

Phase field modeling of the cyclic phase transformations in Fe-C-Mn alloys

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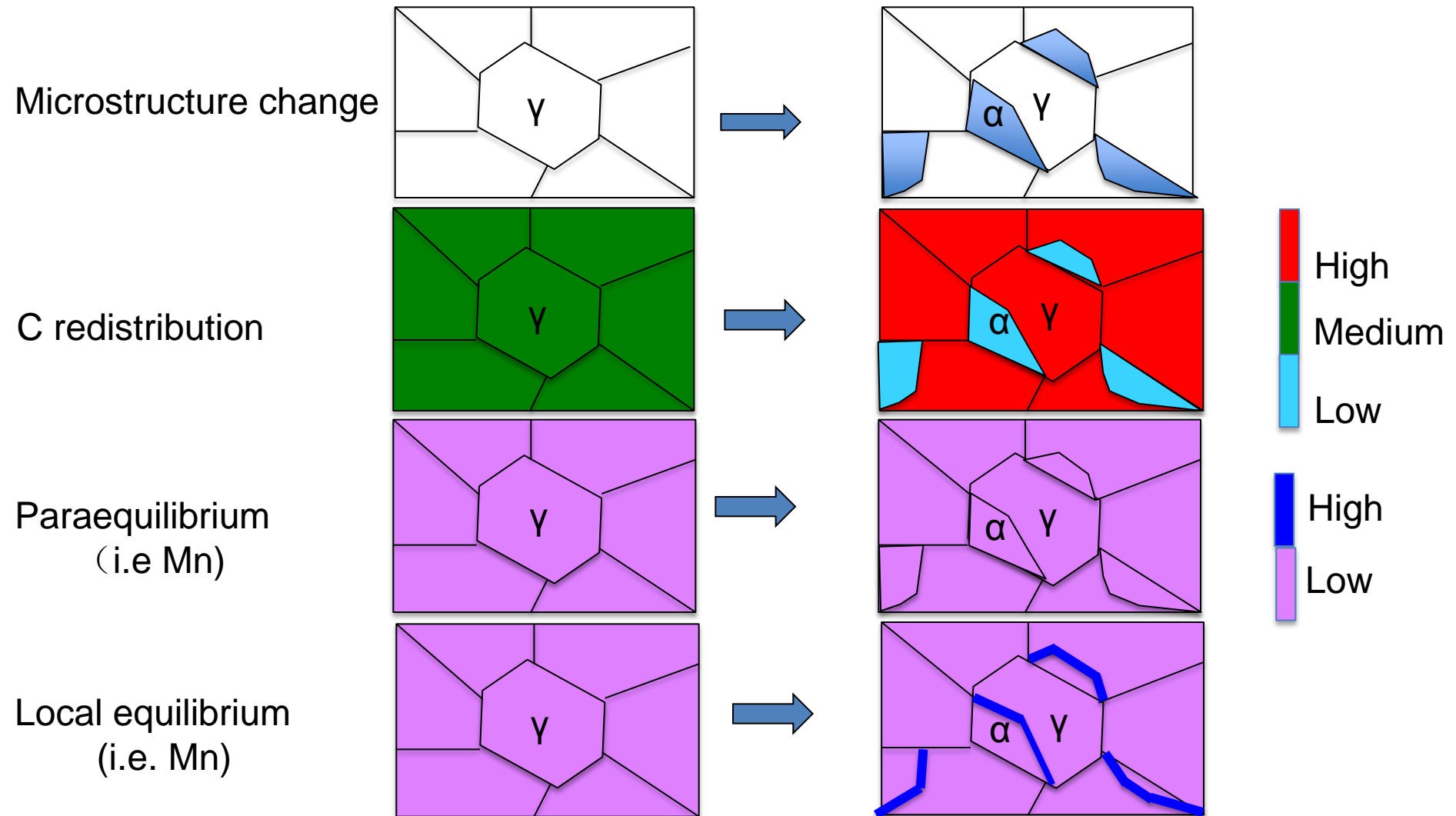
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The austenite to ferrite transformation

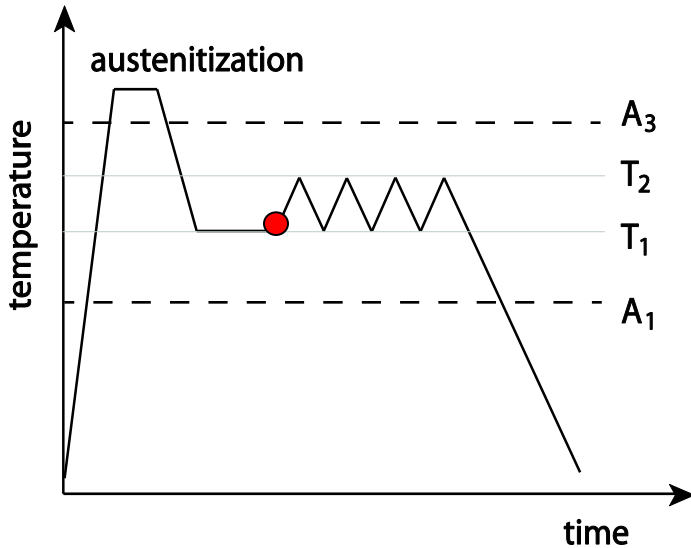


Experimental approaches

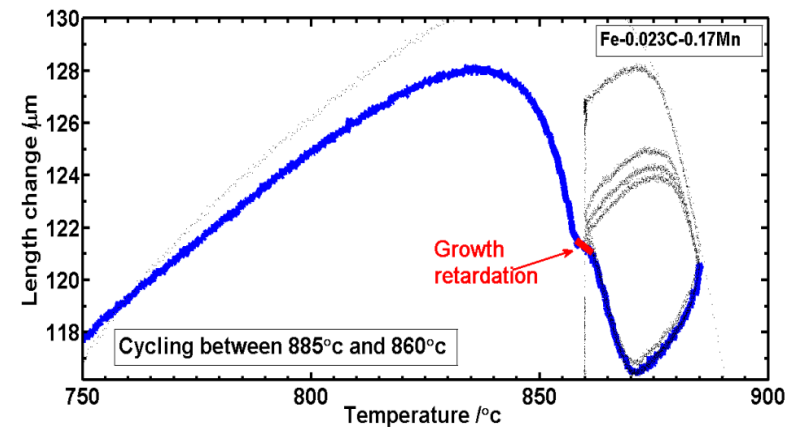
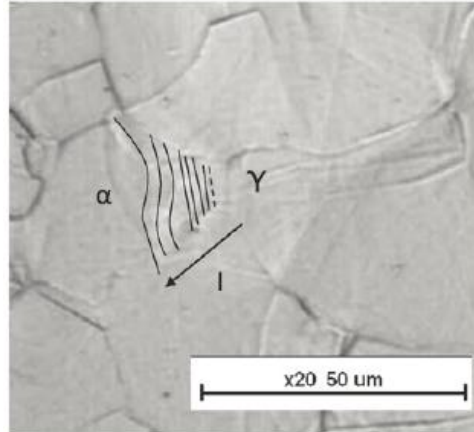
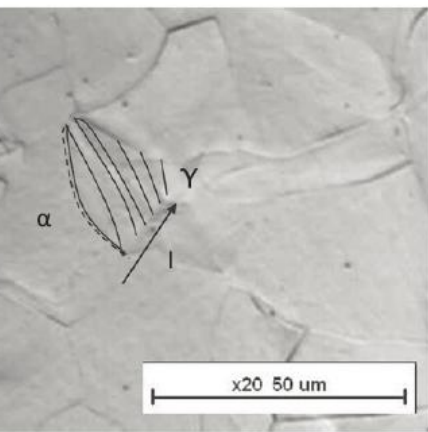
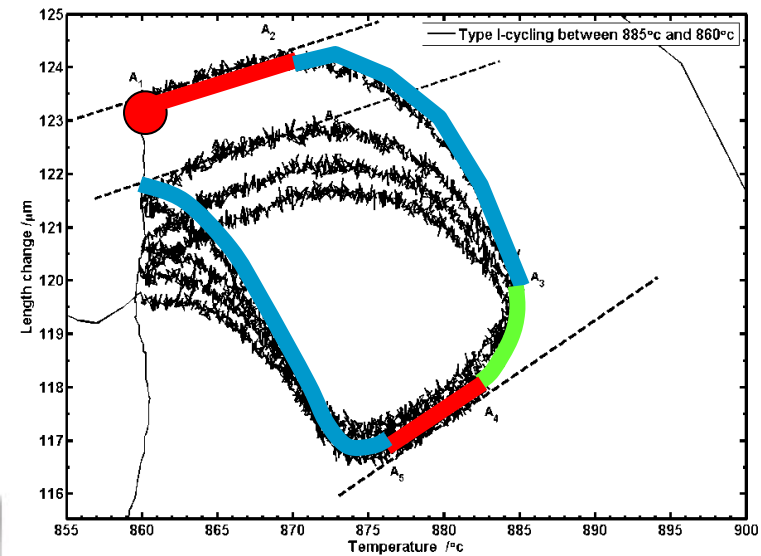
1. Conventional experiments (isothermal or non-isothermal experiments).
2. Decarburization experiments.
3. Gradient experiment
4. The cyclic phase transformation experiments



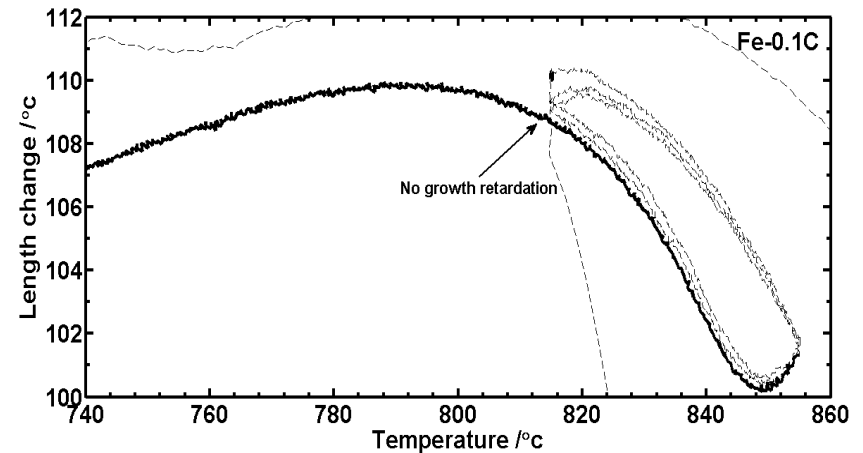
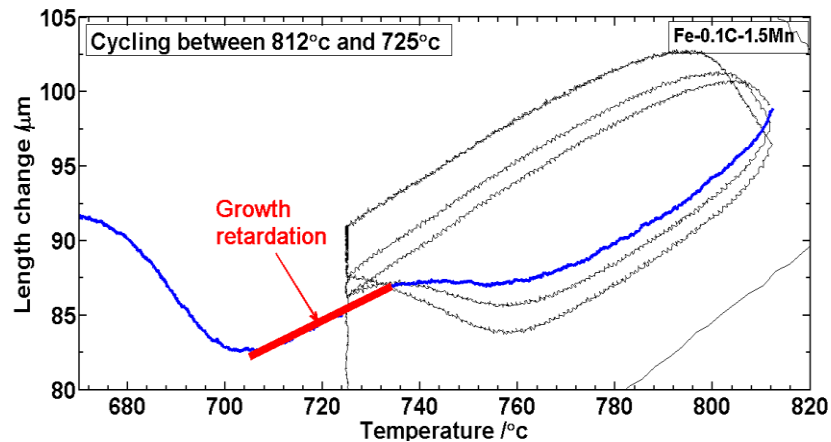
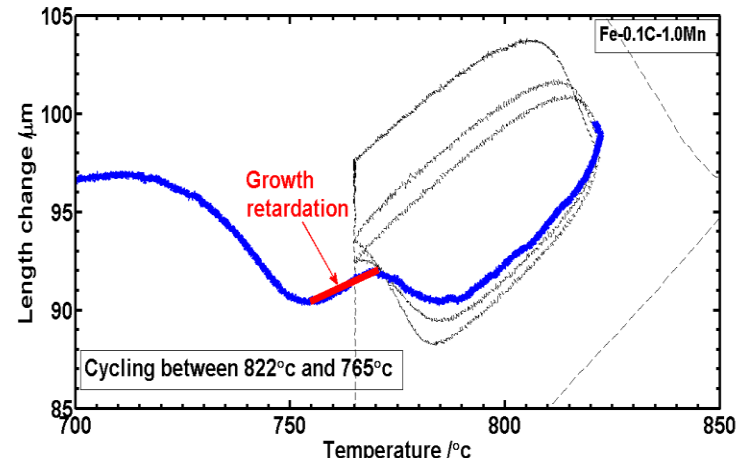
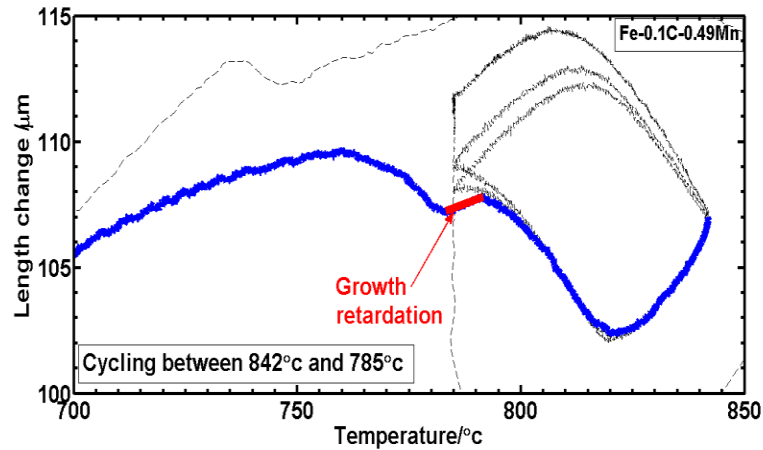
The cyclic phase transformations in Fe-C-Mn alloys



Fe-0.17Mn-0.023C alloy



The effect of Mn concentration



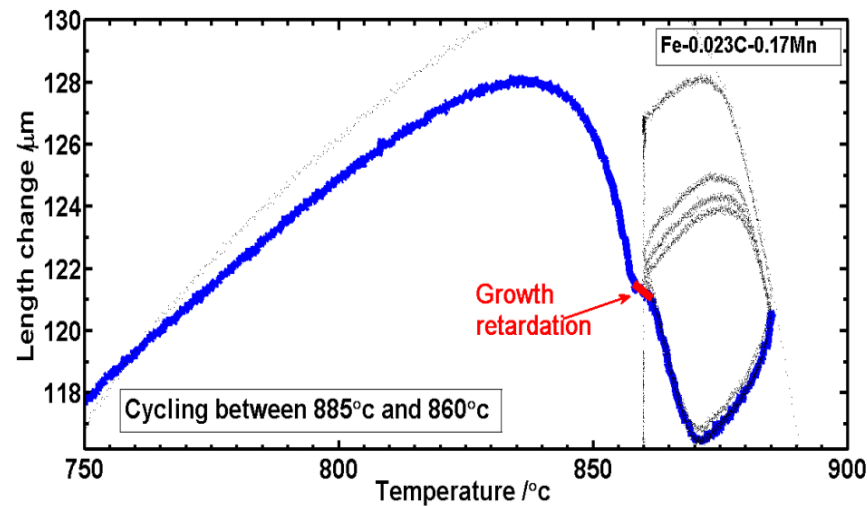
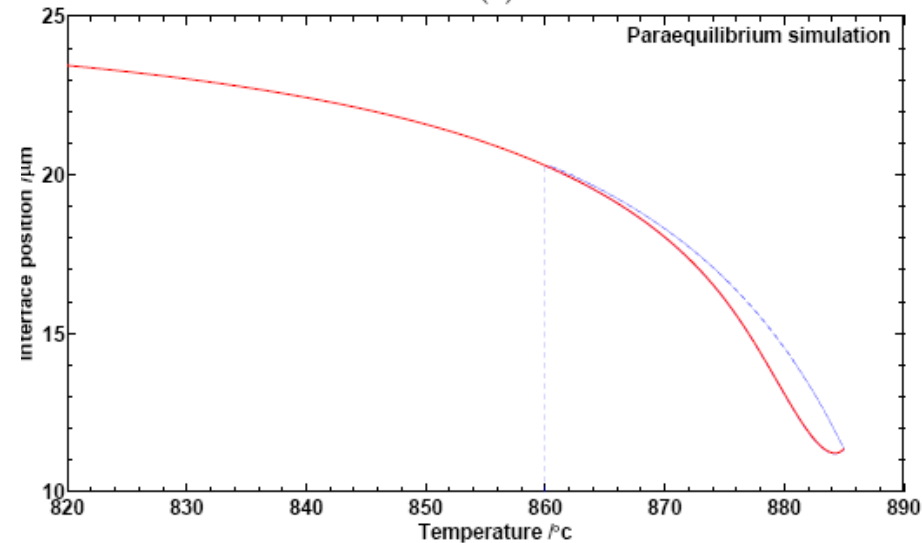
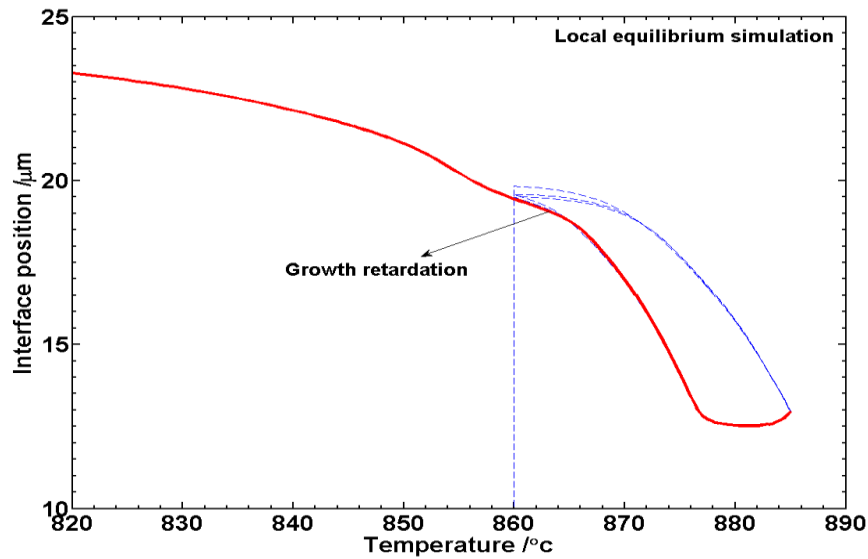
Chen, van der Zwaag, Acta Materialia, 61(2013)1338-1349



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Predictions by sharp interface models



Phase field modeling of the cyclic phase transformations in Fe-C-Mn alloys



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Different modes in MICRESS

1. Paraequilibrium mode (Only C diffuses)
- 2. Standard mode (Both C and Mn diffuse)**
3. NPLe(new mode)

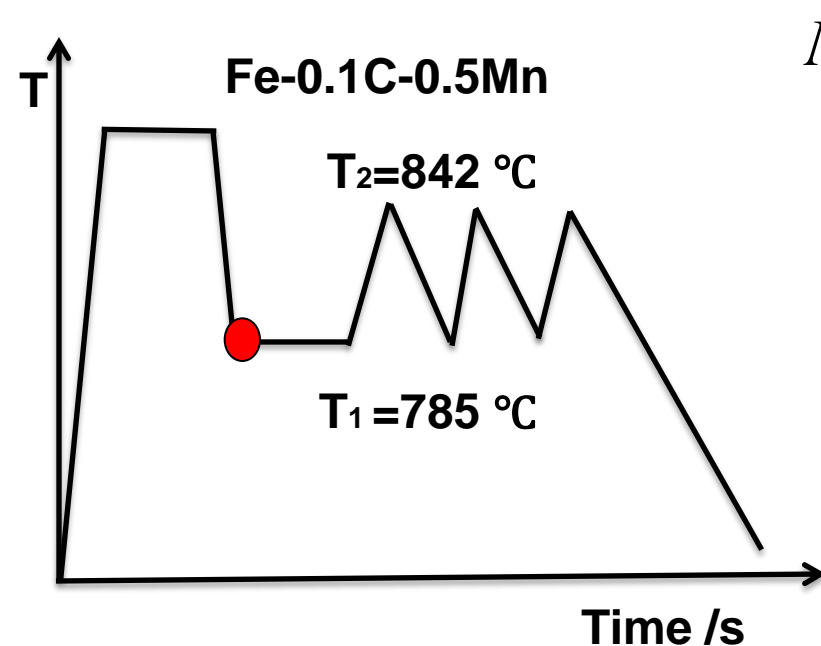


Motivation of this work

1. PFM can predict the transition from Negligible partitioning to partitioning growth mode???
2. Can PFM capture the basic features of the cyclic transformations??
3. What's the effect of interface mobility on the kinetics of the cyclic transformations?



Cyclic transformation in a Fe-0.1C-0.5Mn alloy

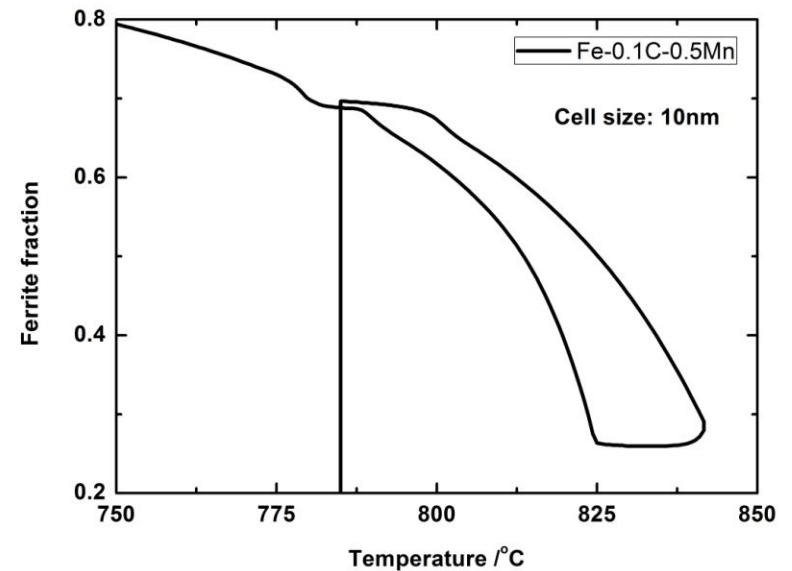
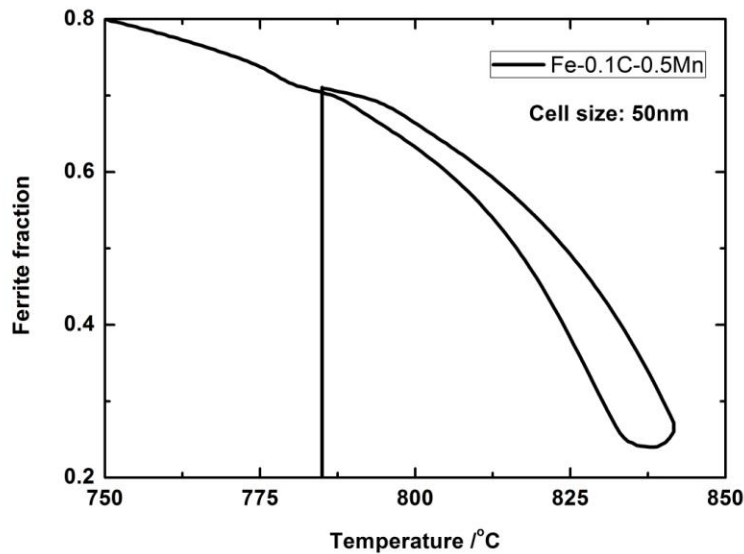
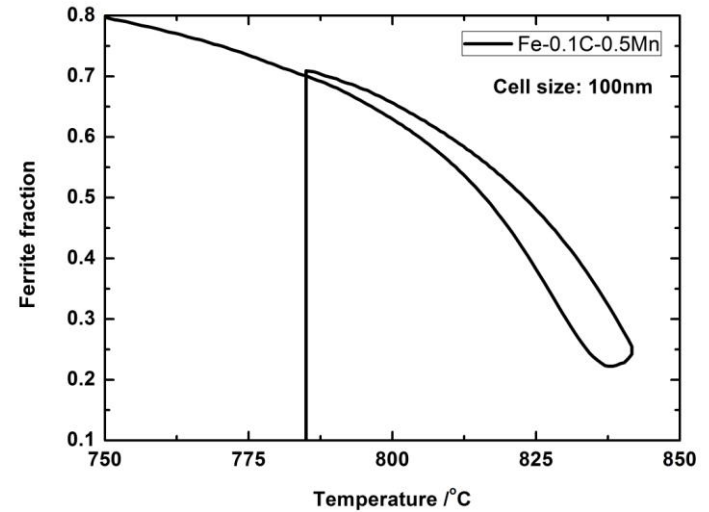
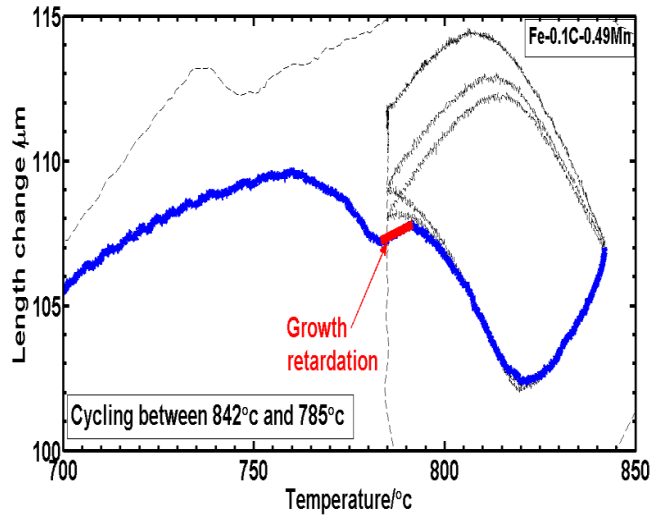


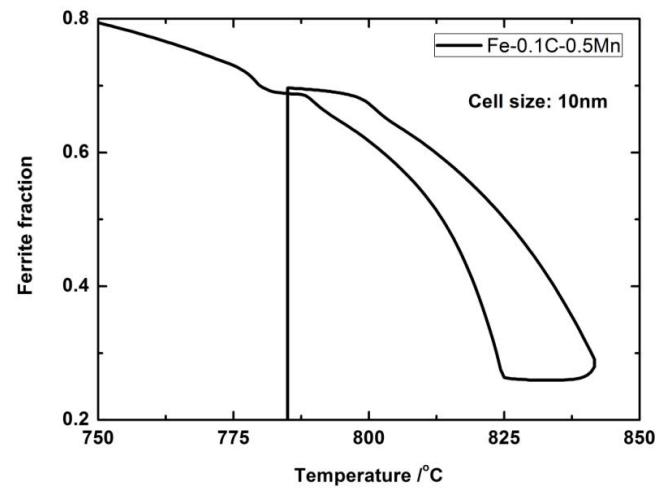
$$M = 4 \times 10^{-7} \exp(-140000 / RT) m^4 / Js$$

Starting condition:

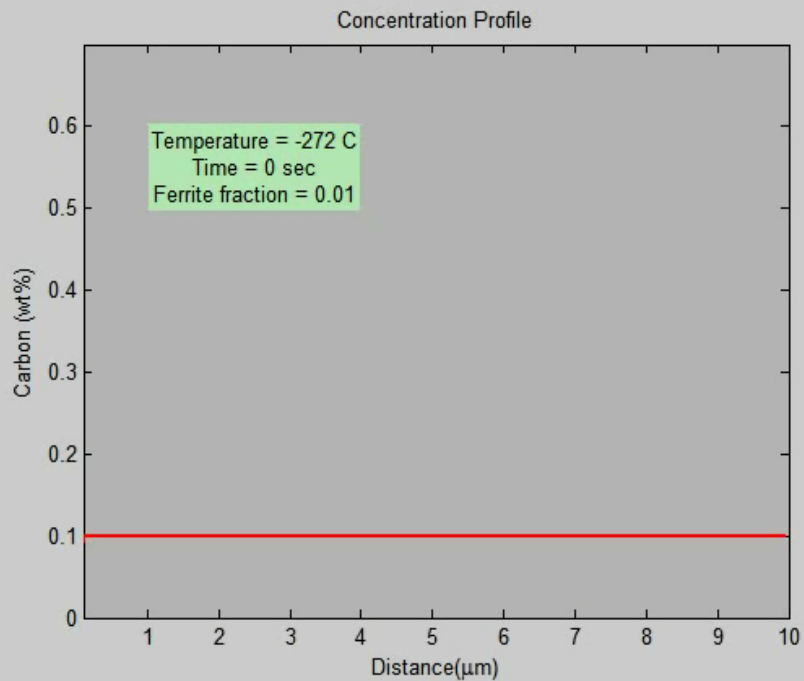


Cell size effect

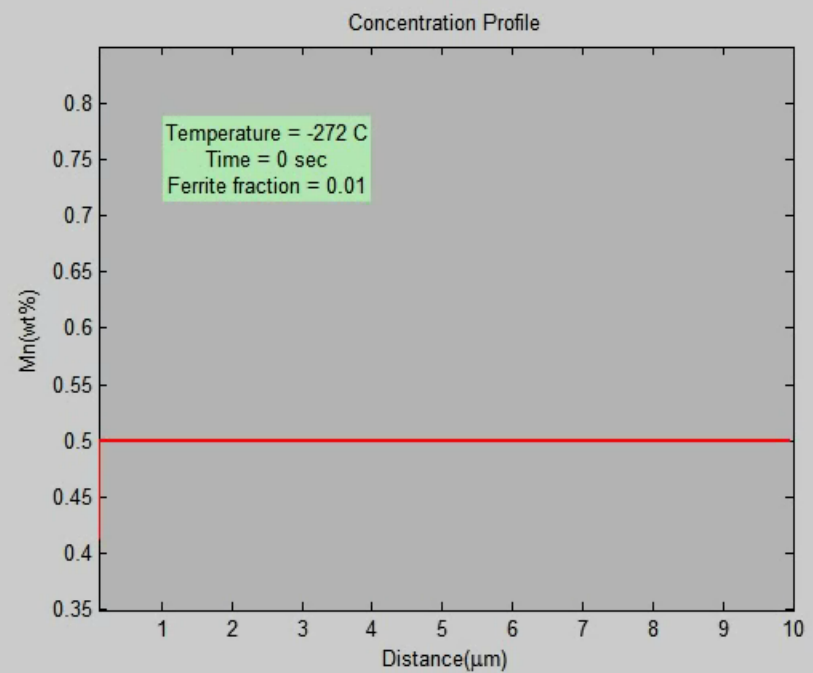




Carbon profile



Mn profile

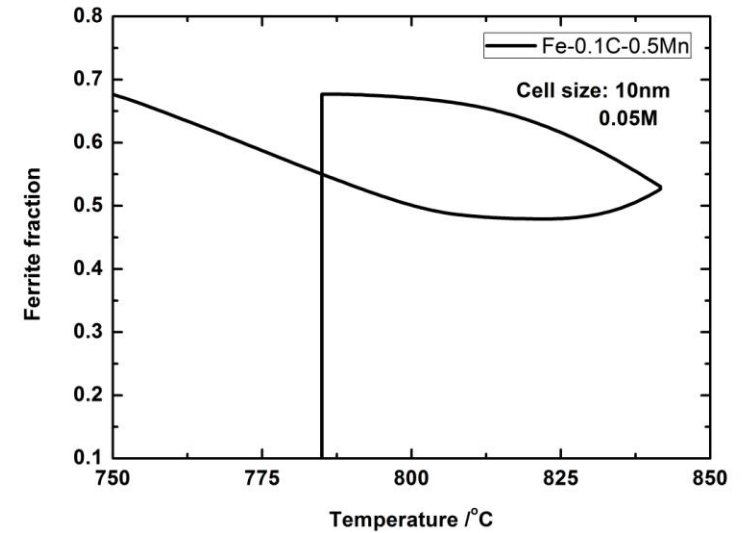
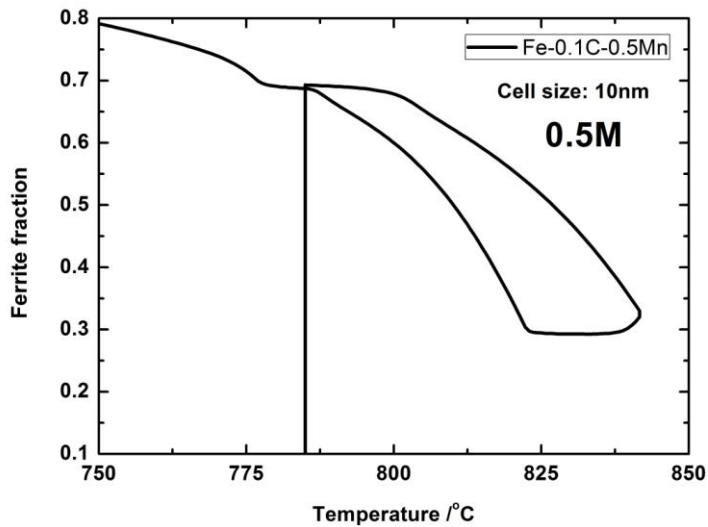
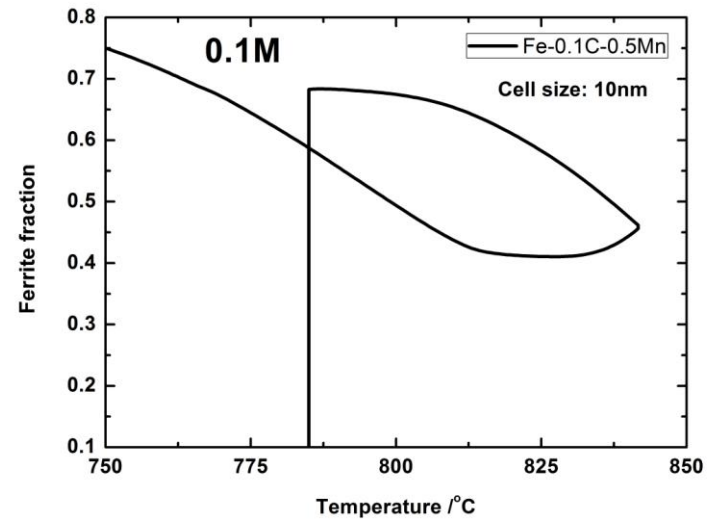
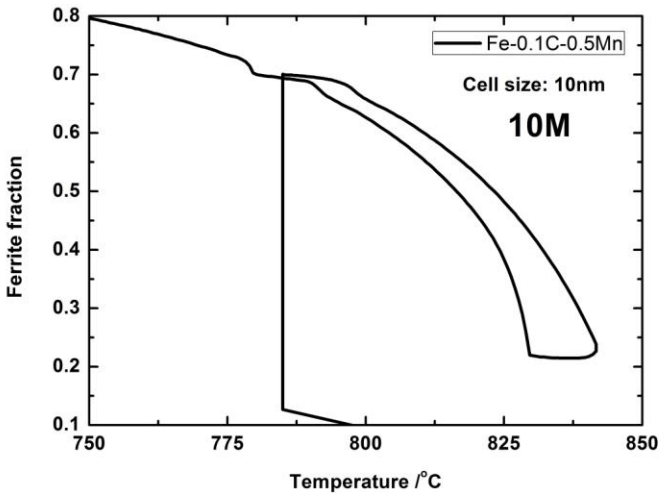


Interim summary

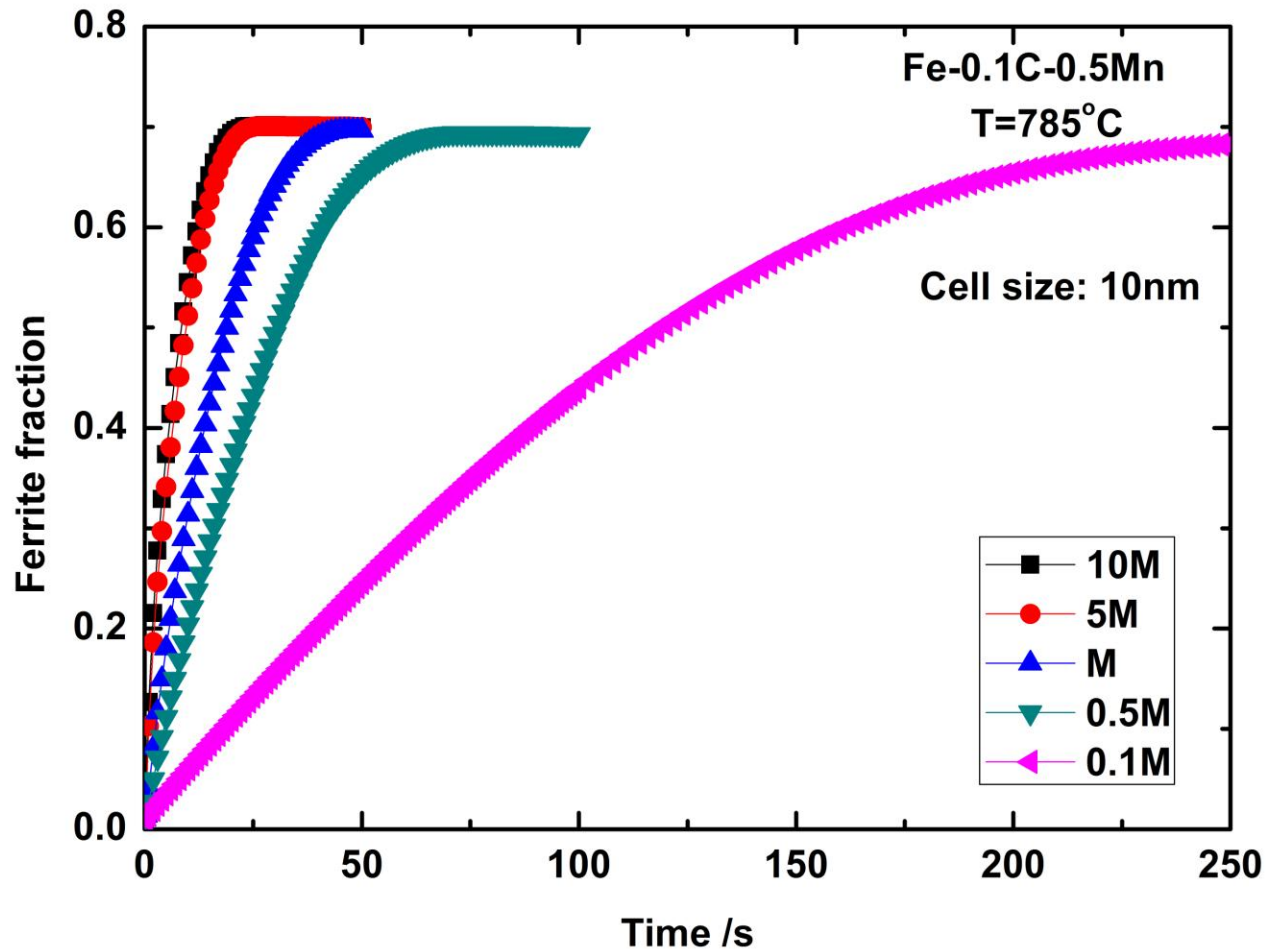
1. The kinetic transition from negligible partitioning of Mn to Partitioning of Mn is predicted by PFM.
2. PFM can qualitatively capture the basic features of the cyclic phase transformations if the cell size is small enough.



The effect of interface mobility

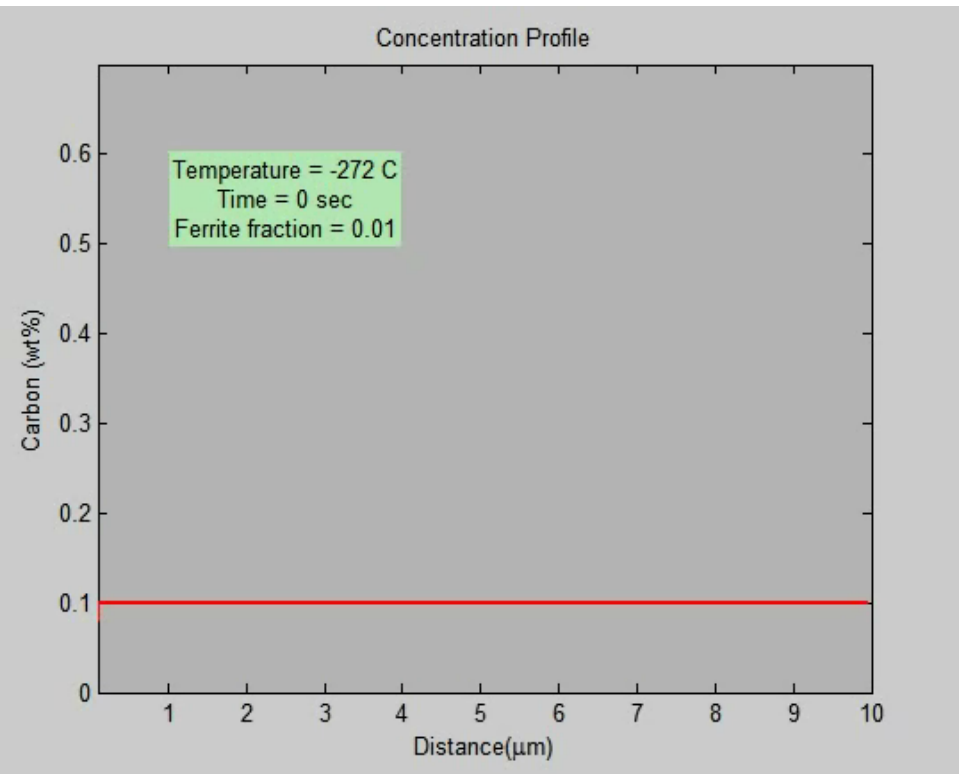


The effect of interface mobility

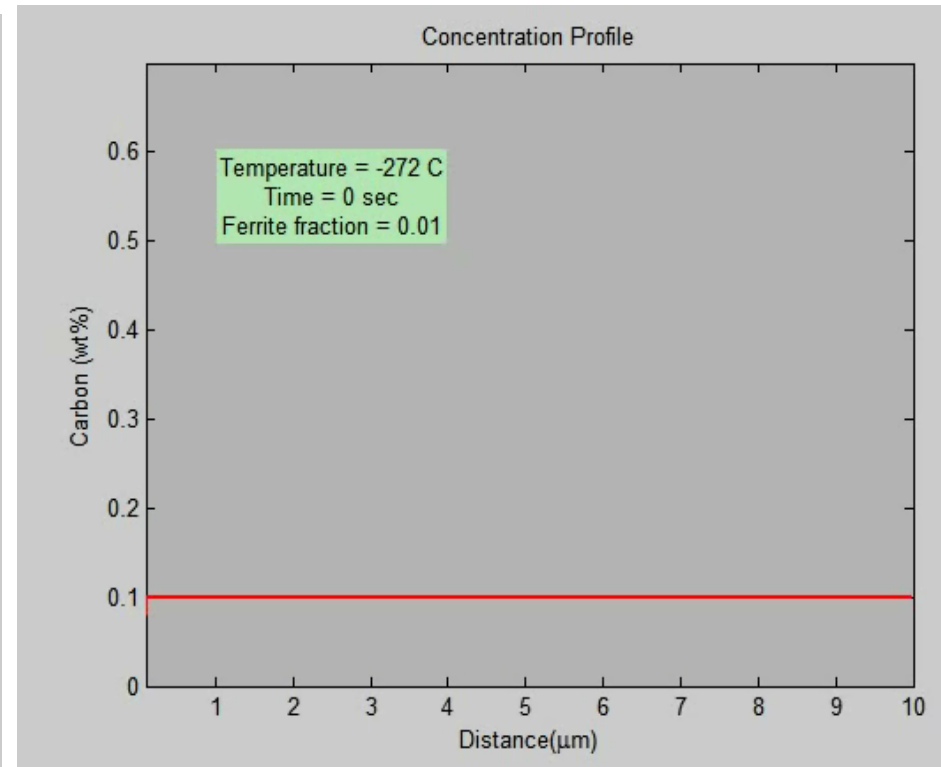


Carbon Profile

0.05M

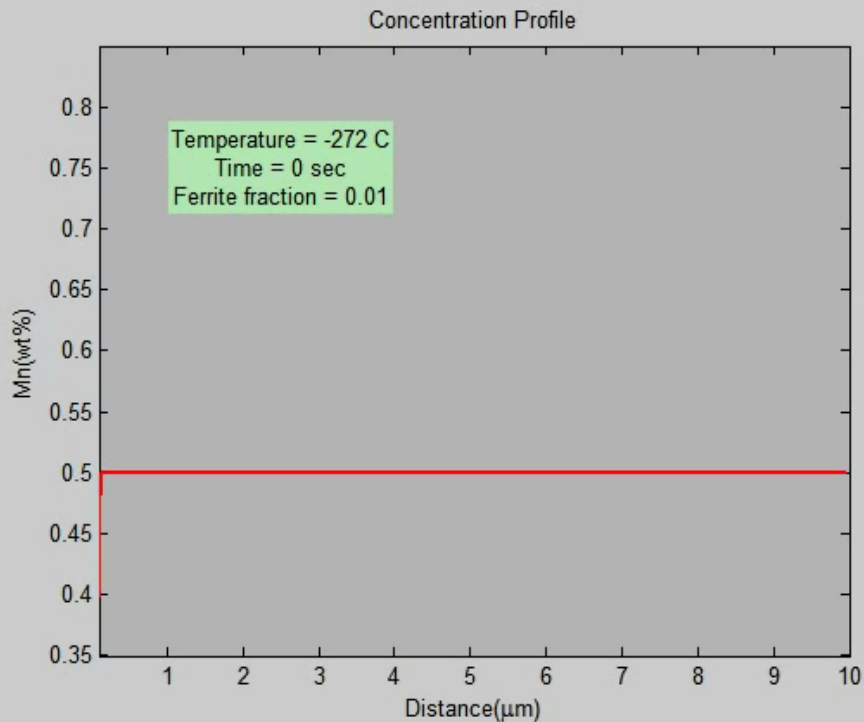


10M

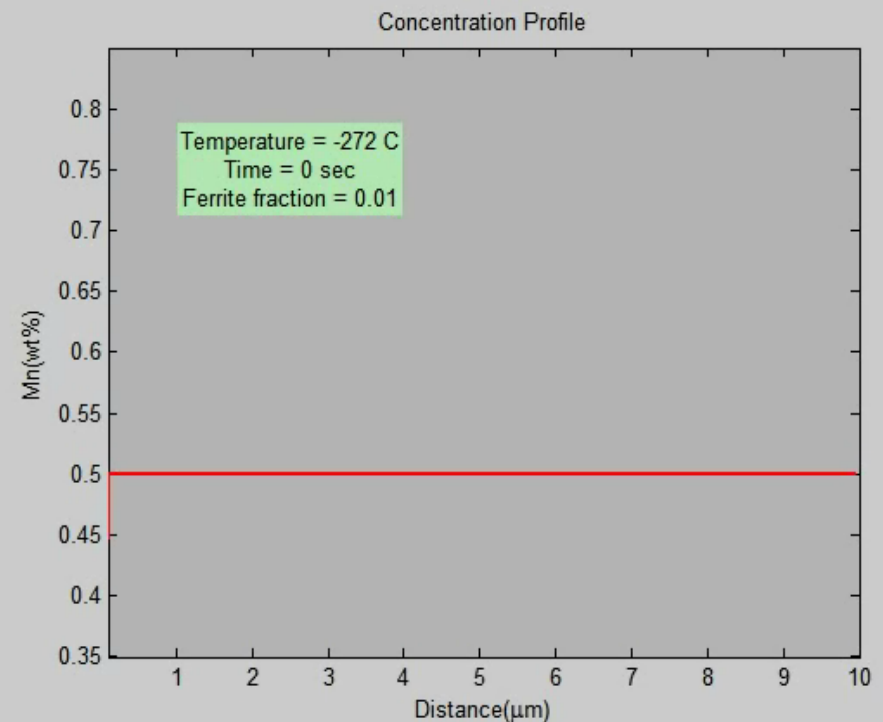


Mn Profile

0.05M



10M



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Summary

1. The PFM can predict the transition from negligible partitioning to partitioning mode.
2. The basic features of the cyclic phase transformations can be captured by PFM simulations if the cell size is small enough.
3. The role of interface mobility on the transformation kinetics in Fe-C-Mn alloys needs to be further studied.

