Revisiting Observations of PE at High Temperatures in Fe-Mn-C

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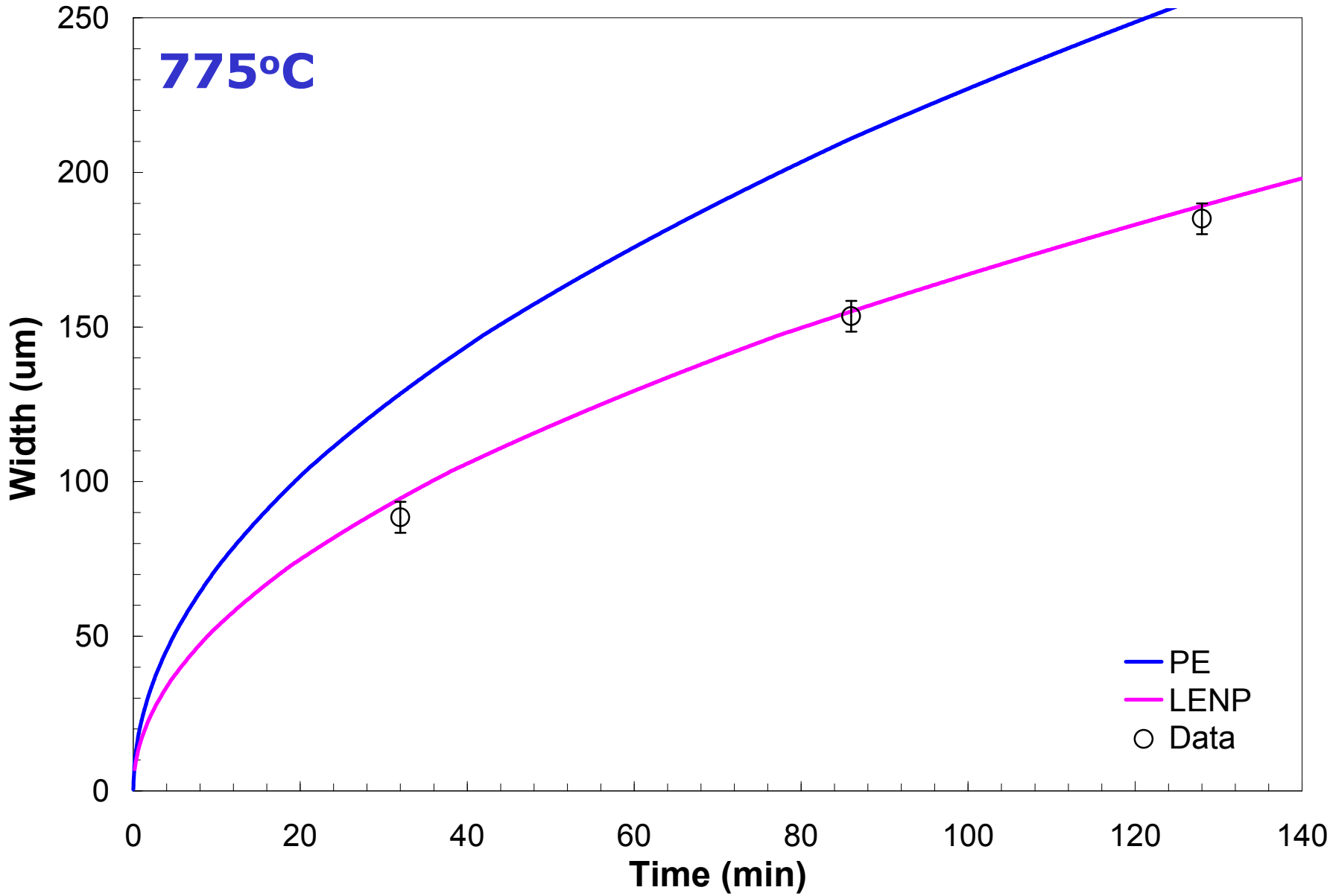
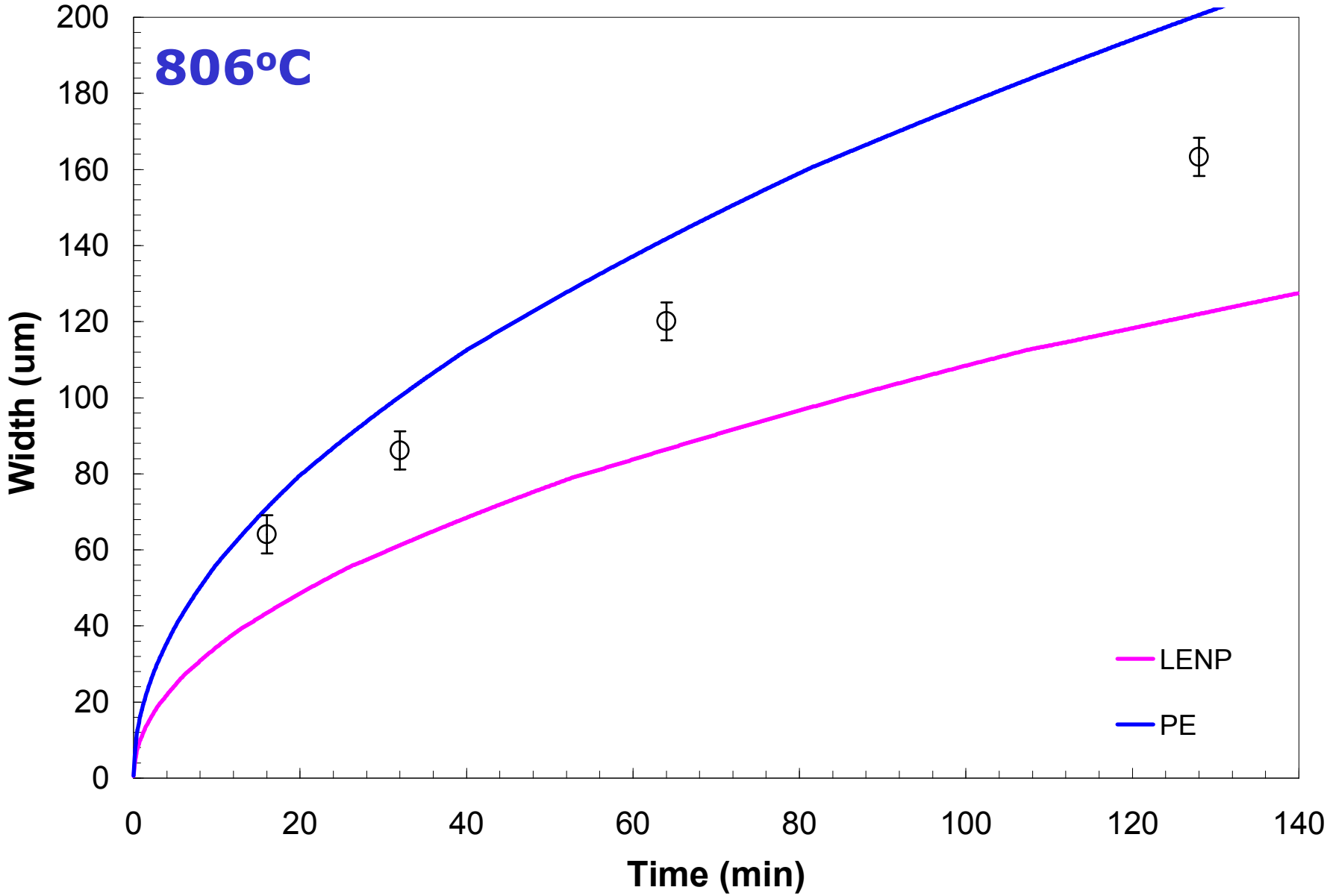
Earlier Observations:

- In the past we reported PE kinetics during ferrite growth under decarburization conditions at high temperature [Acta Materialia 56, 2203].
- The limit for non-partitioned ferrite growth in the FeMnC system appeared to be the PE limit.
- These observations are in contrast to earlier work on Ni which suggests that the limit for non-partitioned growth is close to the LENP limit.

Fe-C-Mn: 0.94%Mn-0.57%C



Fe-C-Mn: 0.94%Mn-0.57%C



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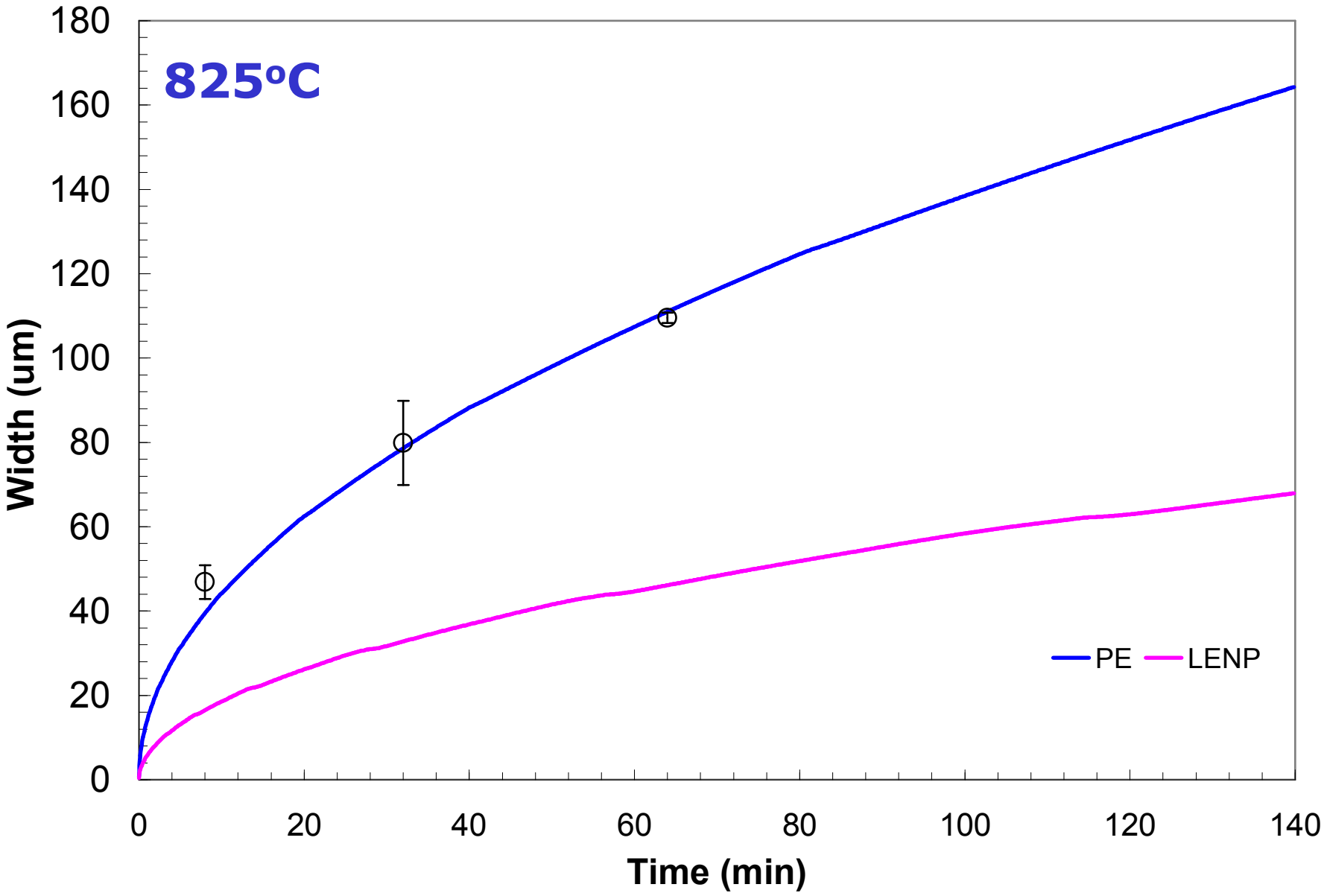
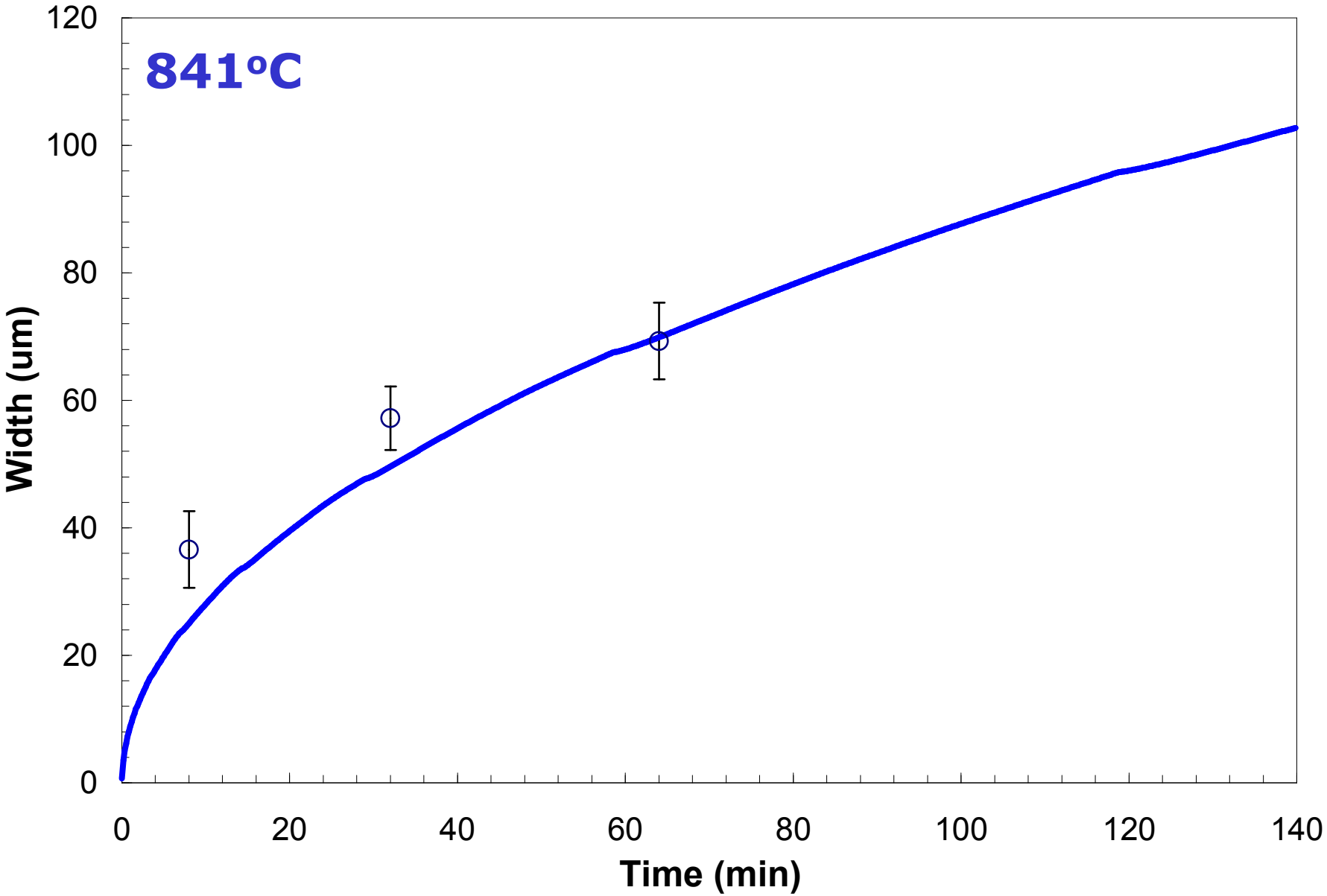
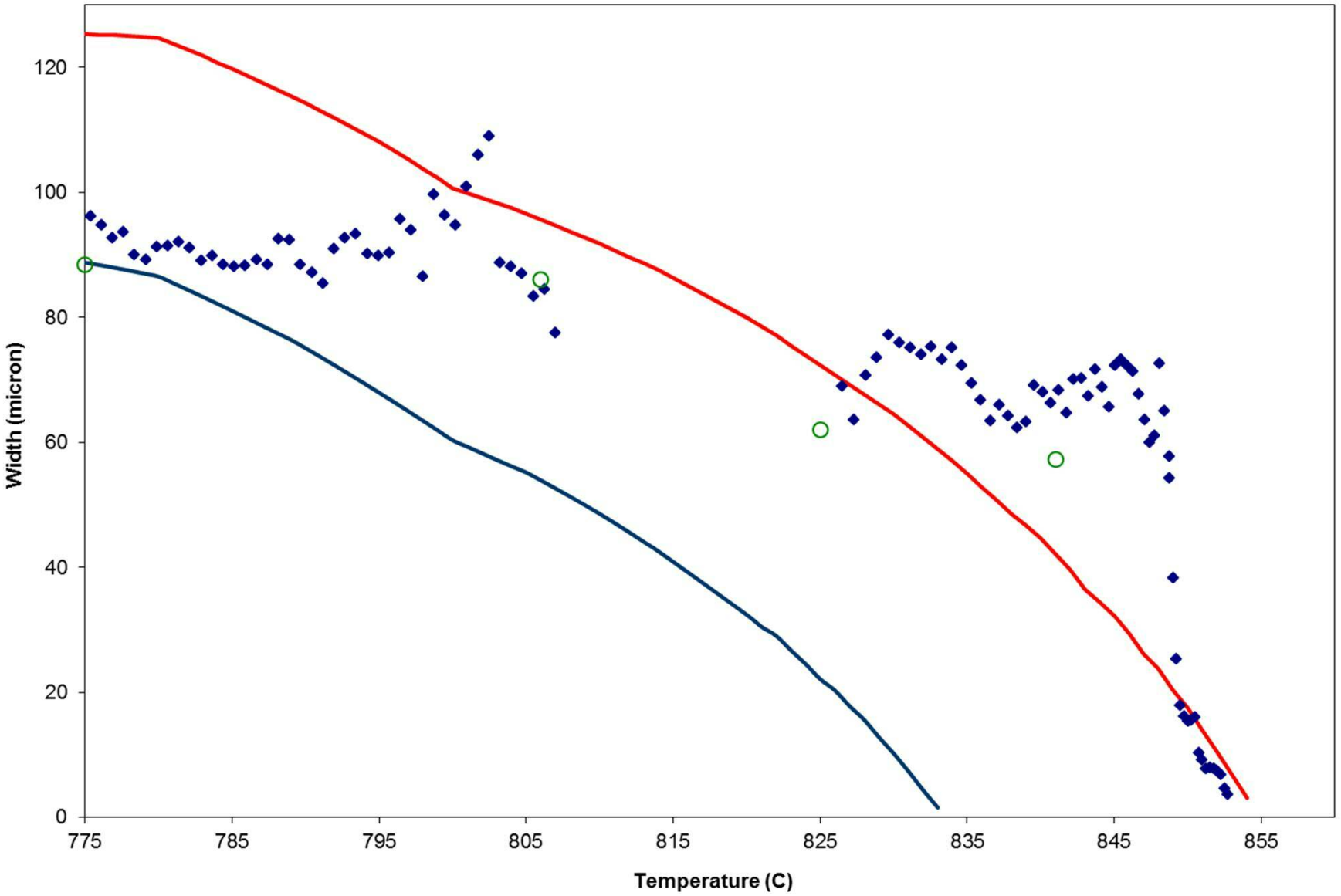


Fe-C-Mn: 0.94%Mn-0.57%C




120
100
80
60
40
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0
Width (micron)
775
785
795
805
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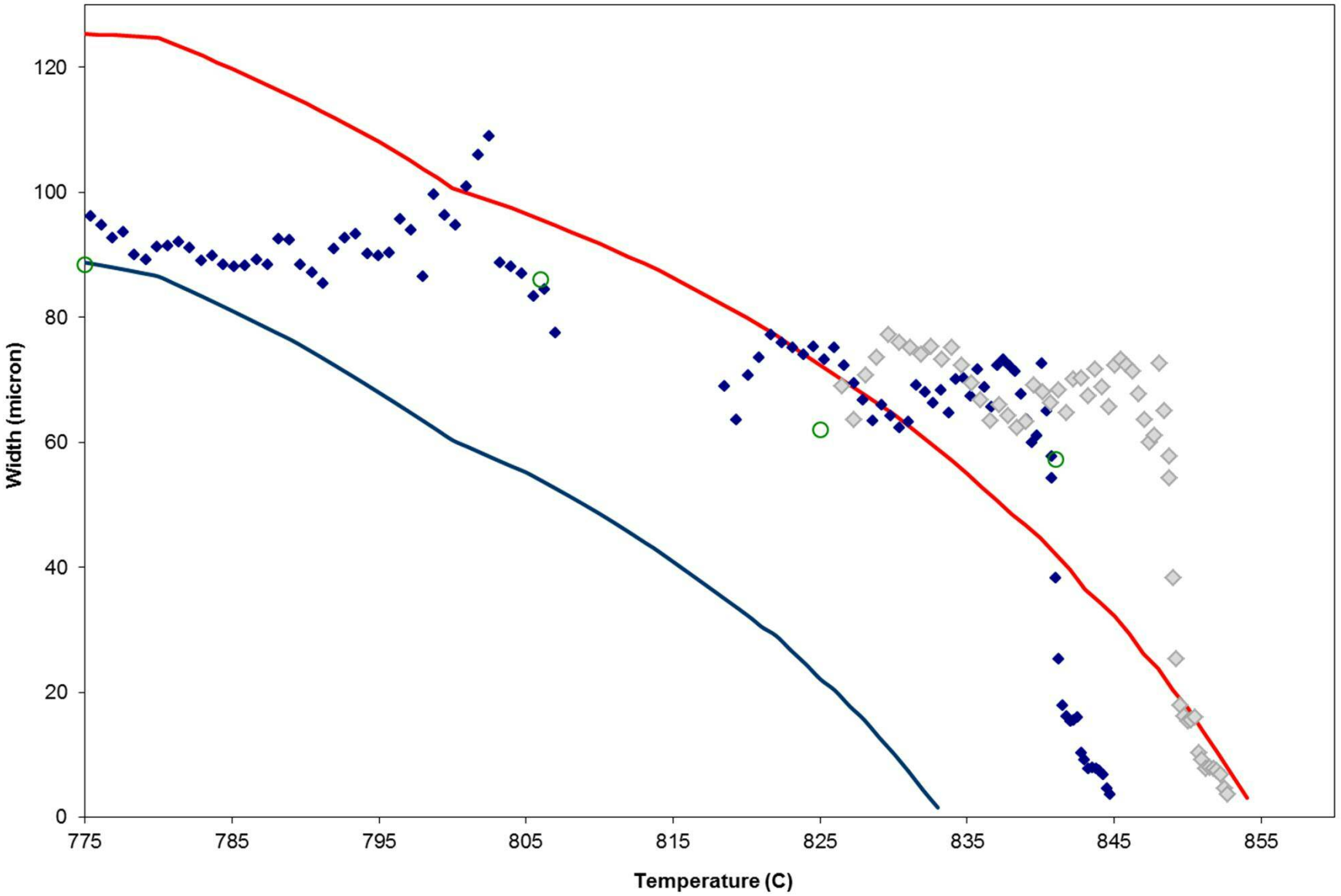
Temperature (C)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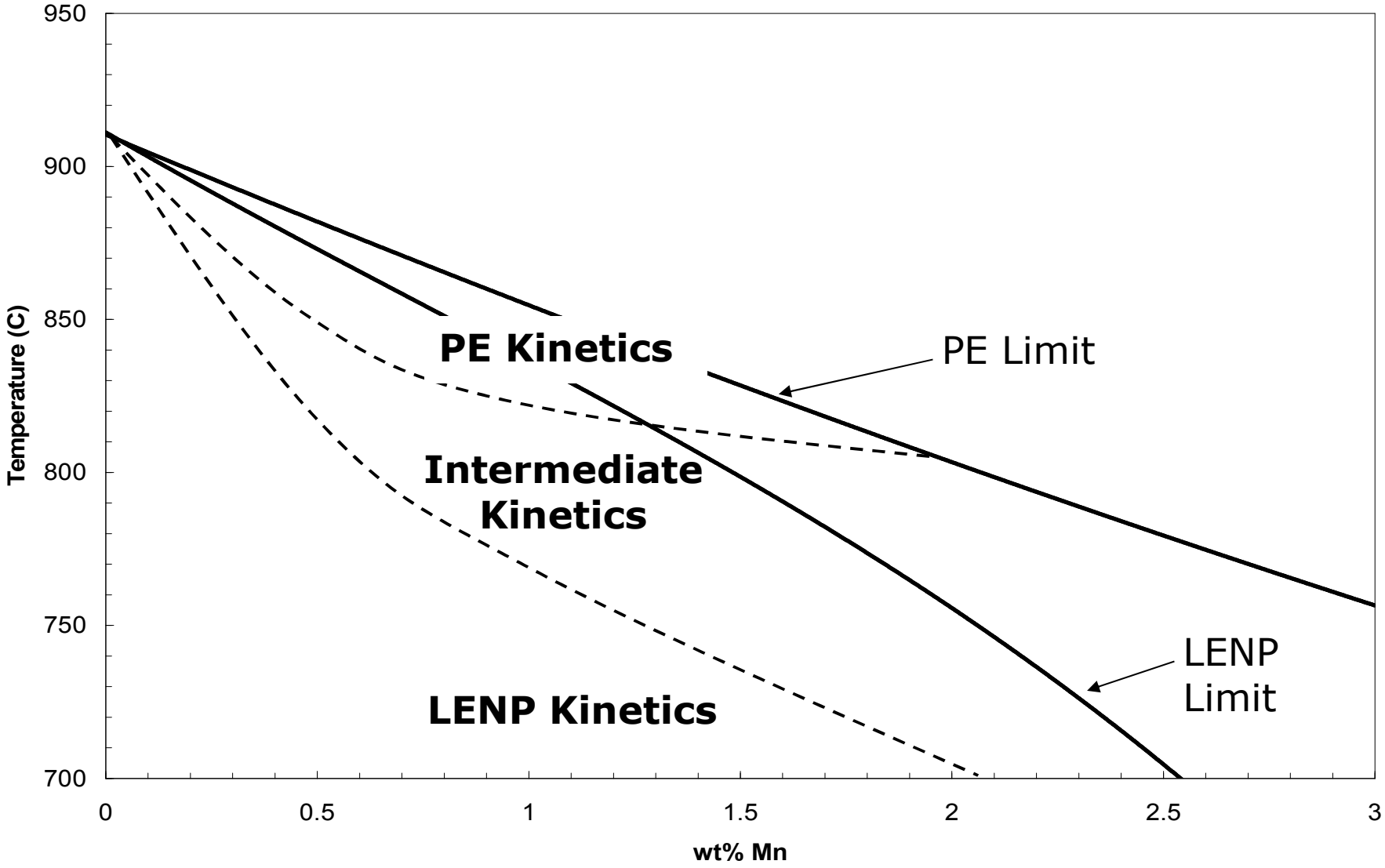
Temperature (C)

Summary of Results: Fe-C-Mn



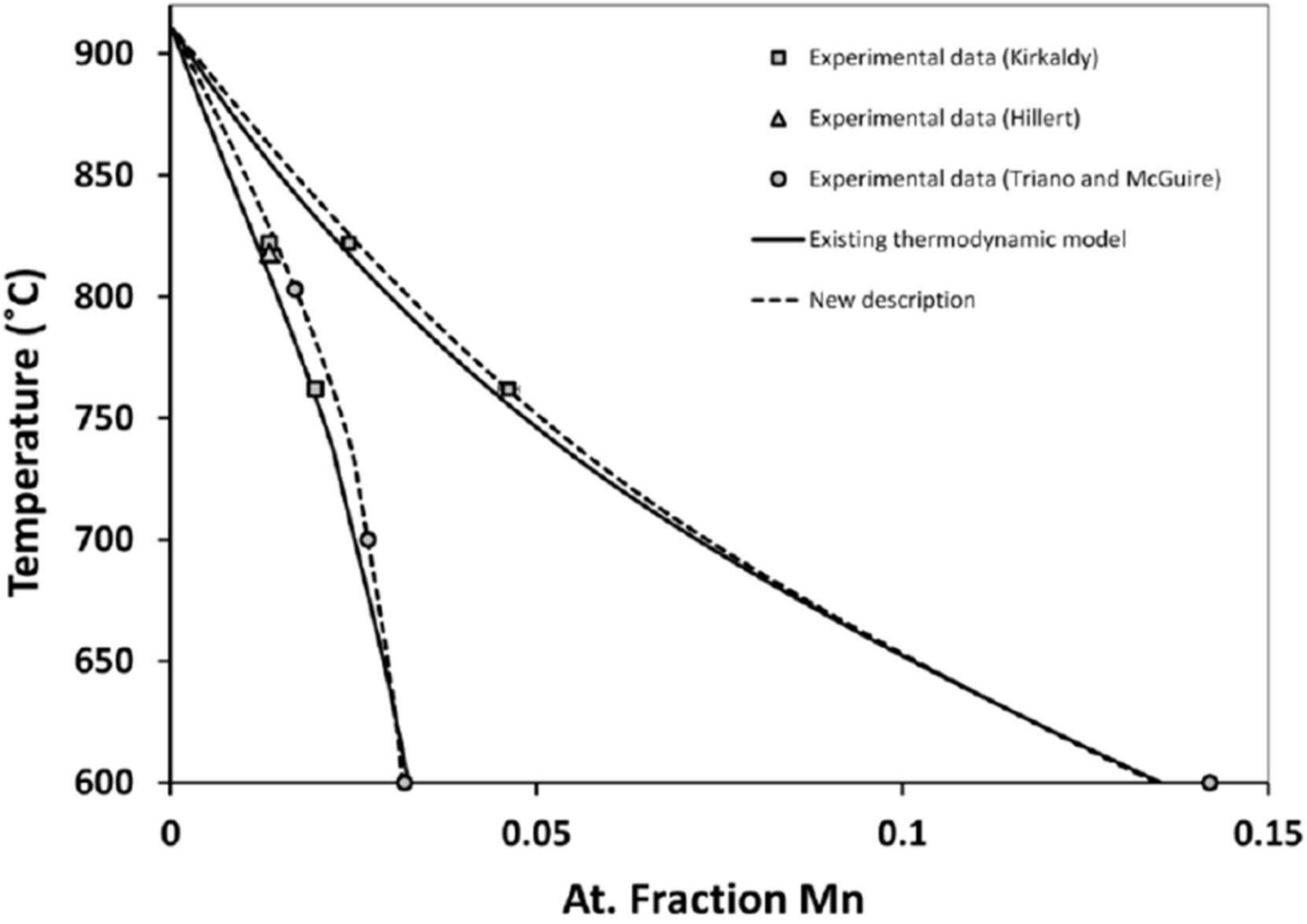
Interface Capacity

- Our first attempt at explaining this unusual observation.

- The idea is that solute atoms can only occupy a limited number of sites within a moving interface. As a result, the moving interface has a limited capacity for solute.

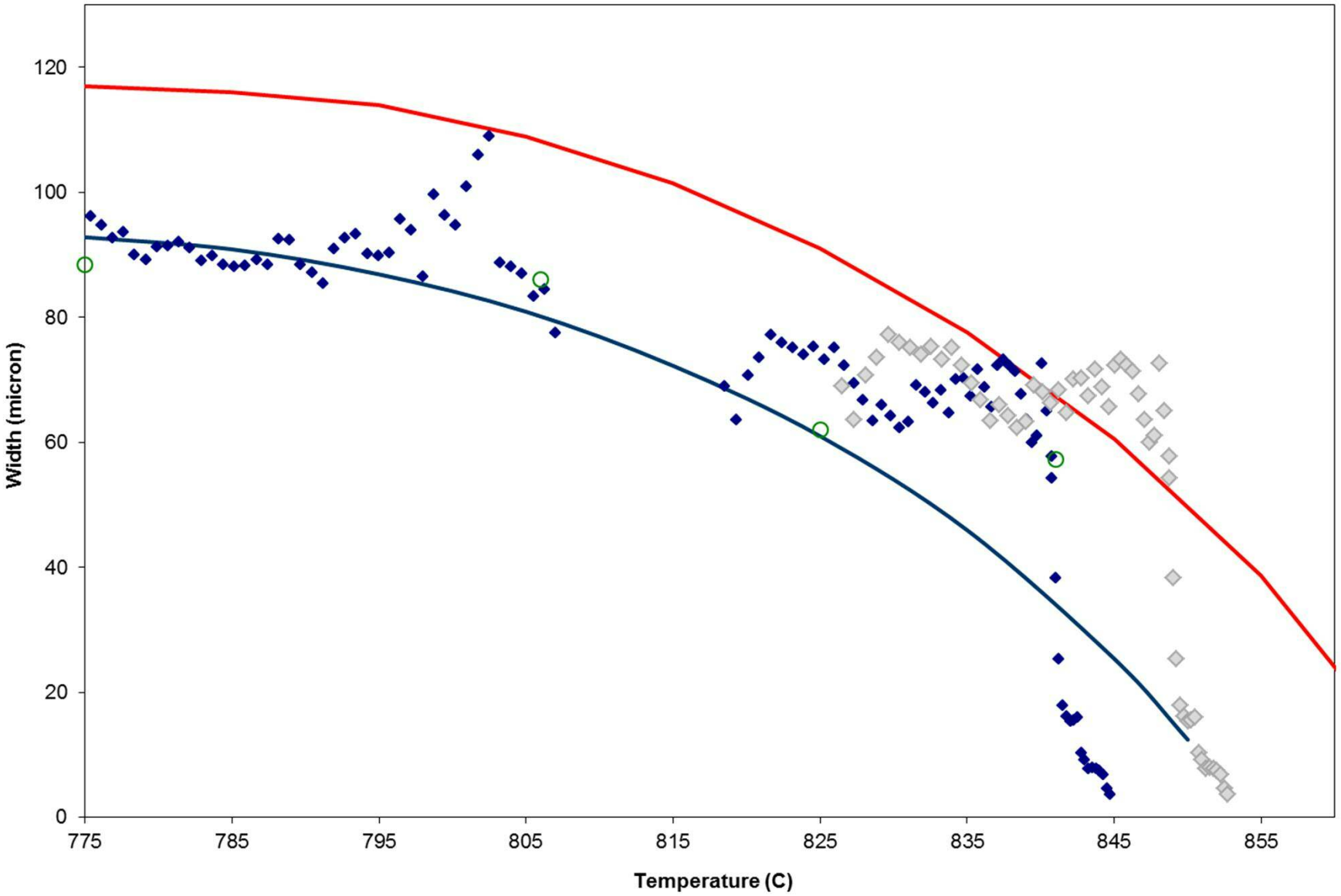
- This limits Mn diffusion across the interface and prevents the build up of a Mn spike in austenite. As result, PE conditions persist.

Simpler Explanation



A portion of Fe-Mn-C equilibrium phase diagram. Experimental data points along with the calculat

$$L^{NEW} = L^{TCFE2} + \left(4007.8 - 4.44\,T(k)\right) \qquad J/mole$$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Width (micron)
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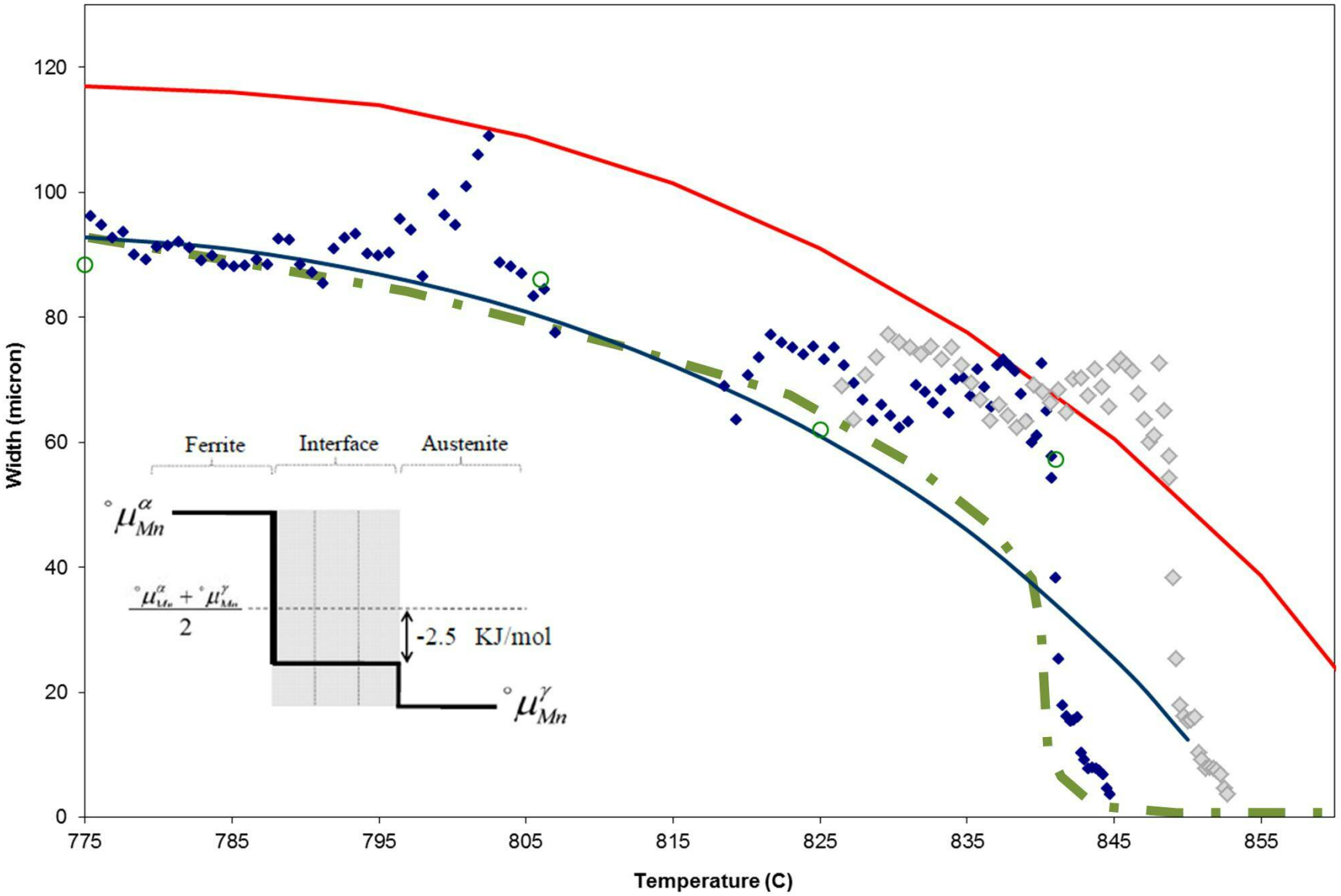
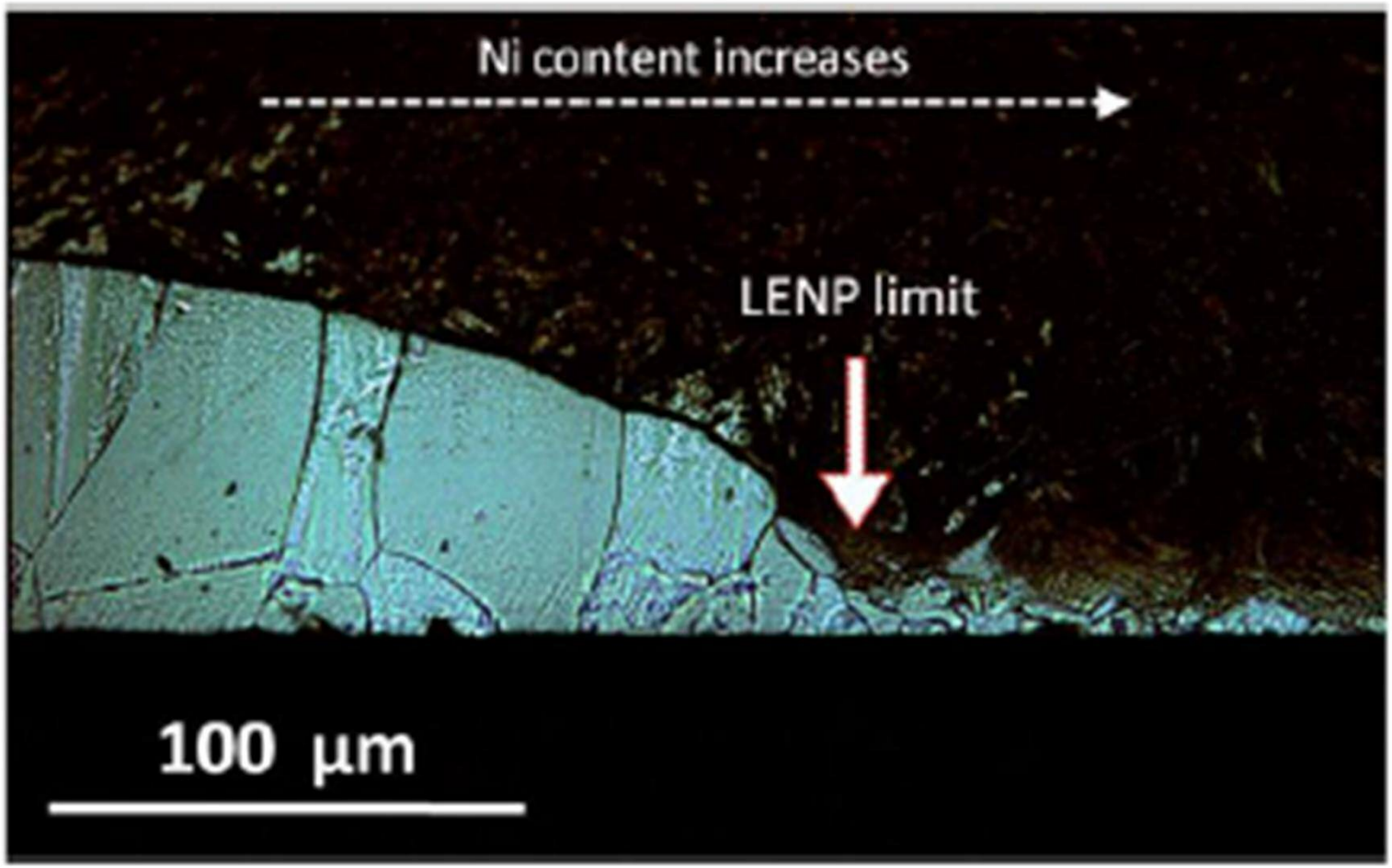
Temperature (C)

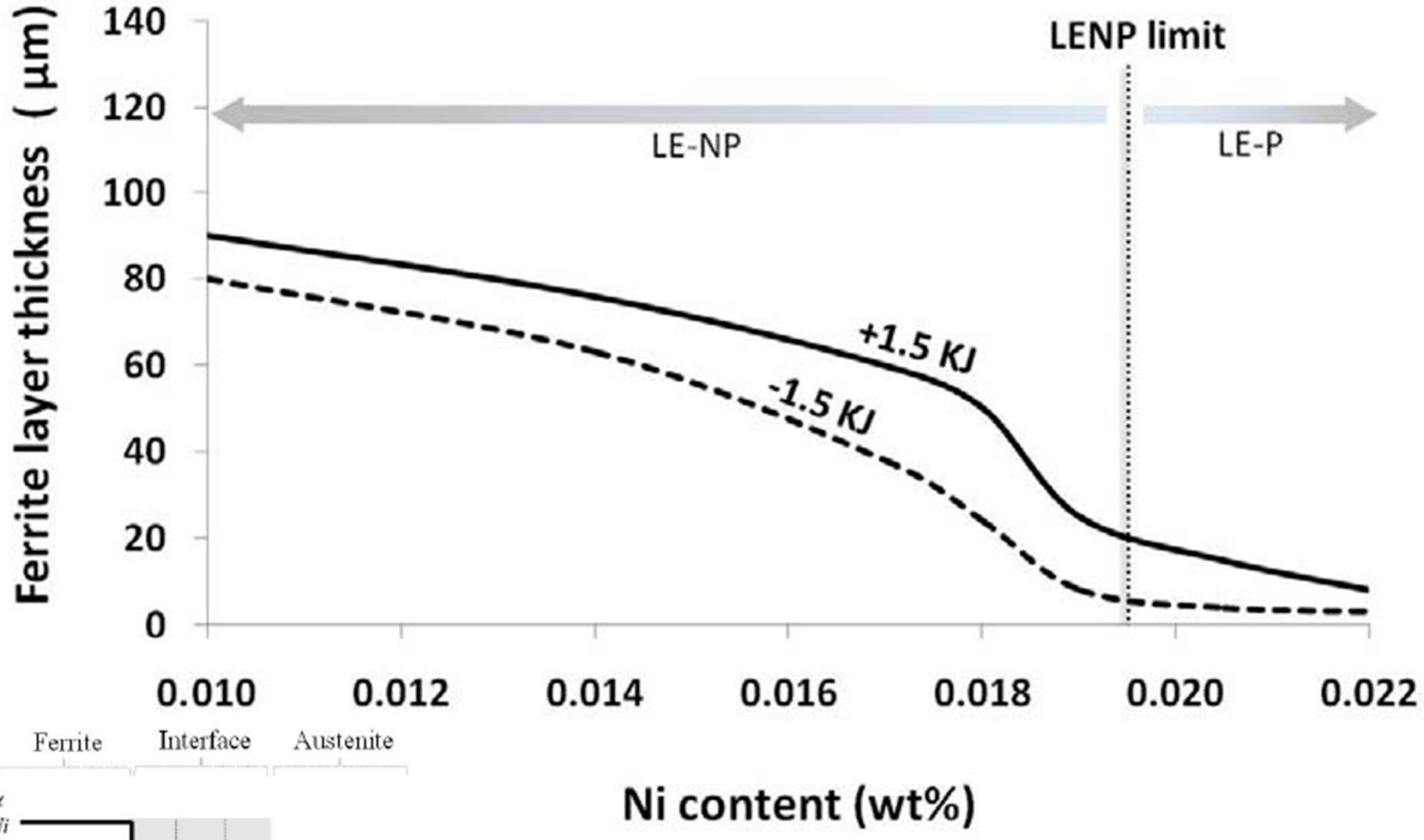

120
100
80
60
40
20
0
Width (micron)
775
785
795
805
815
825
835
845
855
Temperature (C)
Ferrite
Interface
Austenite
$^{\circ}\mu^{\alpha}_{Mn}$
$\frac{^{\circ}\mu^{\alpha}_{Mn} + {}^{\circ}\mu^{\gamma}_{Mn}}{2}$
-2.5 KJ/mol
$^{\circ}\mu^{\gamma}_{Mn}$

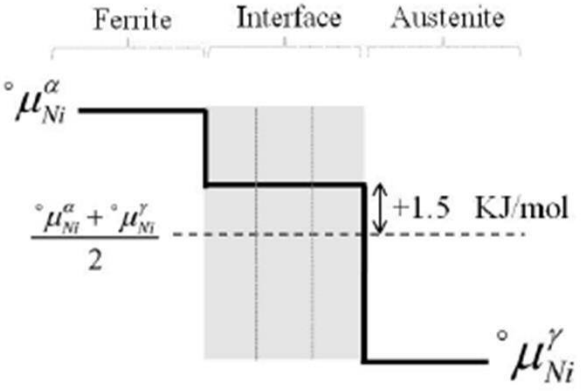
So, do we have a consistent picture for high T behaviour?



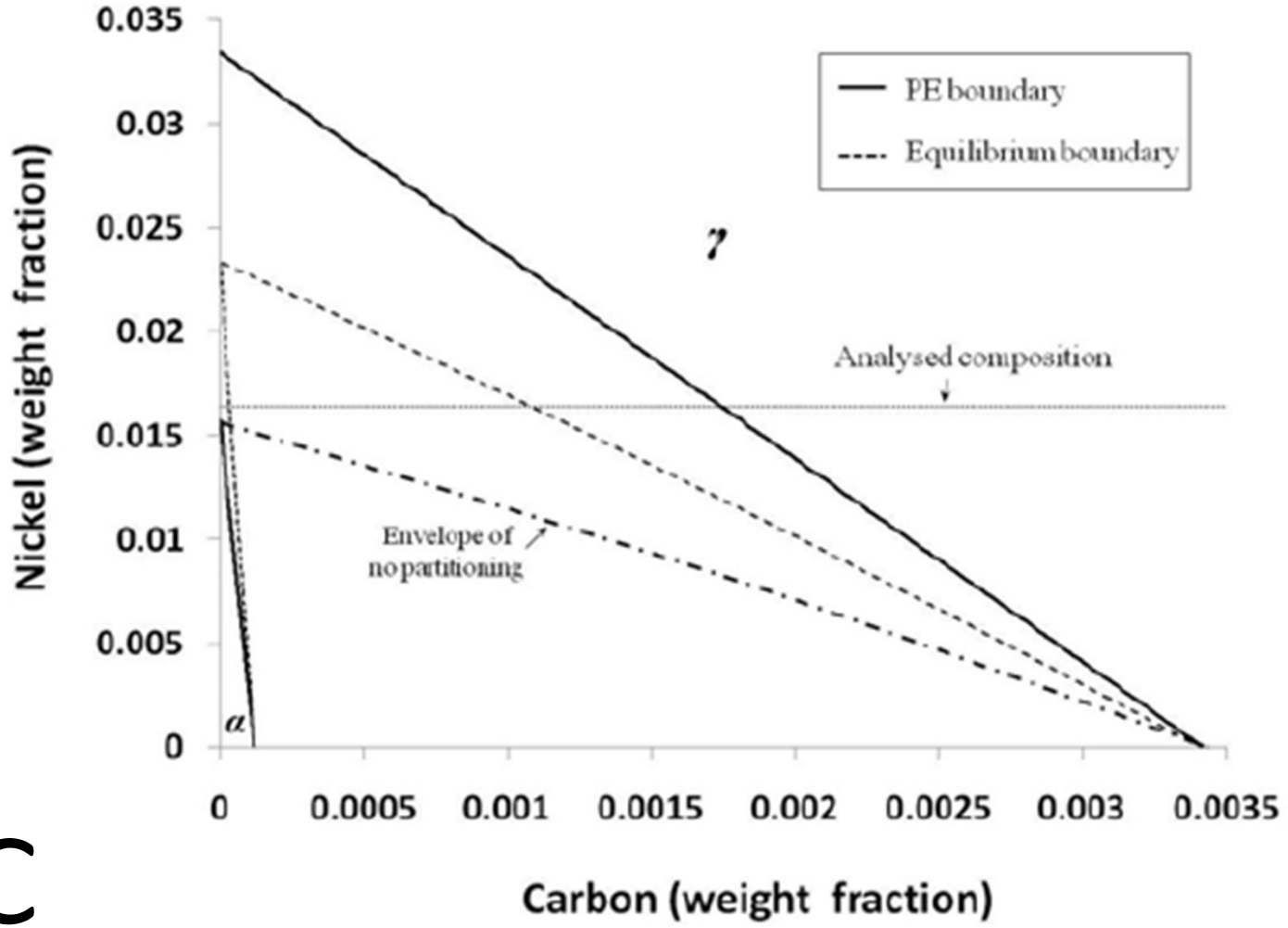
Fe-Ni Diffusion Couple- decarburized at 775C for 16 minute.

Comparison with Model

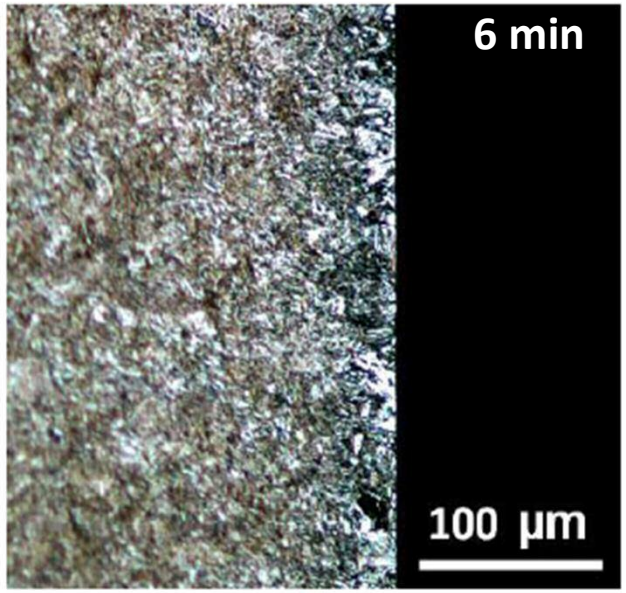


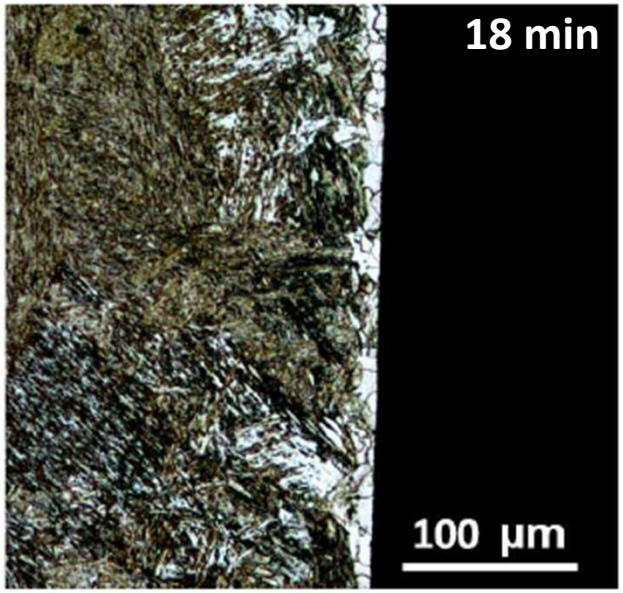


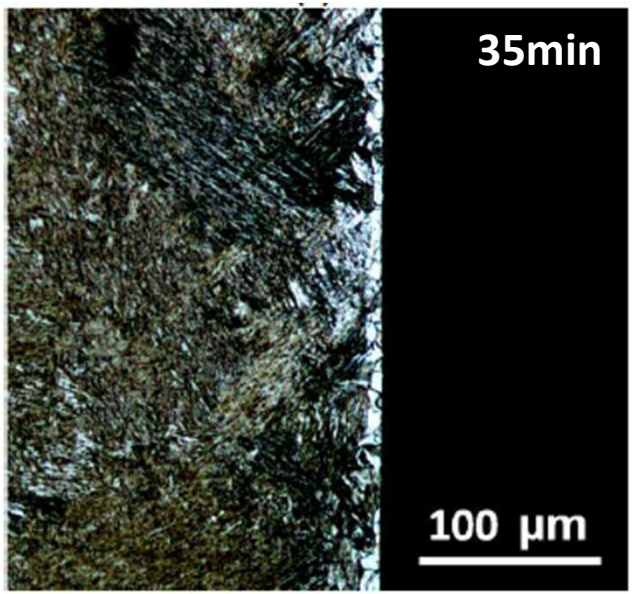
Isothermal Growth Kinetics above LENP Limit

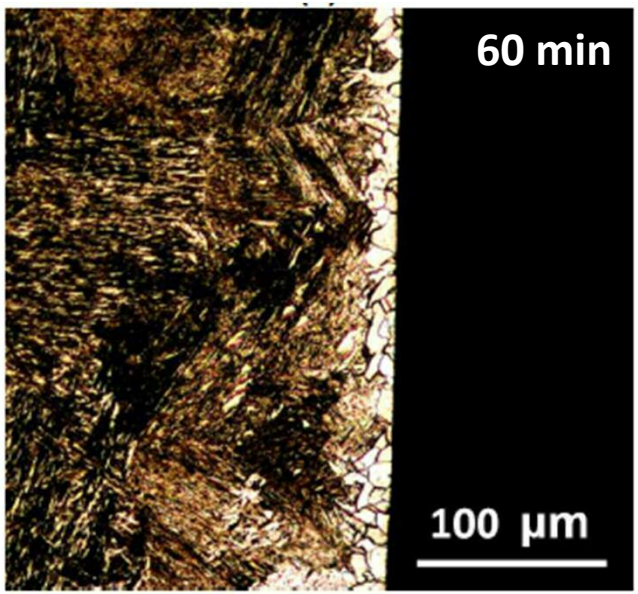


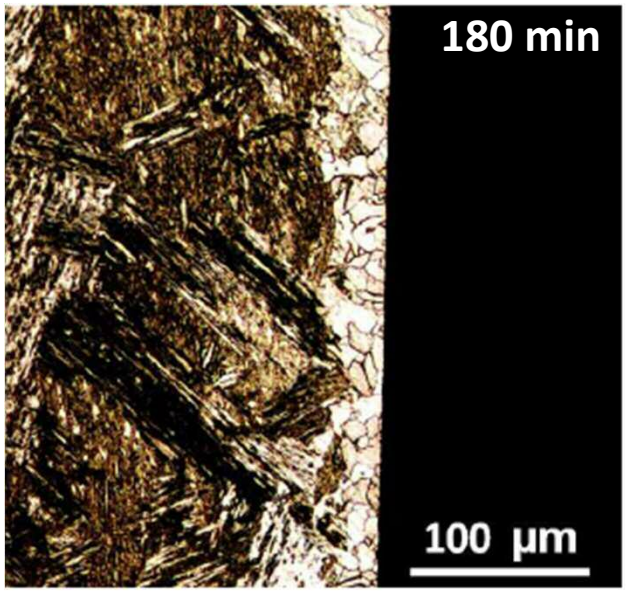
800C

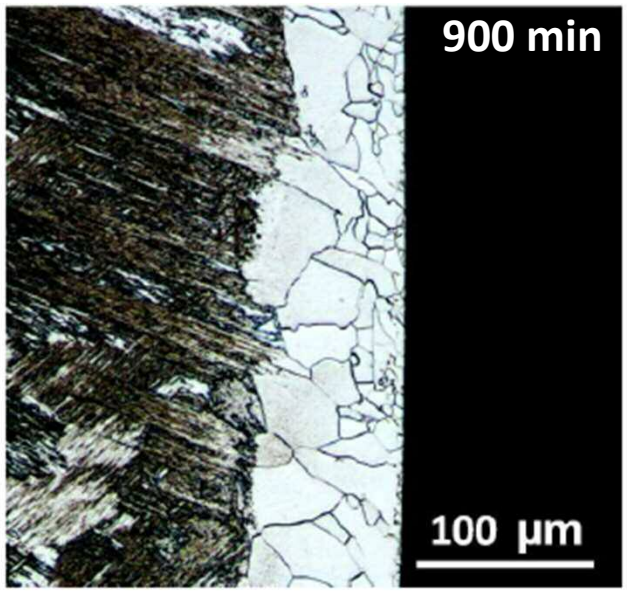

6 min
100 µm


18 min
100 µm


35min
100 µm


60 min
100 µm


180 min
100 µm

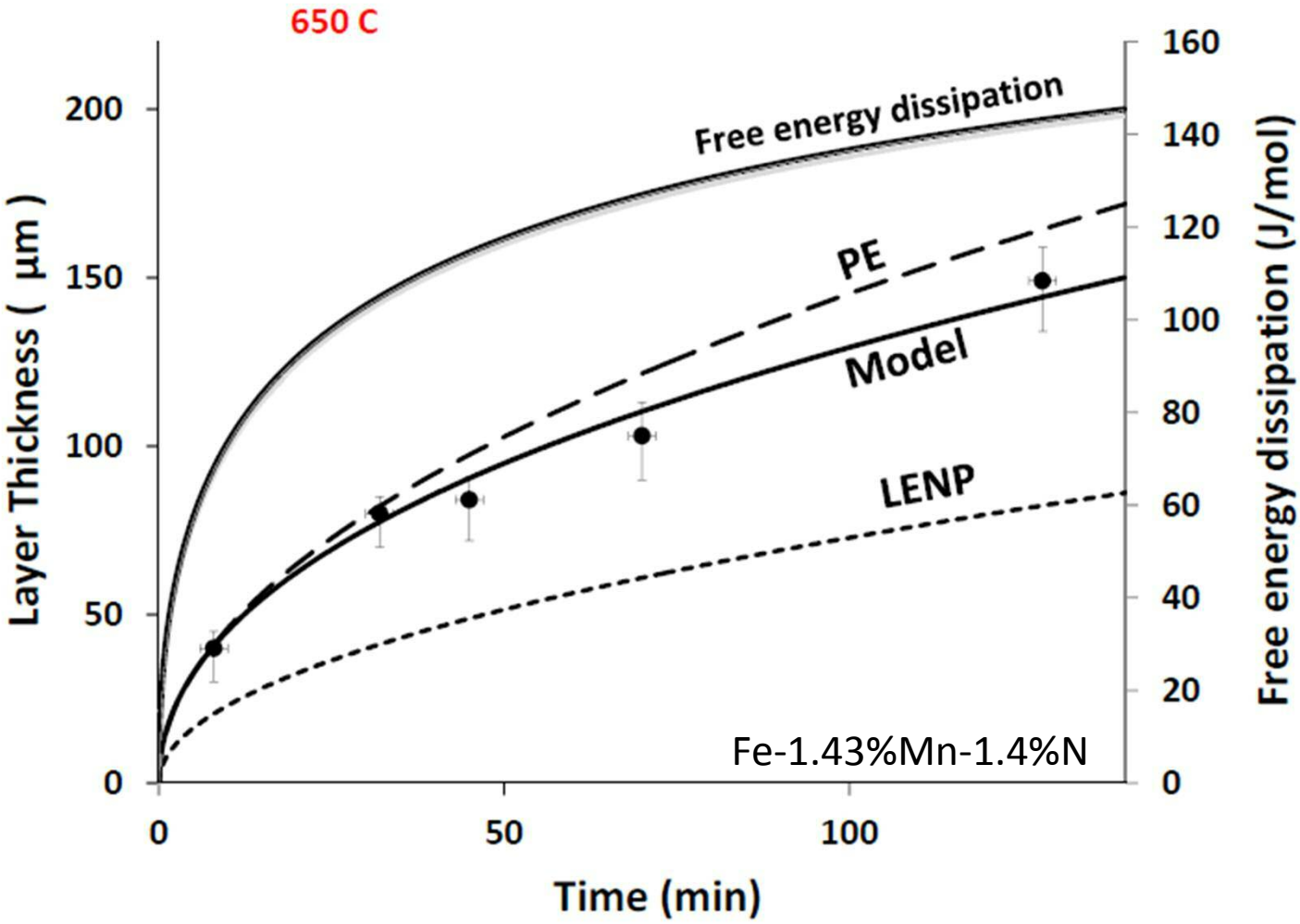

900 min
100 µm

Difference in Morphology

Below LENP Limit

Above LENP Limit

When Should We Expect PE Kinetics?



Conclusions

- It is very likely that earlier observations of PE at high temperature are due to uncertainties in the thermodynamic description of the Fe-Mn system.

- A simple picture in which the LENP limit is approached at high T is preferred.