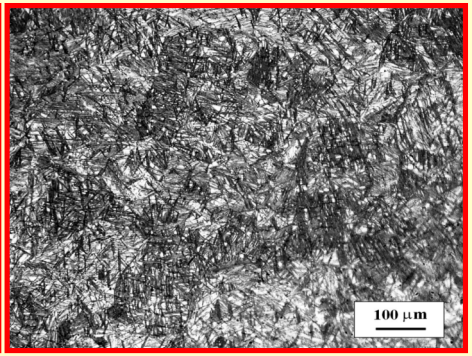
1 day



2 days

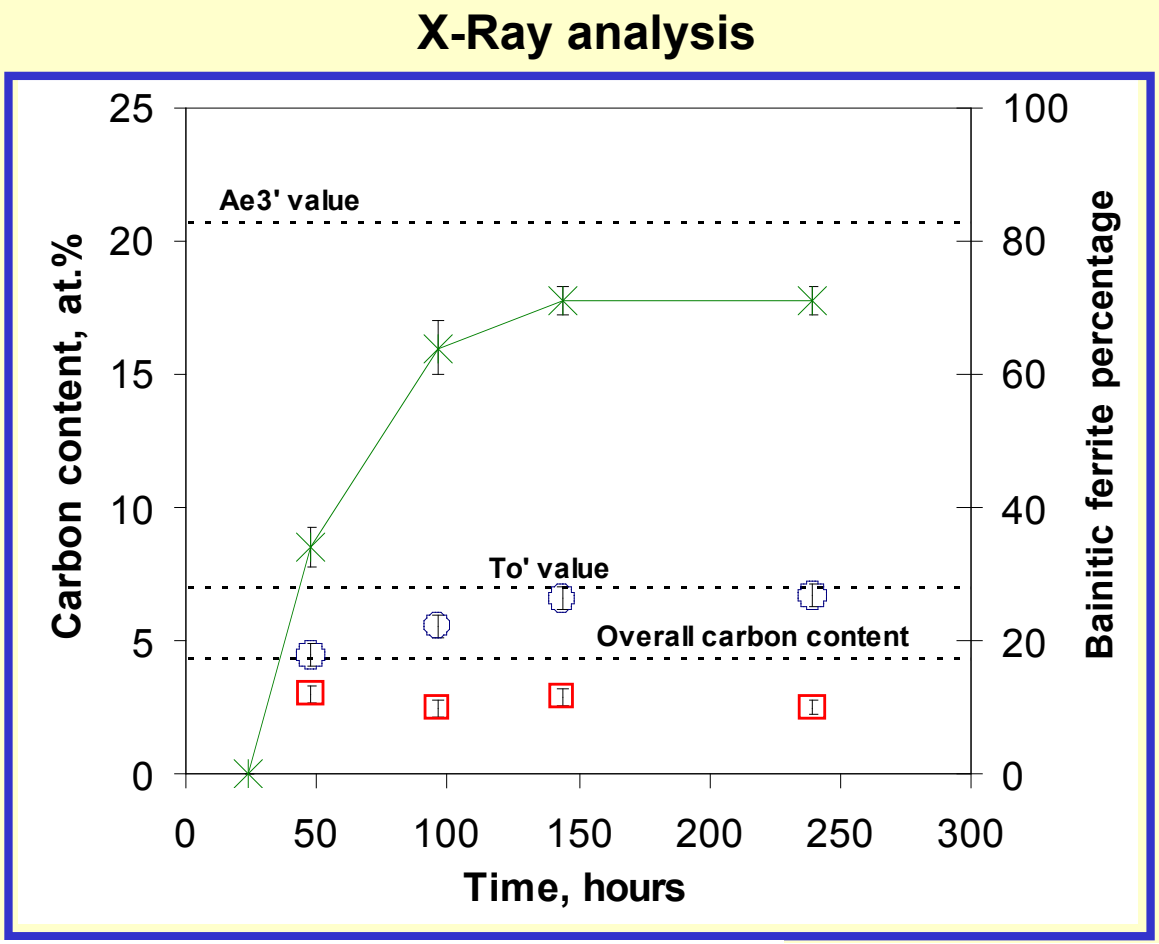


4 days

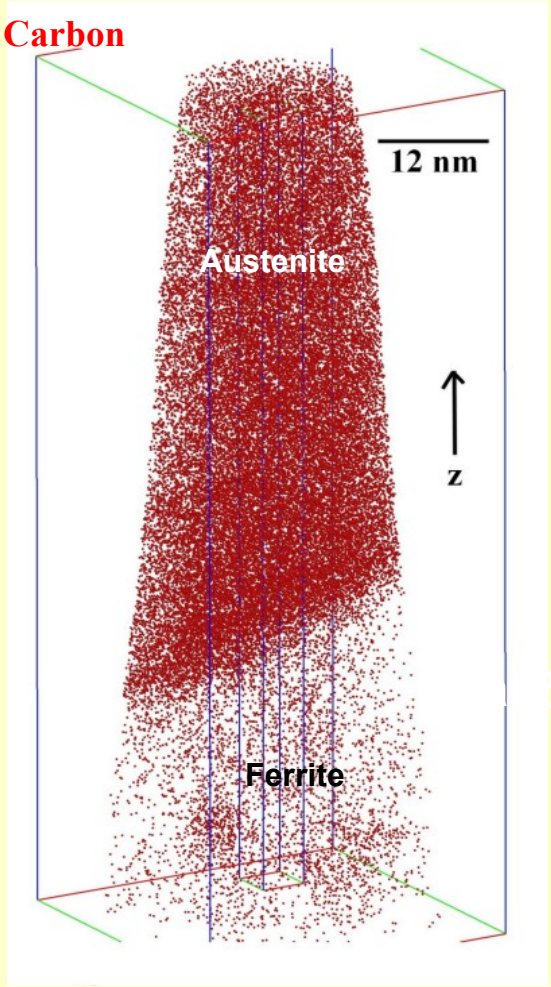


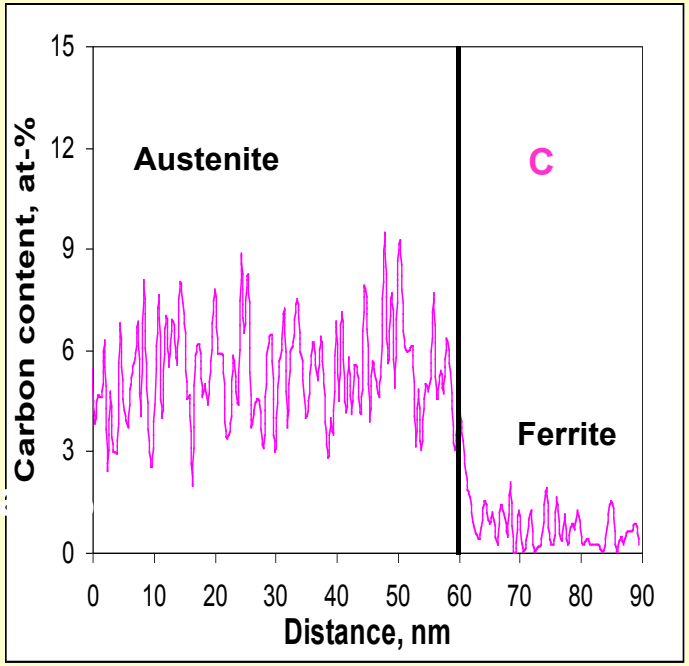
6 days

The Incomplete Reaction Phenomena



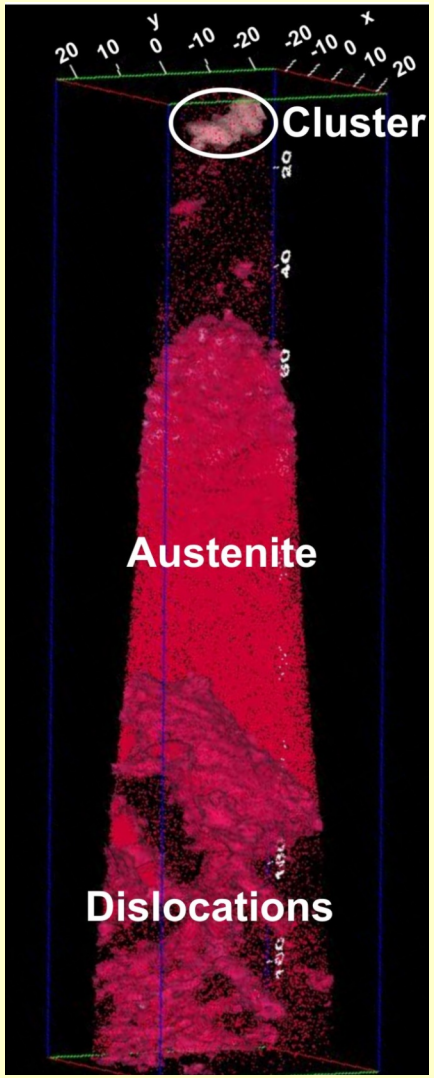
The Incomplete Reaction Phenomena at the Atomic Scale



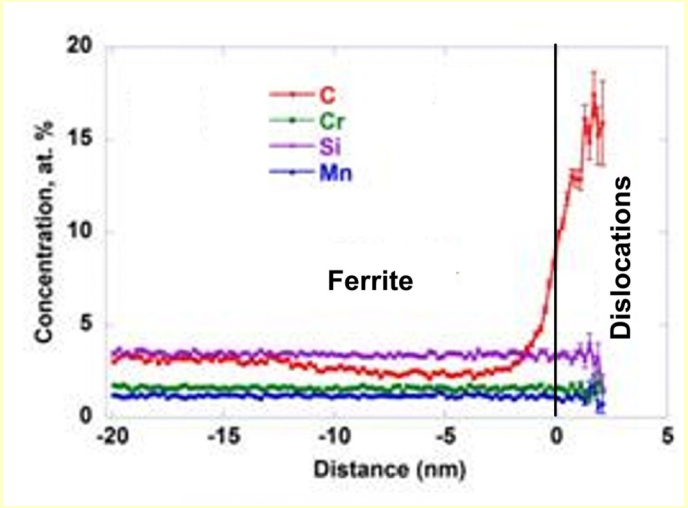


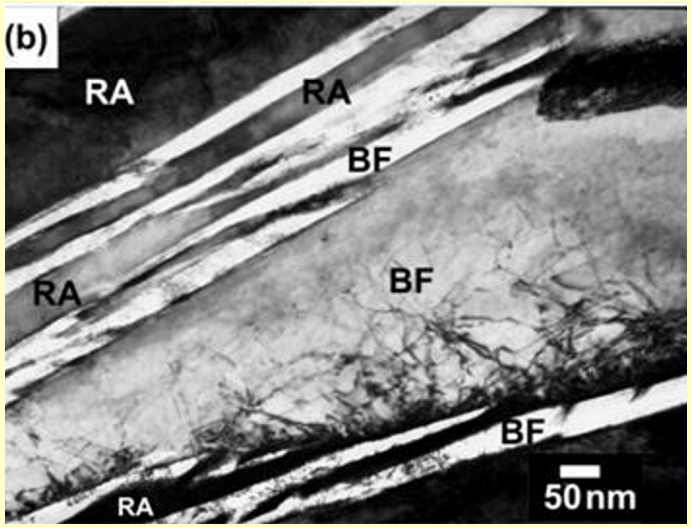
200 ºC for 6 days

Dislocations in the Vicinity of the Interface



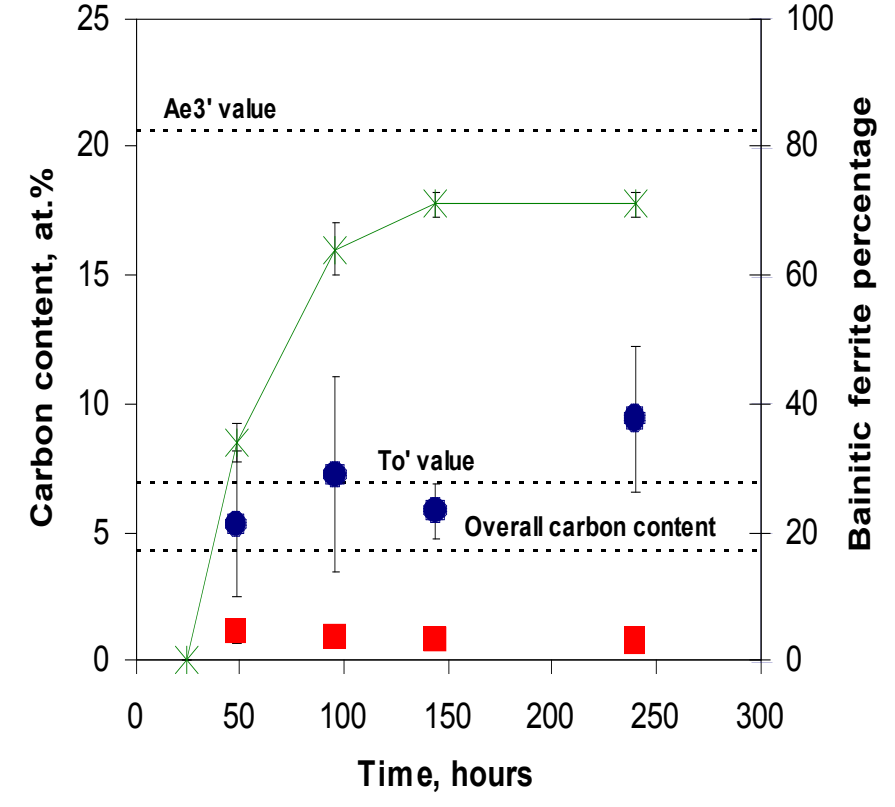
Carbon isoconcentration surfaces at 8 at. % C superimposed with the carbon atom map,

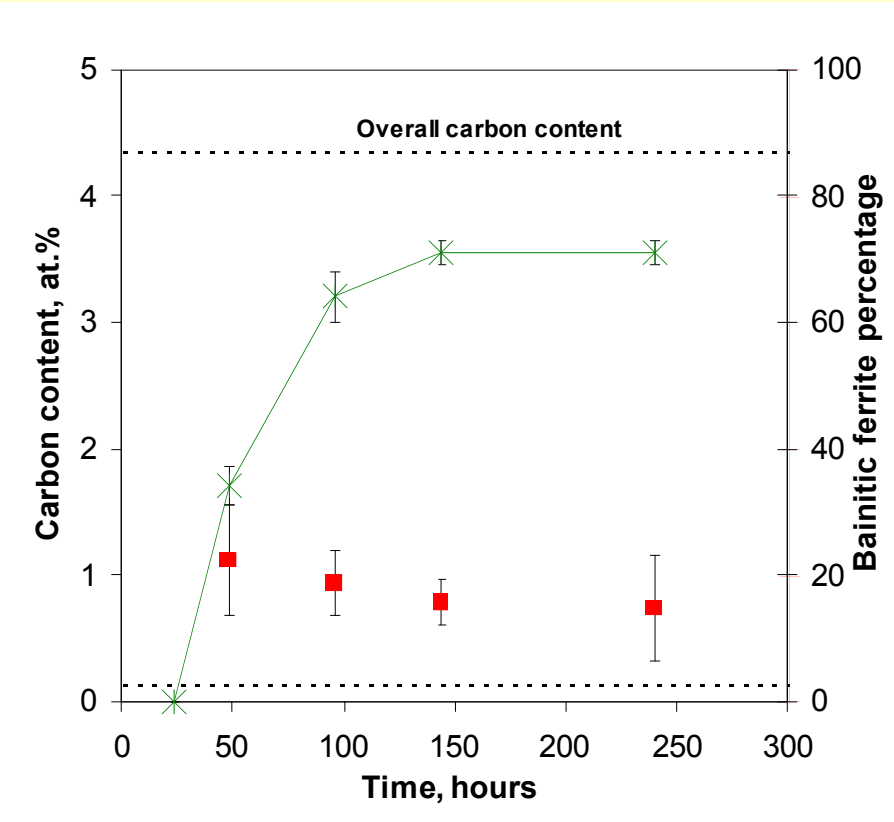




Carbon Content in Austenite and Bainitic Ferrite

Atom Probe Tomography



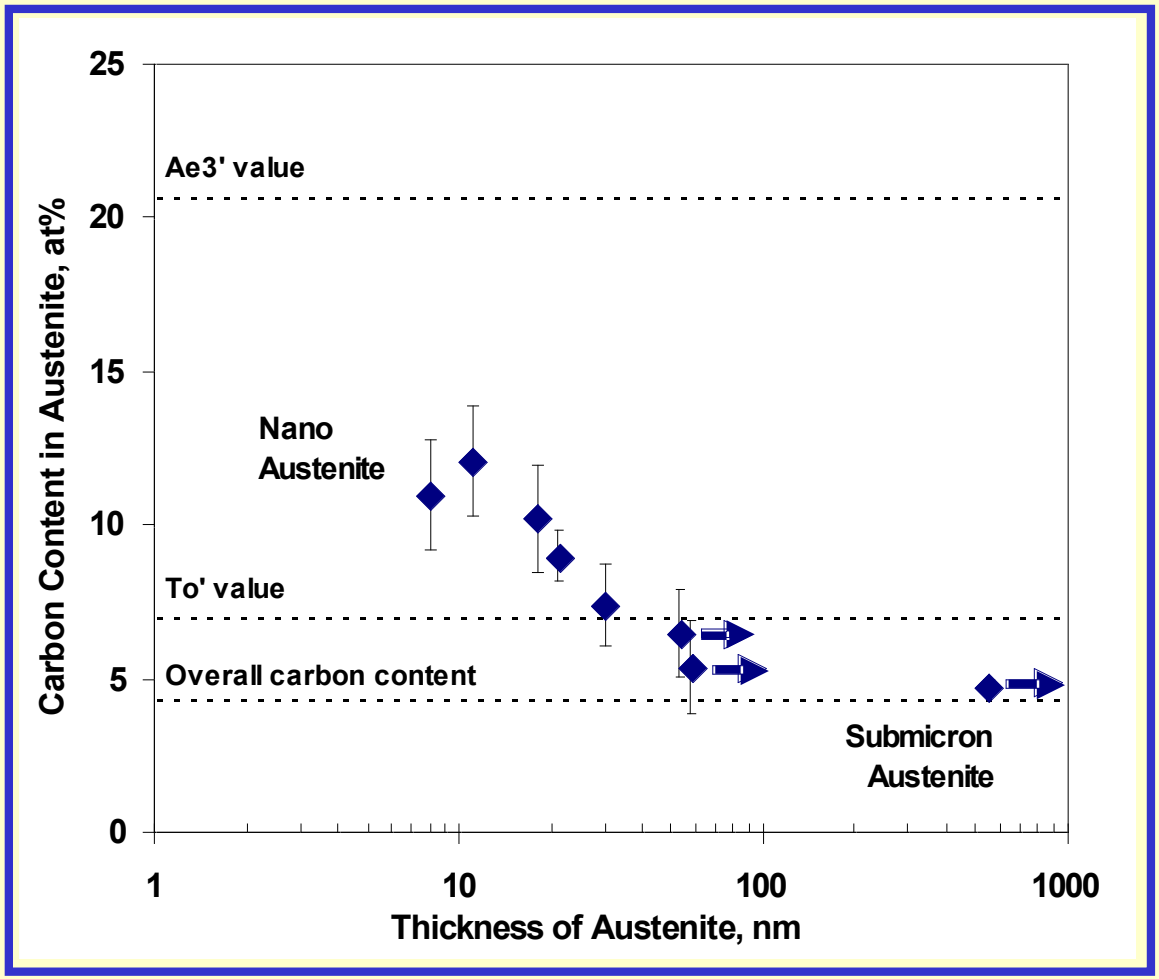


Carbon in Ferrite

Carbon in Austenite

Bainitic Ferrite Percentage

Heterogeneous distribution of carbon in austenite



Heterogeneous distribution of carbon in austenite

Conclusions

Carbon content in bainitic ferrite away from any carbon-enriched regions such as dislocations and boundaries has been determined by atom probe tomography as bainite transformation progresses, taking advantage of the slow bainite reaction at 200 ºC of a nanocrystalline steel.

Results have shown that the original bainitic ferrite retains much of the carbon content of the parent austenite providing strong evidence for the diffusionless mechanisms controlling bainitic ferrite growth.