Partitioning kinetics of alloying elements in a medium Mn steel during Q&P treatments using phase field modelling

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Study of partitioning kinetics of alloying elements in a medium Mn steel during Q&P treatments using phase field modelling

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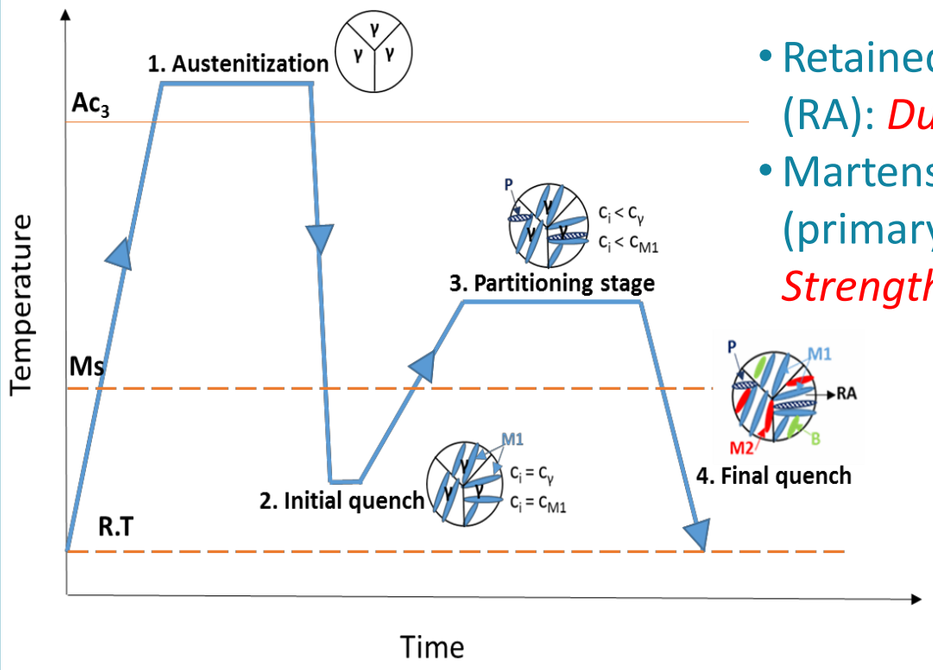
Background

Development:

AHSS in automotive parts to accomplish resource efficiency, high strength and less weight.

Q&P steels:



- Retained austenite (RA): *Ductility*
- Martensite (primary or fresh): *Strength*

- Partitioning of alloying elements from martensite (α^l) to austenite (γ) and stabilization of austenite is crucial for Q&P process .
- So far carbon, an interstitial alloying element, is considered as the main austenite stabilizer in the Q&P process.
- Manganese and Nickel are also strong austenite stabilizers.

Objective

- To develop a model using phase field modelling for the study of the partitioning of interstitial and substitutional alloying elements (Mn, Si and Ni) during the quenching and partitioning process.

Approach

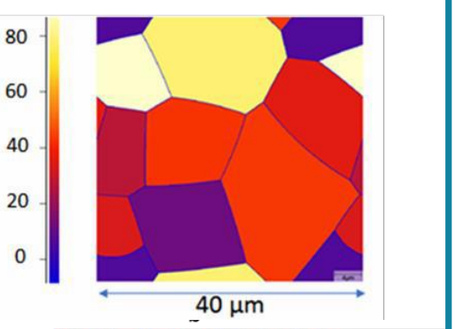
- Study different alloying systems: *FeCMn, FeCMnSi, FeCSiNi, FeCMnSiNi, FeCMnNi.*

Element	C	Mn	Si	Ni	Fe
Conc., (at. %)	1.38	4.58	2.91	1.86	89.27

- Partitioning conditions : 400, 500 and 600 °C
  : upto 500 s

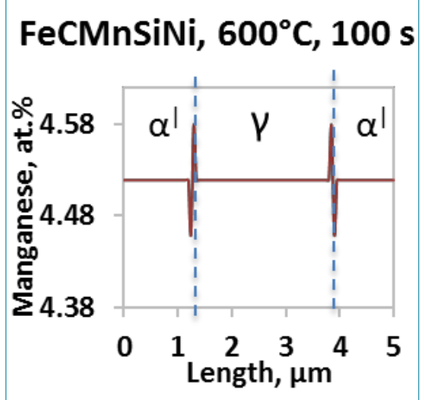
Results

100 % Austenite → Initial Quench → 75/25 % Martensite/ Austenite → Partitioning @ 600 °C



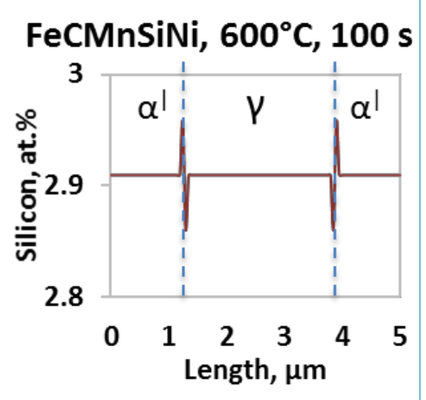
Partitioning of Mn

Mn diffused from α^l into γ .



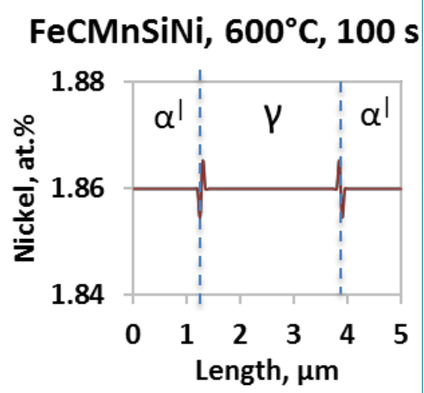
Partitioning of Si

Si diffused from γ into α^l



Partitioning of Ni

Ni diffused from α^l into γ.



No.	Alloy	Time at which partitioning starts to be detected (s)		
		Mn	Si	Ni
1	FeCMn	40	-	-
2	FeCMnNi	40	-	50
3	FeCMnSiNi	70	40	90
4	FeCMnSi	125	90	-
5	FeCSiNi	-	125	>500

Discussion

- Partitioning of substitutionals is detected only at 600 °C.
- With the addition of Si a delay in Mn diffusion is observed (1-4) / (2-3).
- Addition of Ni promoted Mn diffusion in the presence of Si (3 - 4).
- In the absence of Mn, the diffusion of Si and Ni is delayed by long time (5).

Conclusions

Partitioning kinetics of alloying elements (Mn, Si and Ni) during the quenching and partitioning process is studied successfully. It was observed that a mutual impact on the partitioning of alloying elements is observed depending on the alloy systems.

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