

Aplicaciones de Thermo-Calc en el Estudio de Transformaciones de Fases en Aleaciones

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Contenido

Aleación Cu-4%Ti

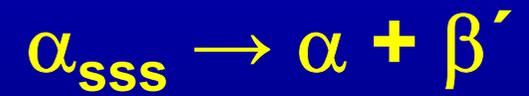
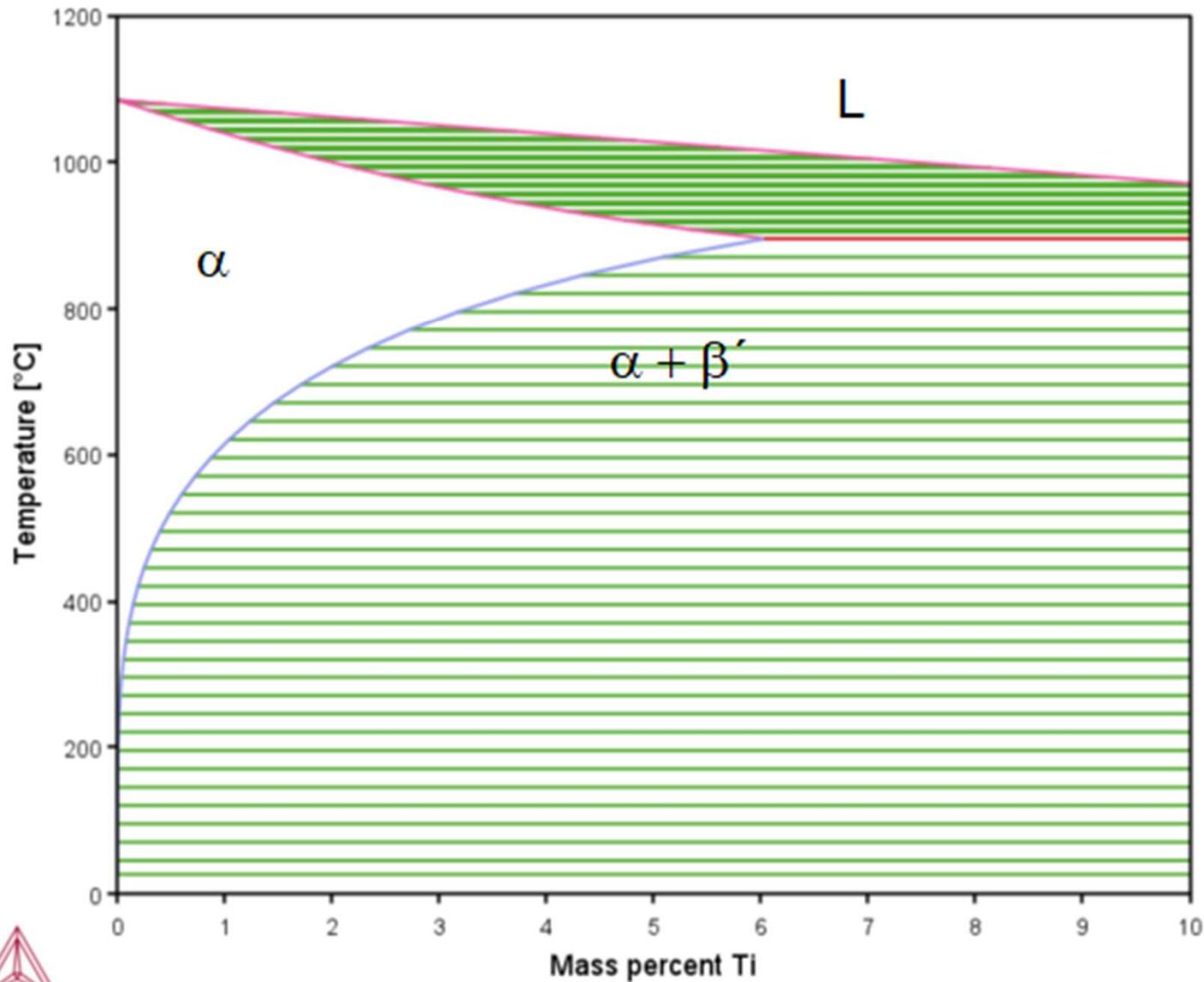
Acero HK40

Acero AISI M4

Aleaciones Cu-Ti

- Las aleaciones Cu-Ti (1-5 %Ti) se han estudiado desde los 30s
- Resistencia mecánica y conductividad térmica comparable a la de las aleaciones Cu-Be
- Estas aleaciones se pueden endurecer por precipitación

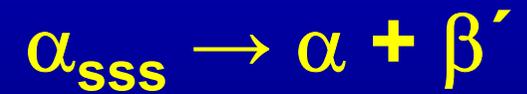
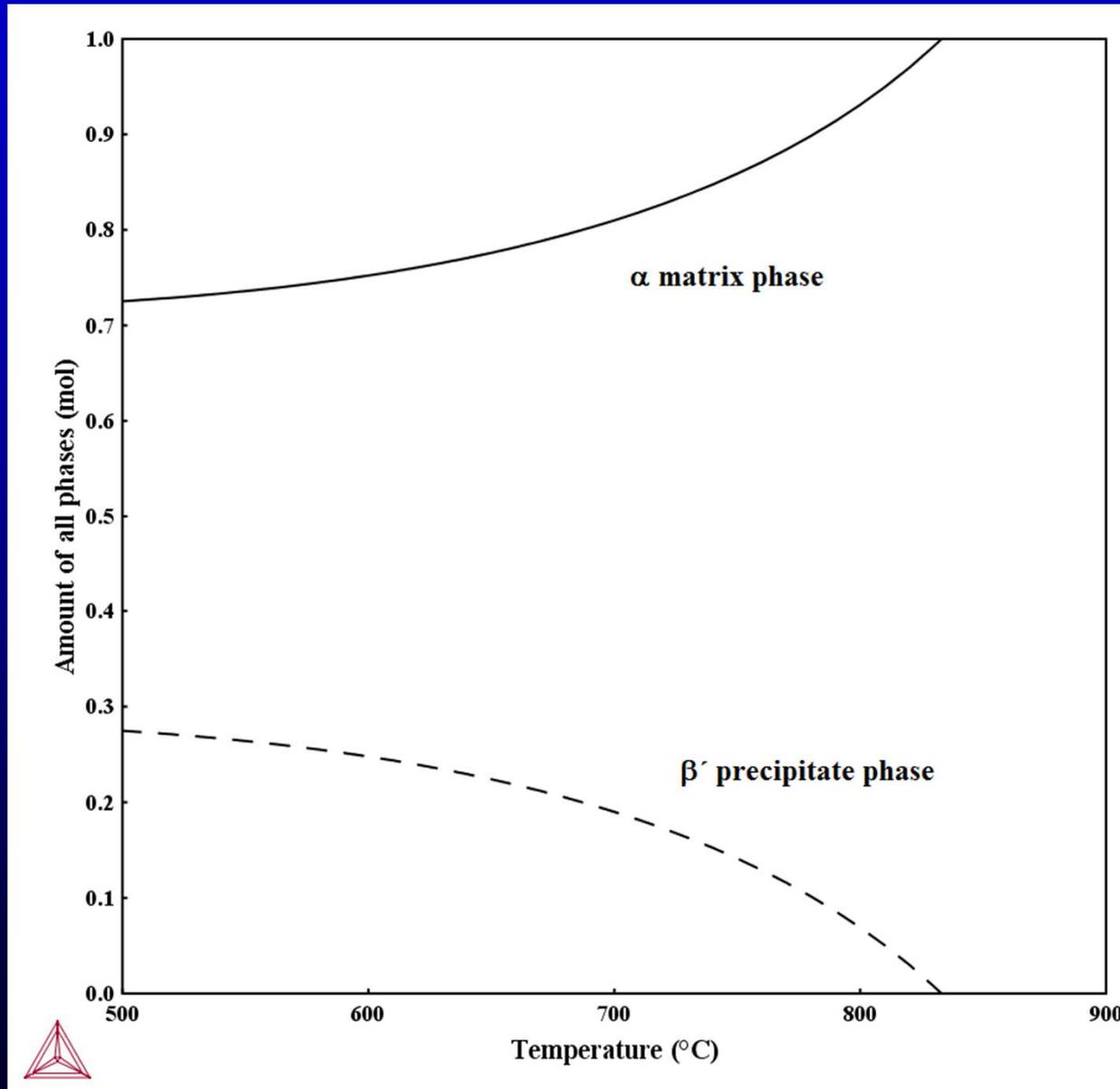
Diagrama de Fases Cu-Ti



TC-Binary Phase
Diagram

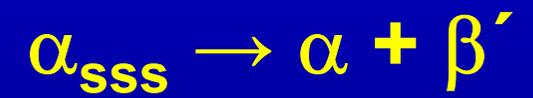
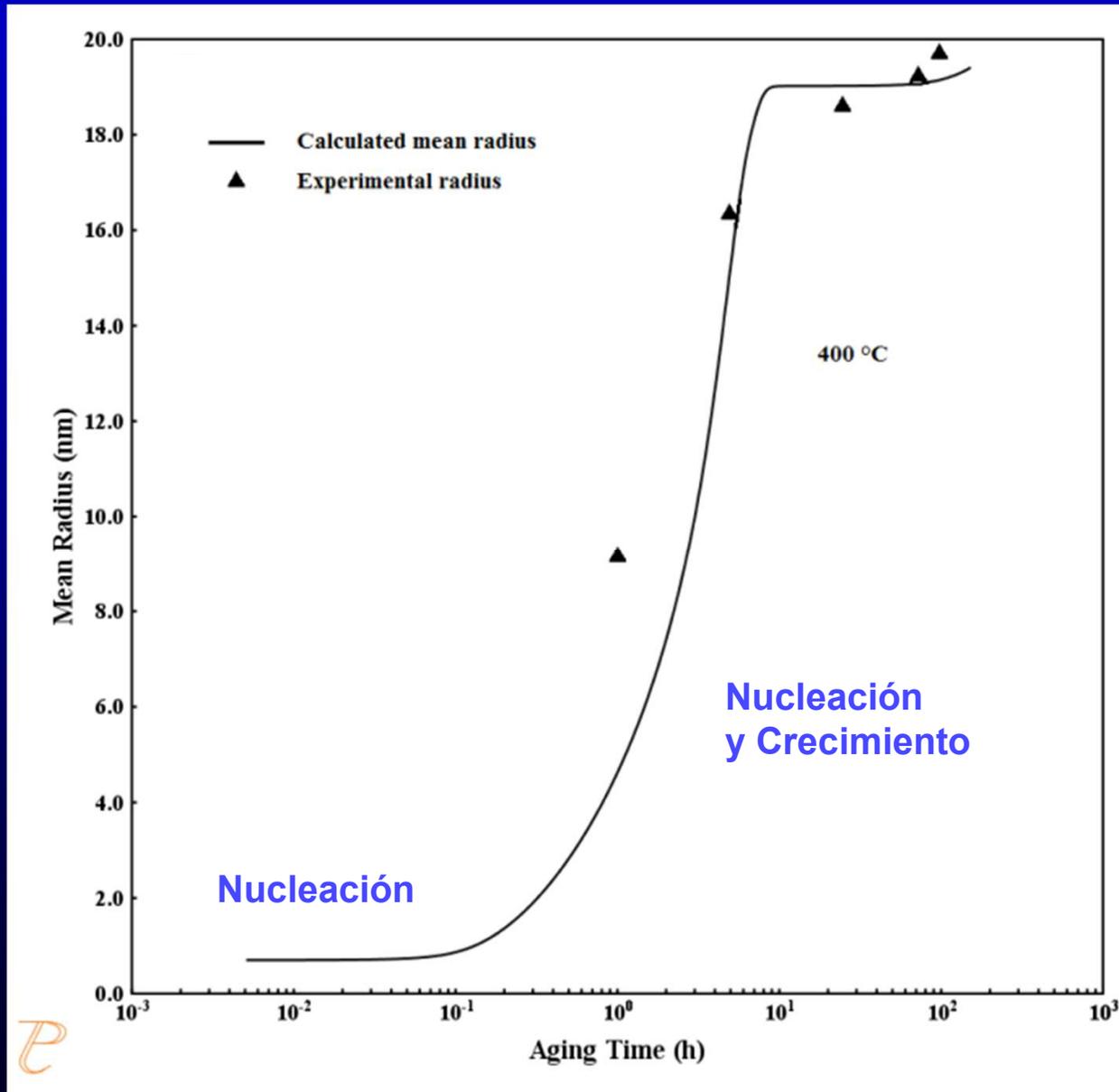


Precipitación de β' (Cu_4Ti)



TC-One axis

Simulación de la Precipitación Intragranular a 400 °C

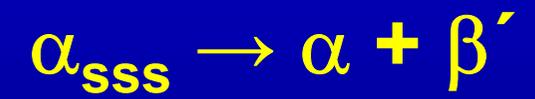
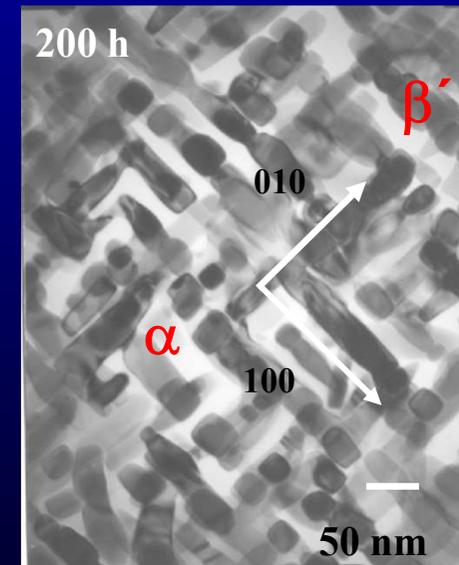
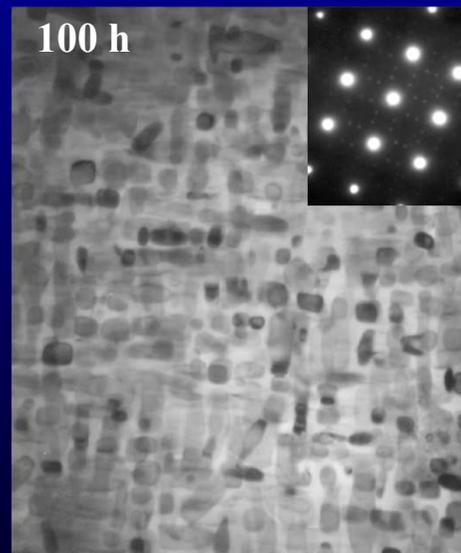
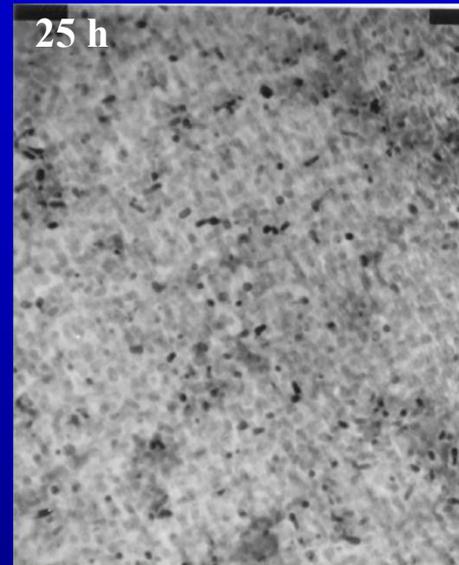
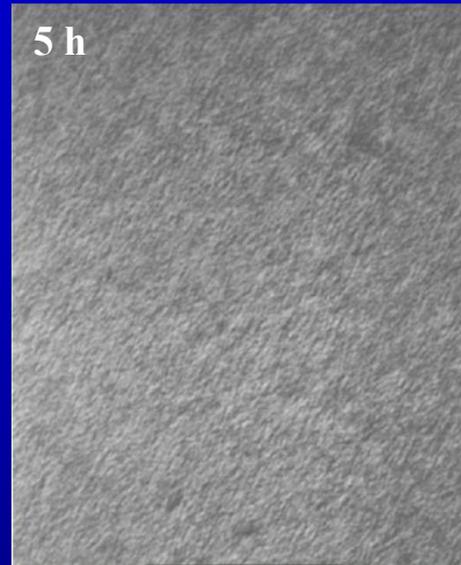


$$\gamma = 0.1135 \text{ Jm}^{-2}$$

Intercaras coherentes

PRISMA

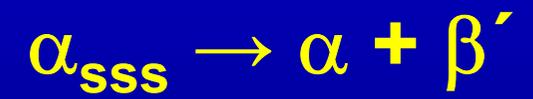
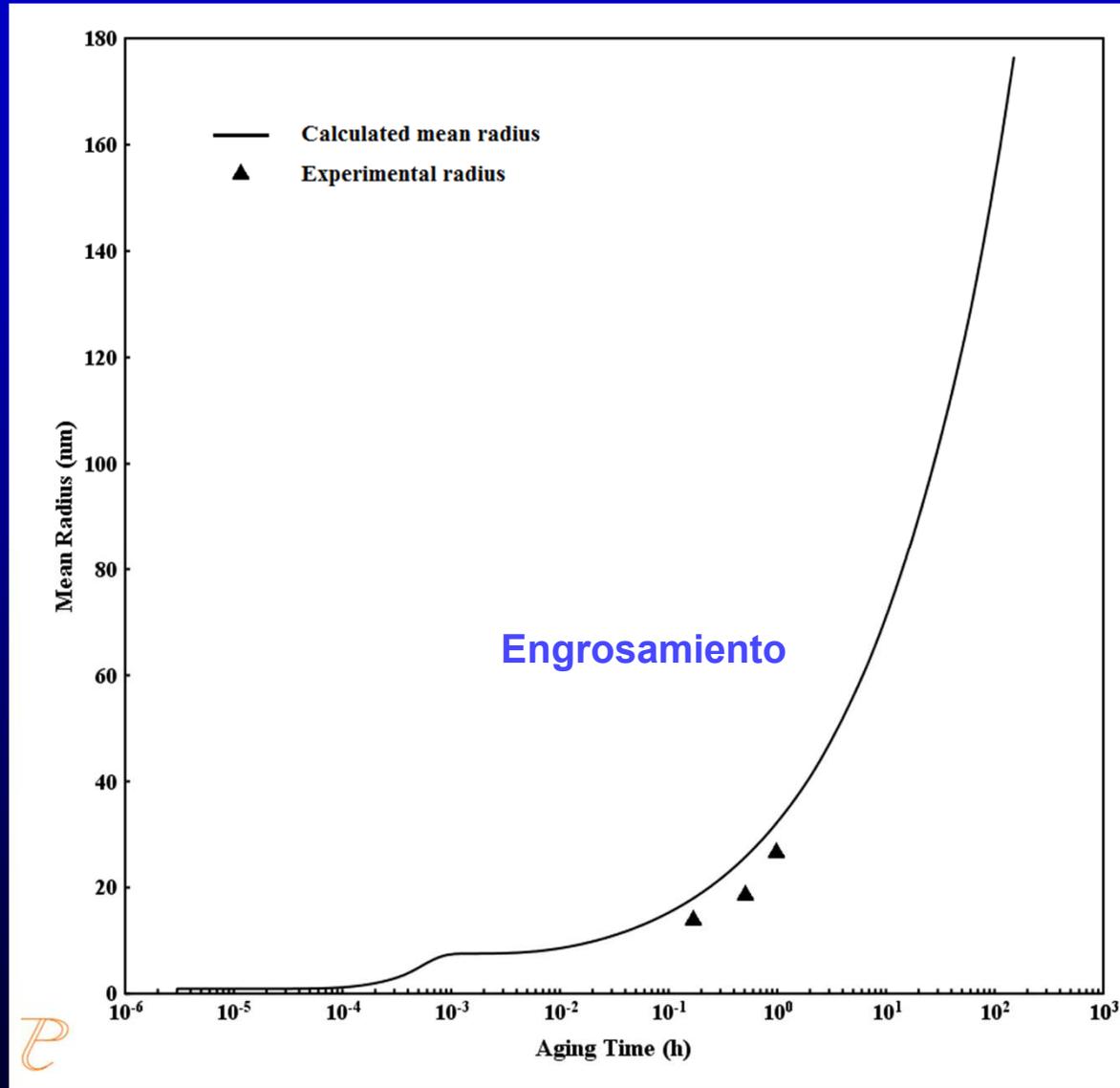
Micrografías MET de la aleación envejecida a 400 °C



Intercaras coherentes

$$\gamma = 0.1135 \text{ Jm}^{-2}$$

Simulación de Precipitación a 600 °C



$$\gamma = 0.0725 \text{ Jm}^{-2}$$

Intercaras coherentes

PRISMA

Micrografías MET de la aleación envejecida a 600 °C

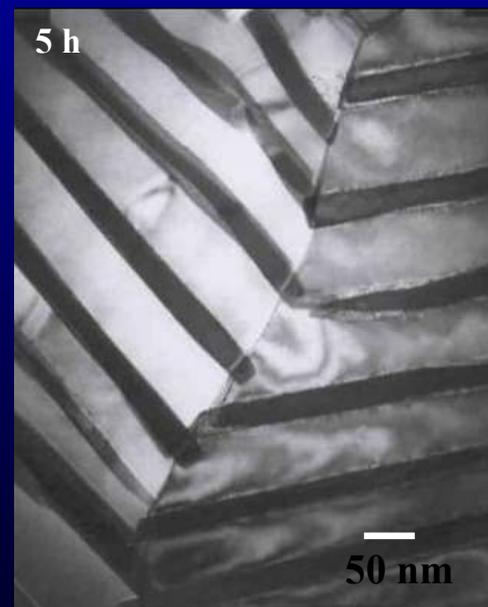
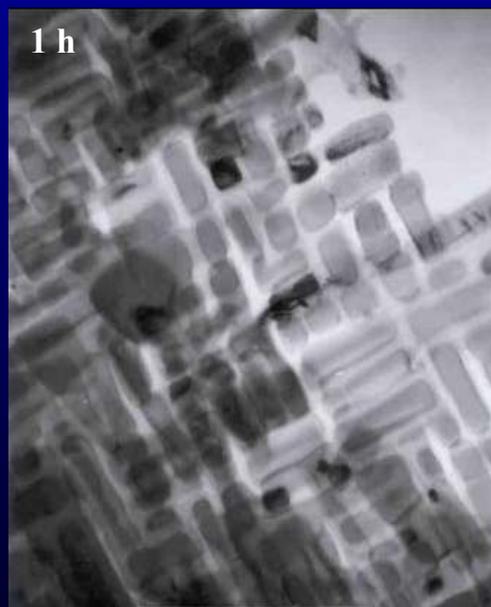
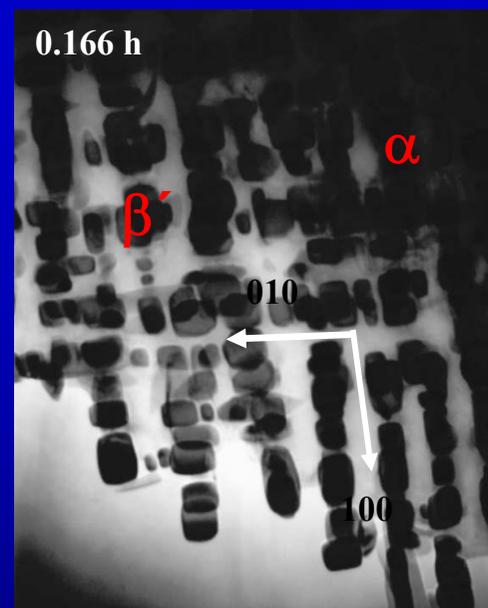
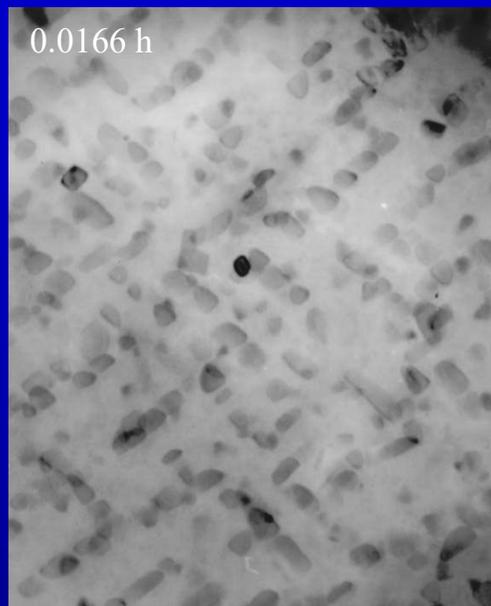
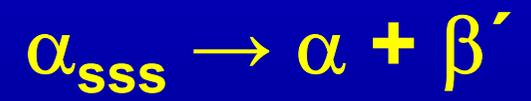
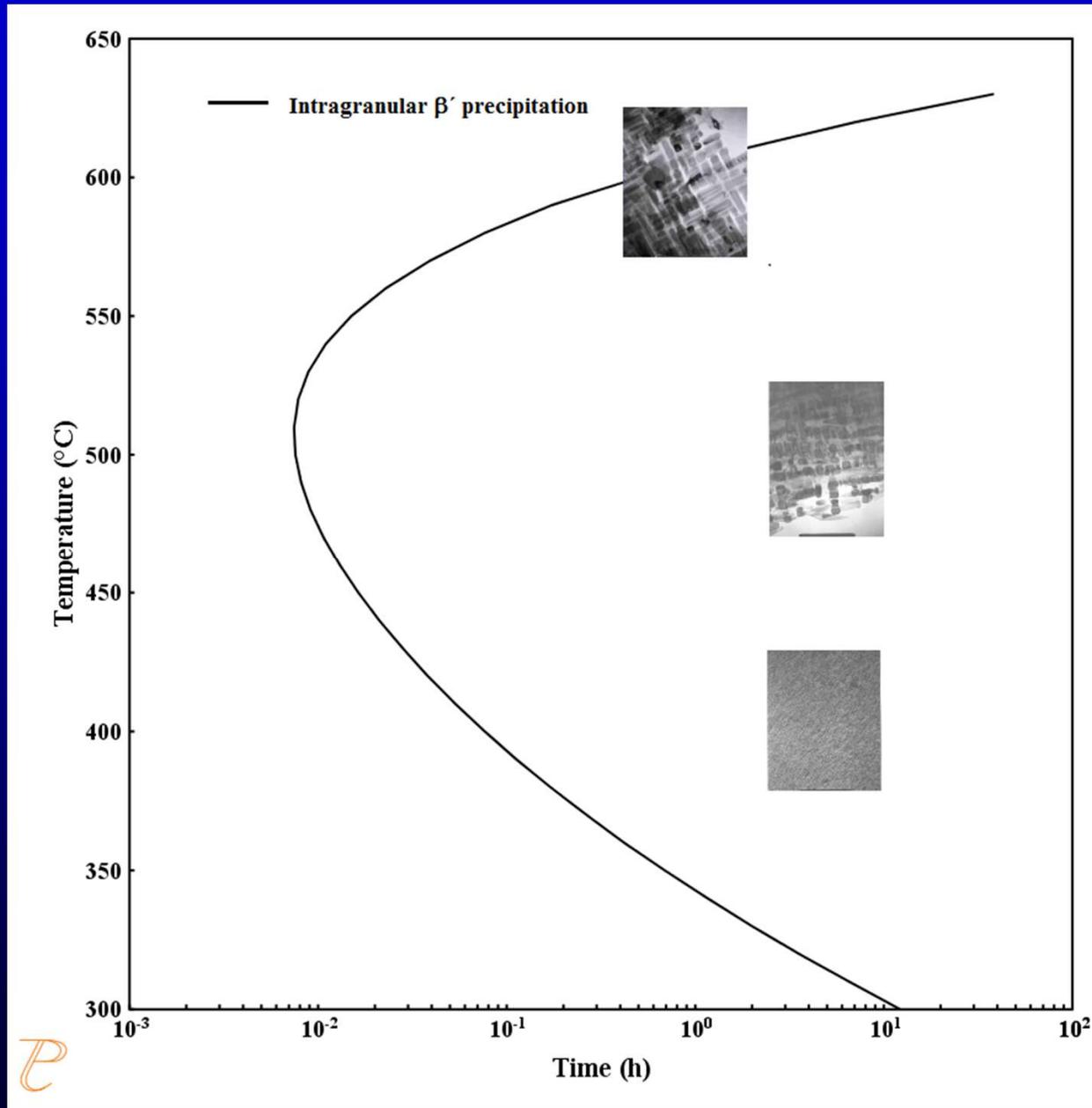
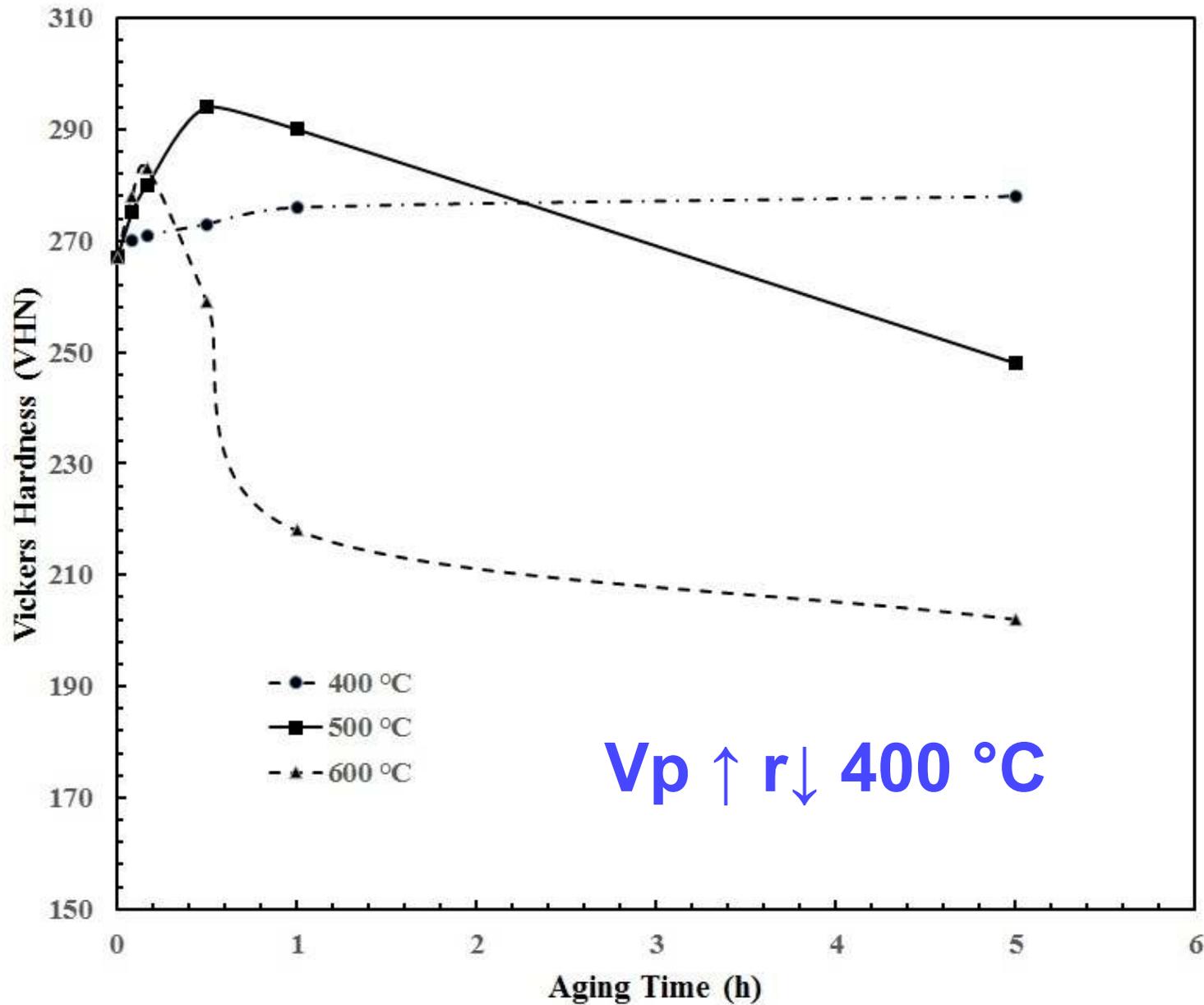


Diagrama TTP



Curvas de Envejecido

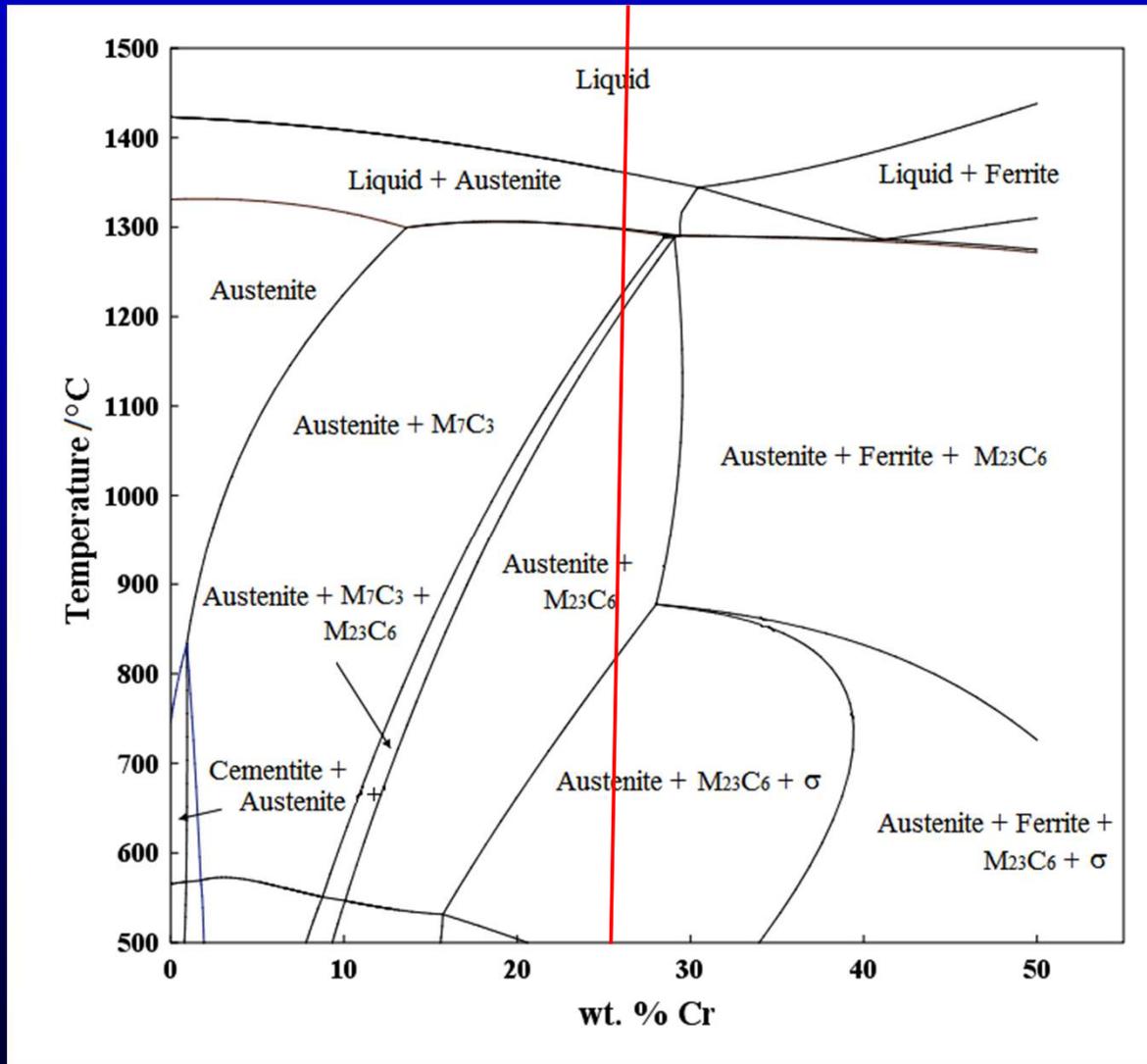


Acero HK40

- Acero resistente al calor con cromo
- Se emplea en estado de colada
- Endurecimiento por precipitación durante su vida de servicio

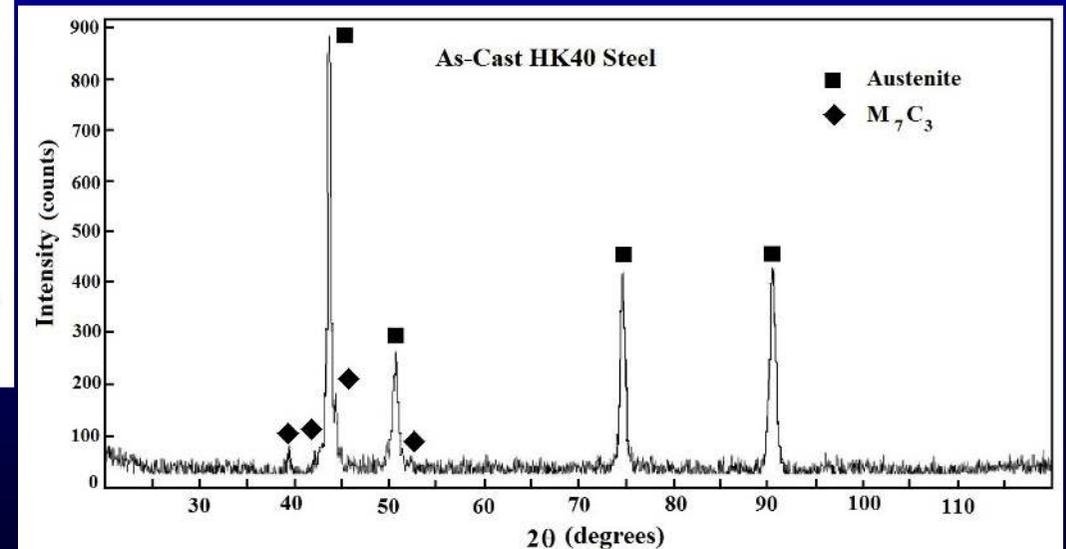
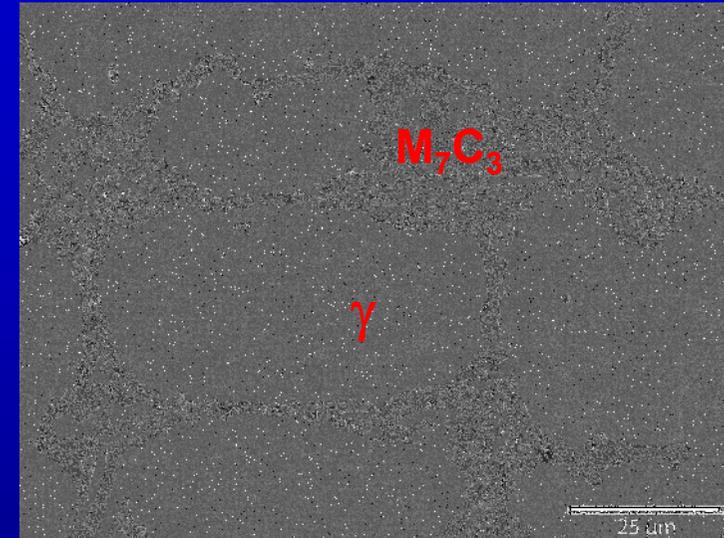
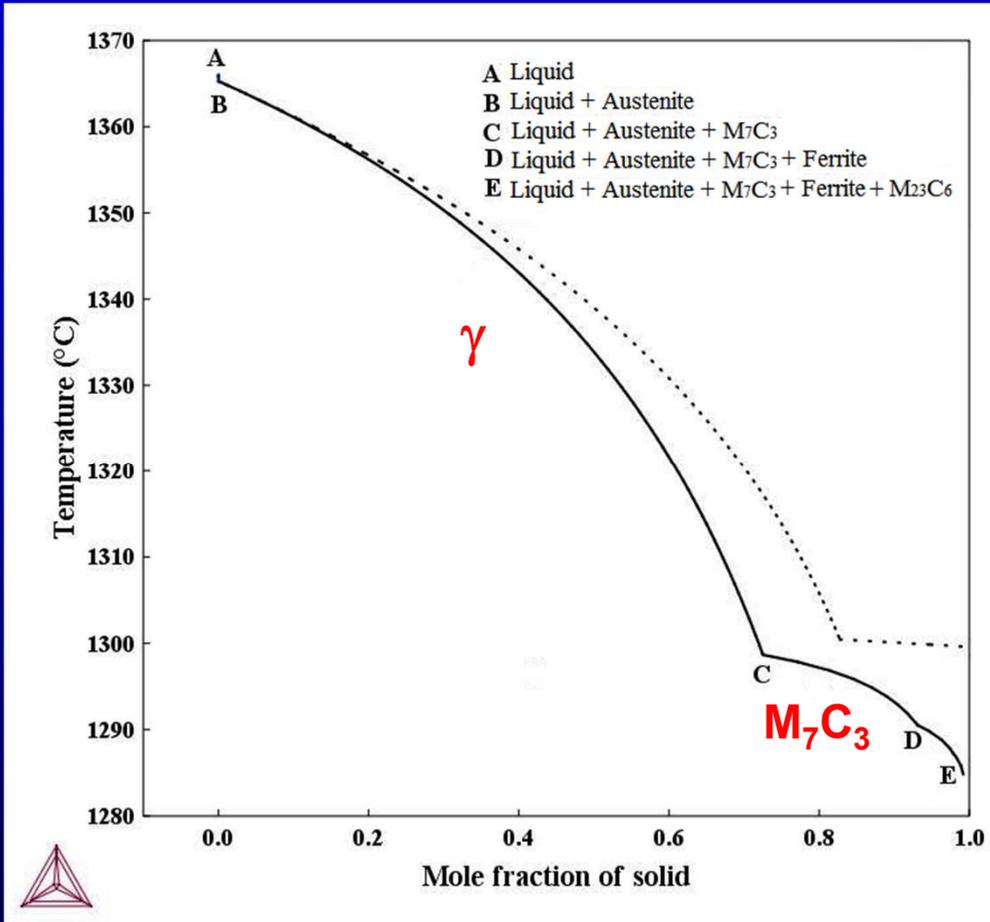
C	Mn	Si	Cr	Ni	S	P	Fe
0.40	1.50	1.60	25.00	20.00	0.03	0.03	Bal.

Diagrama Pseudobinario Fe-Cr



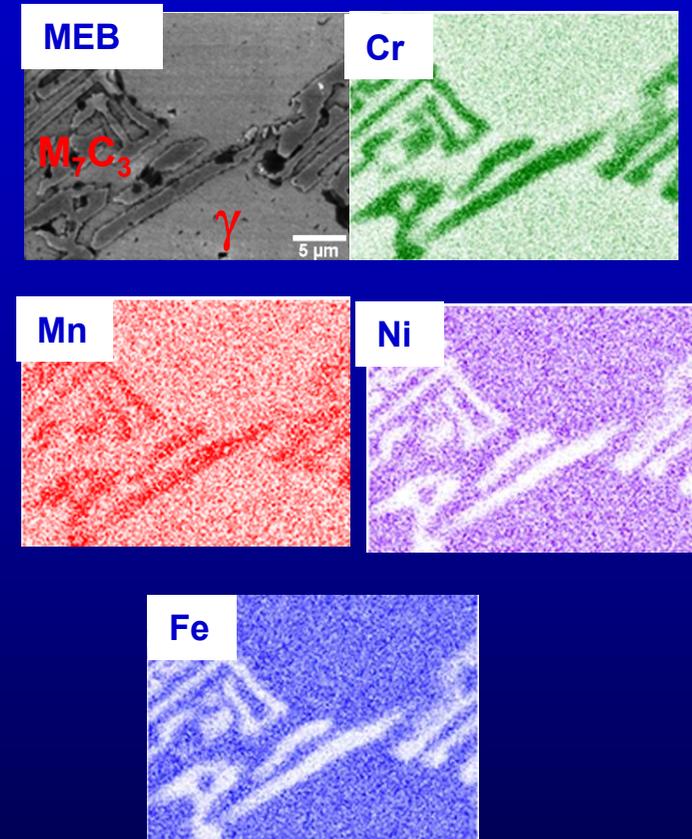
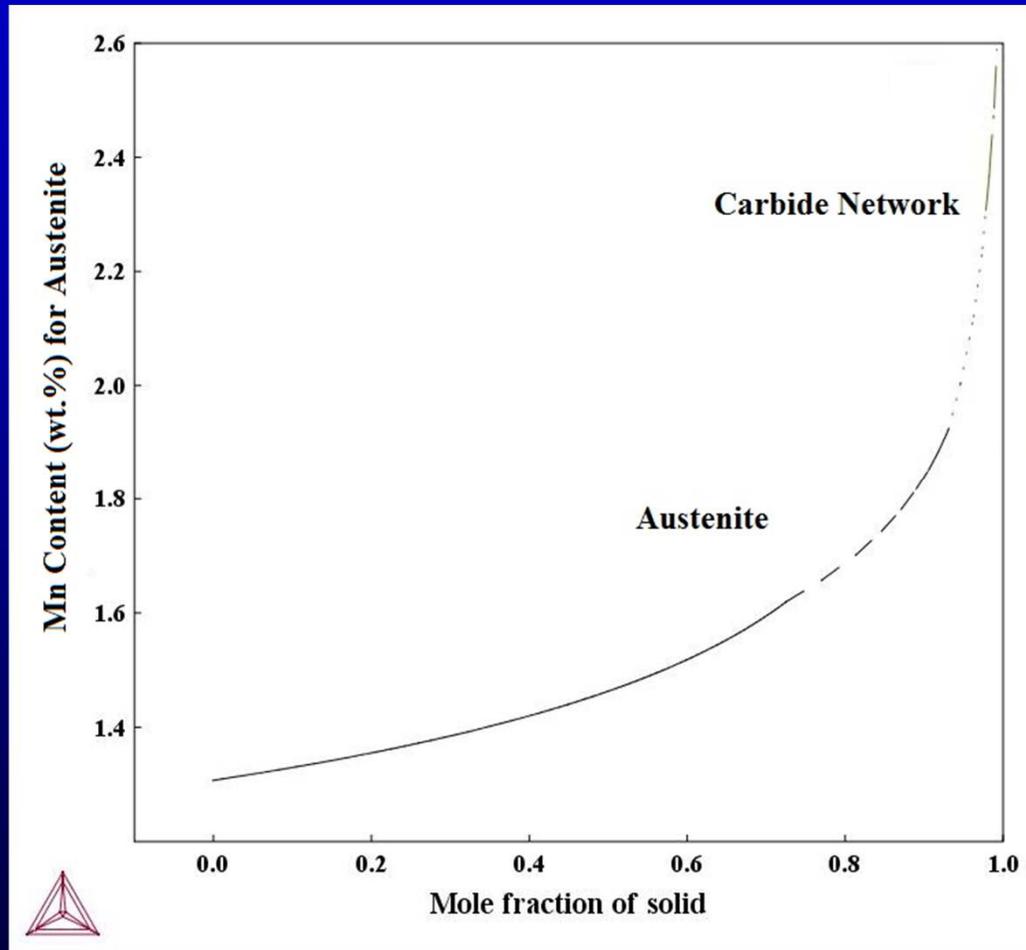
TC-Phase Diagram

Análisis por Scheil



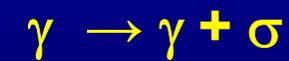
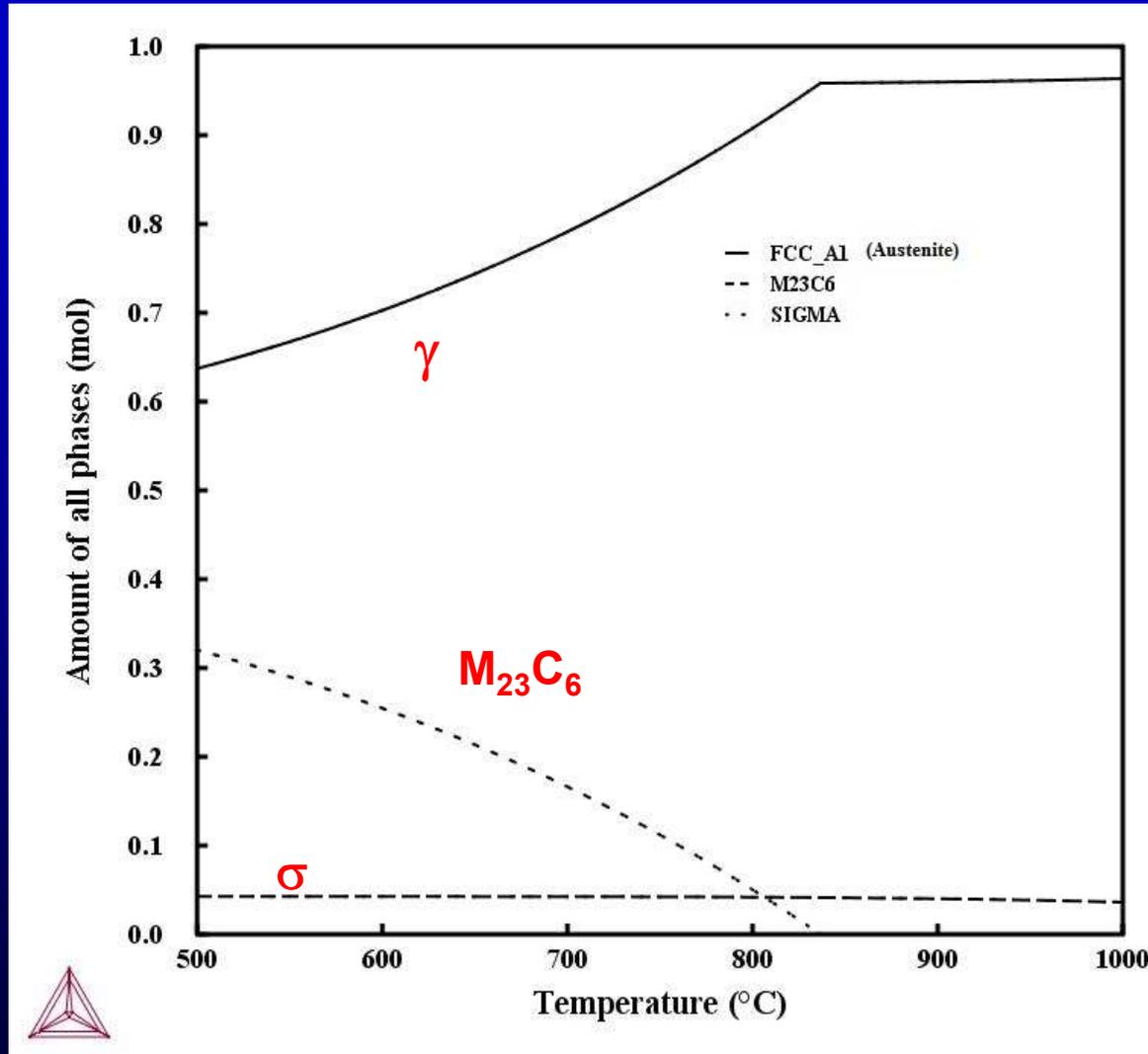
TC-Scheil Modification

Análisis por Scheil



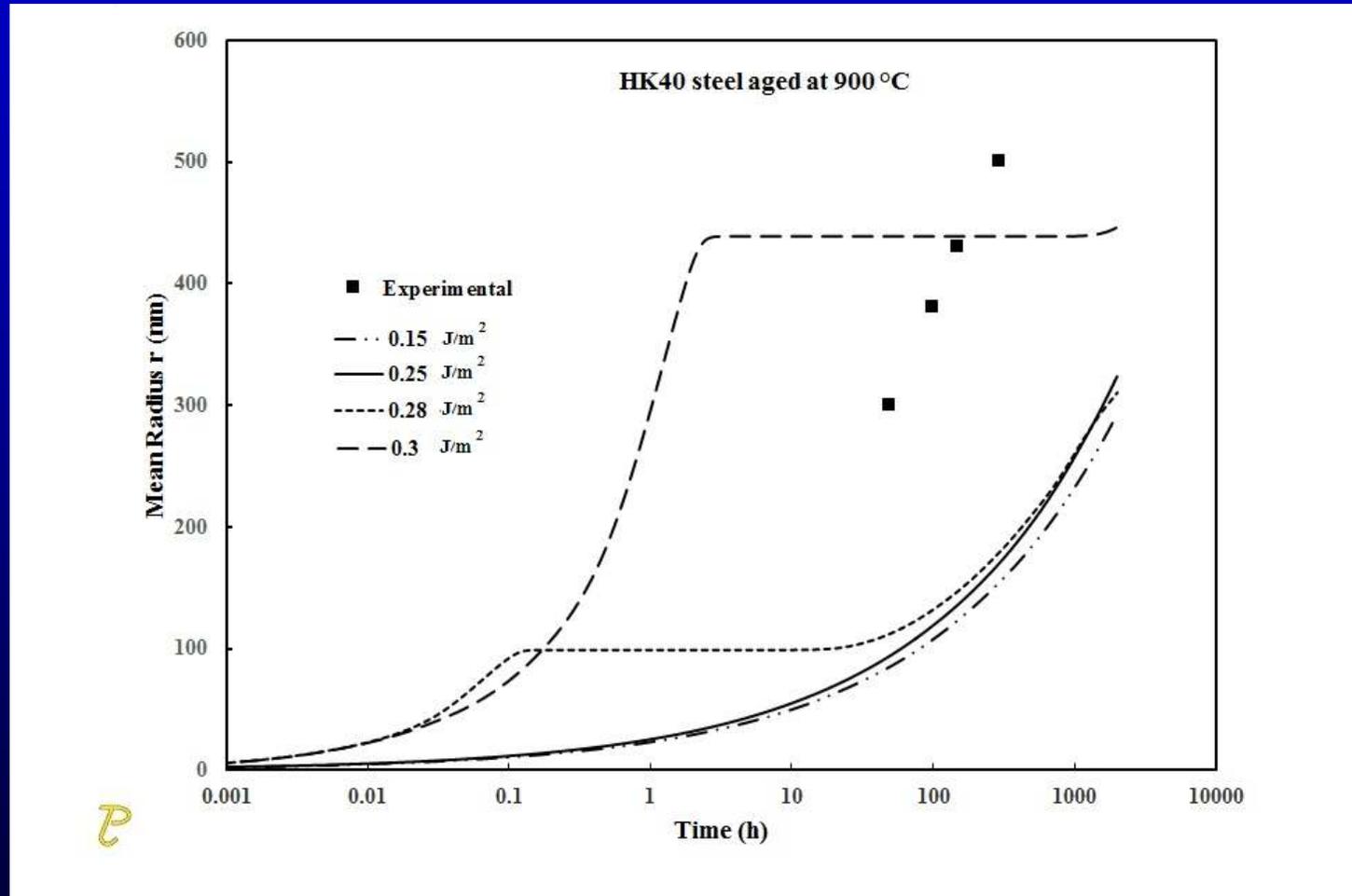
TC-Scheil Solidification

Análisis de Precipitación



TC-One Axis

Análisis de Precipitación Intragranular



Micrografías MEB y DRX del acero envejecido

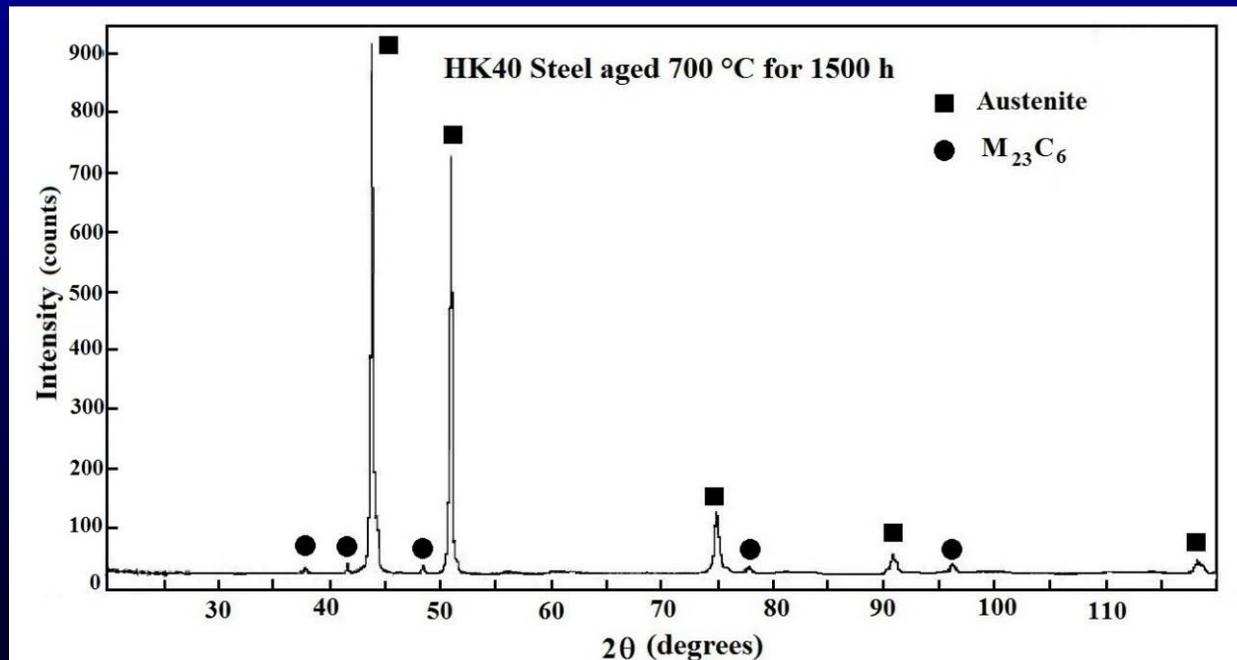
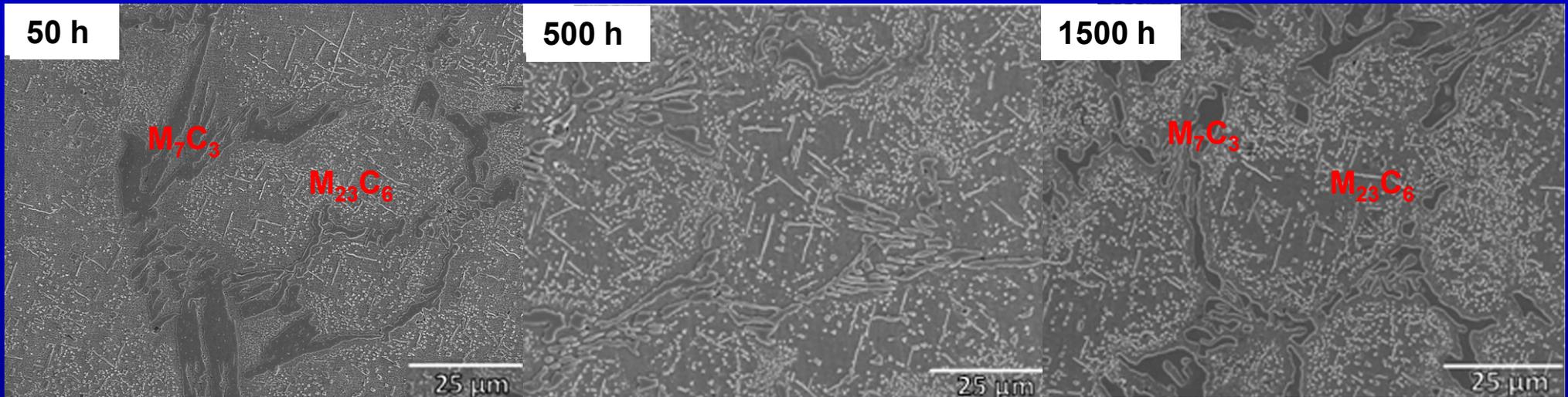
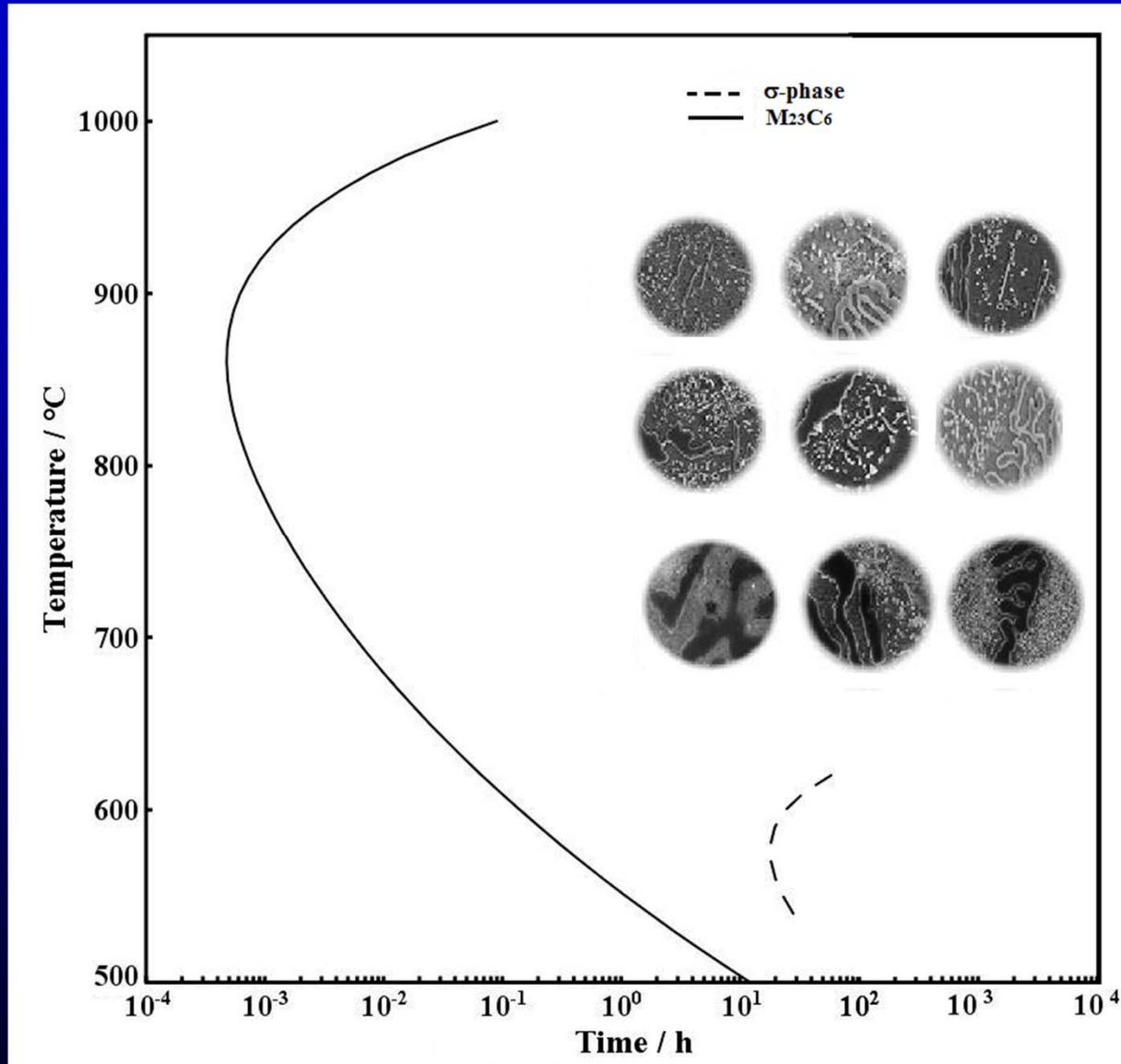
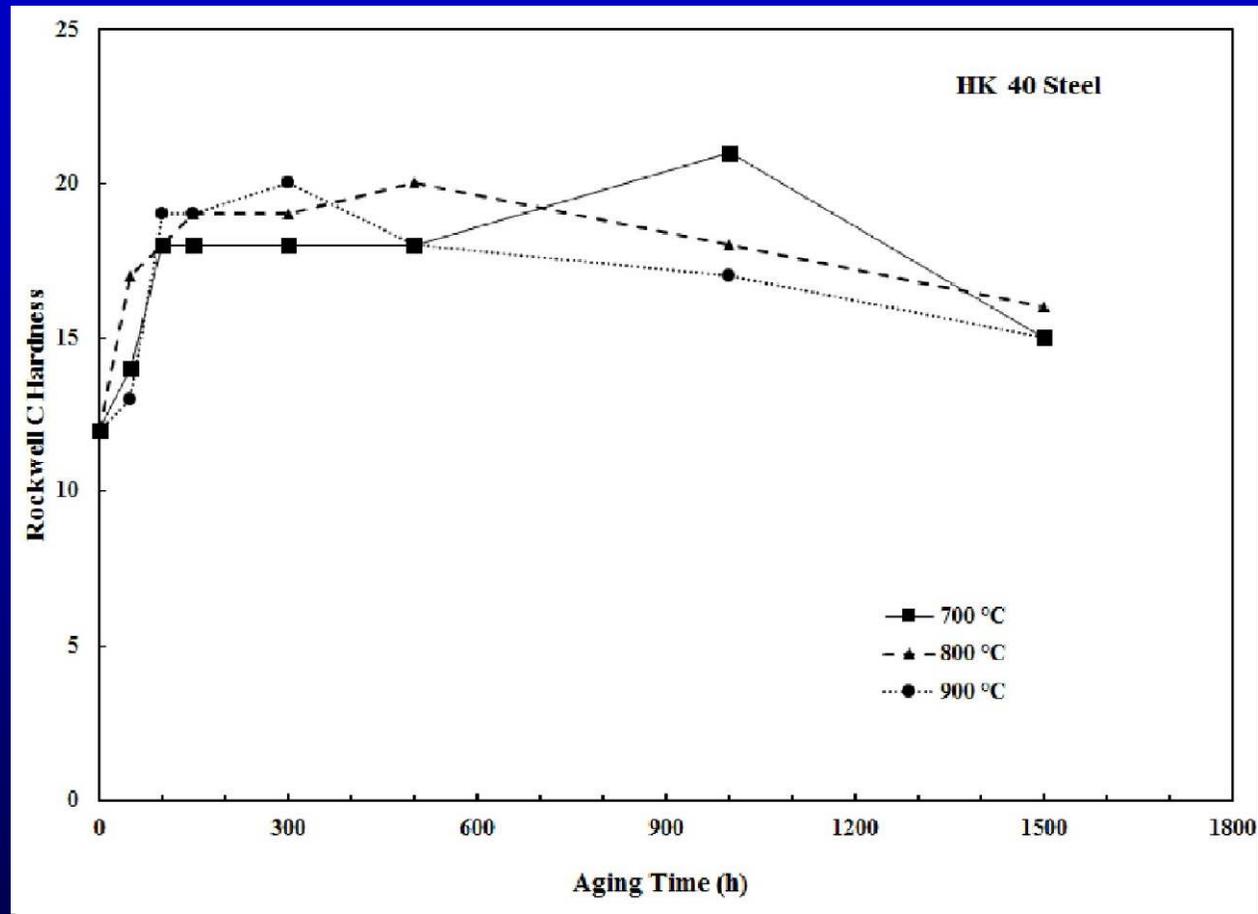


Diagrama TTP para el Acero HK40



PRISMA

Curvas de Envejecido

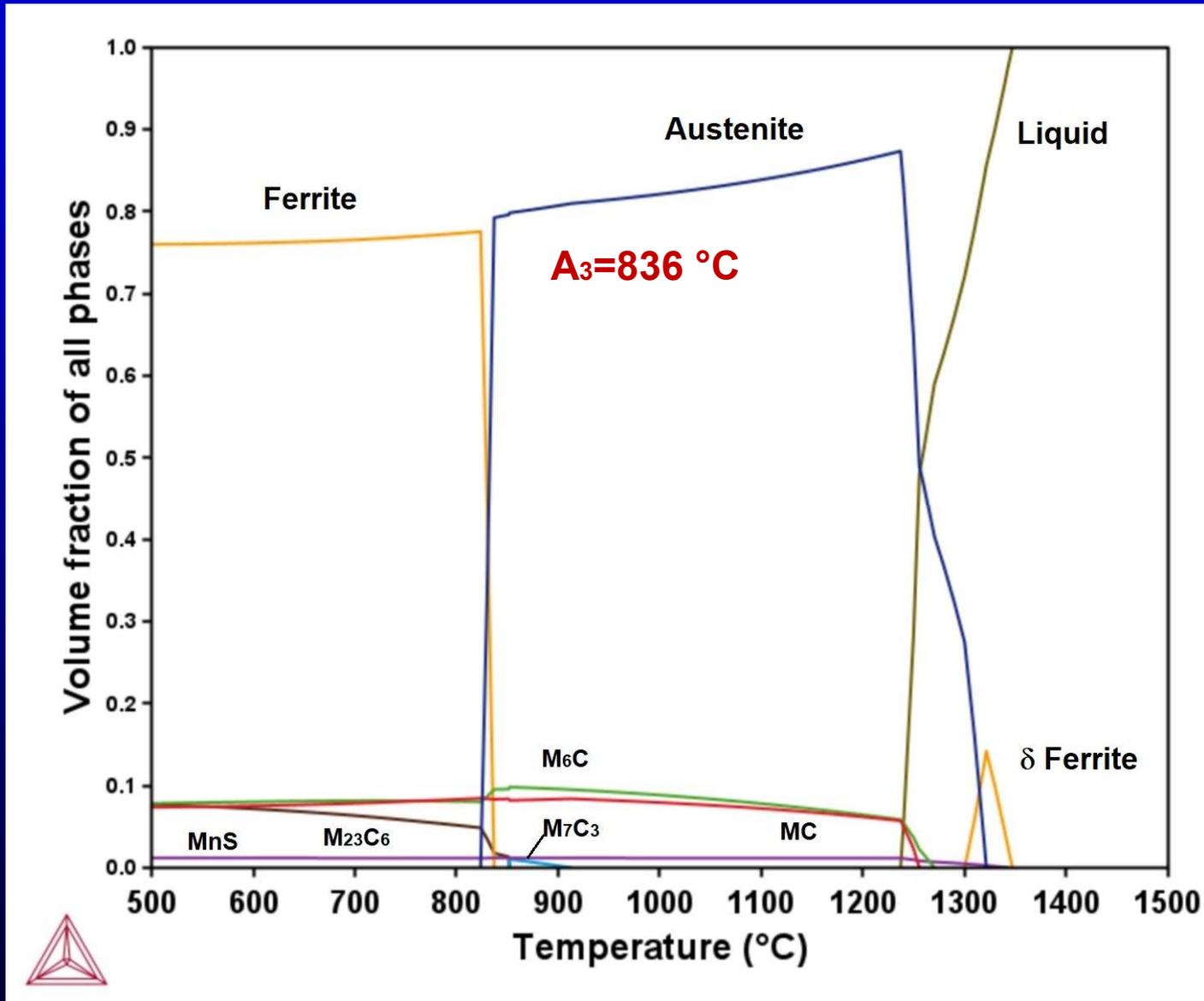


Acero AISI M4

- Acero de alta velocidad obtenido por pulvimetalurgia
- Utilizado para herramientas de corte, troquelado y conformado
- Endurecimiento por temple y revenido

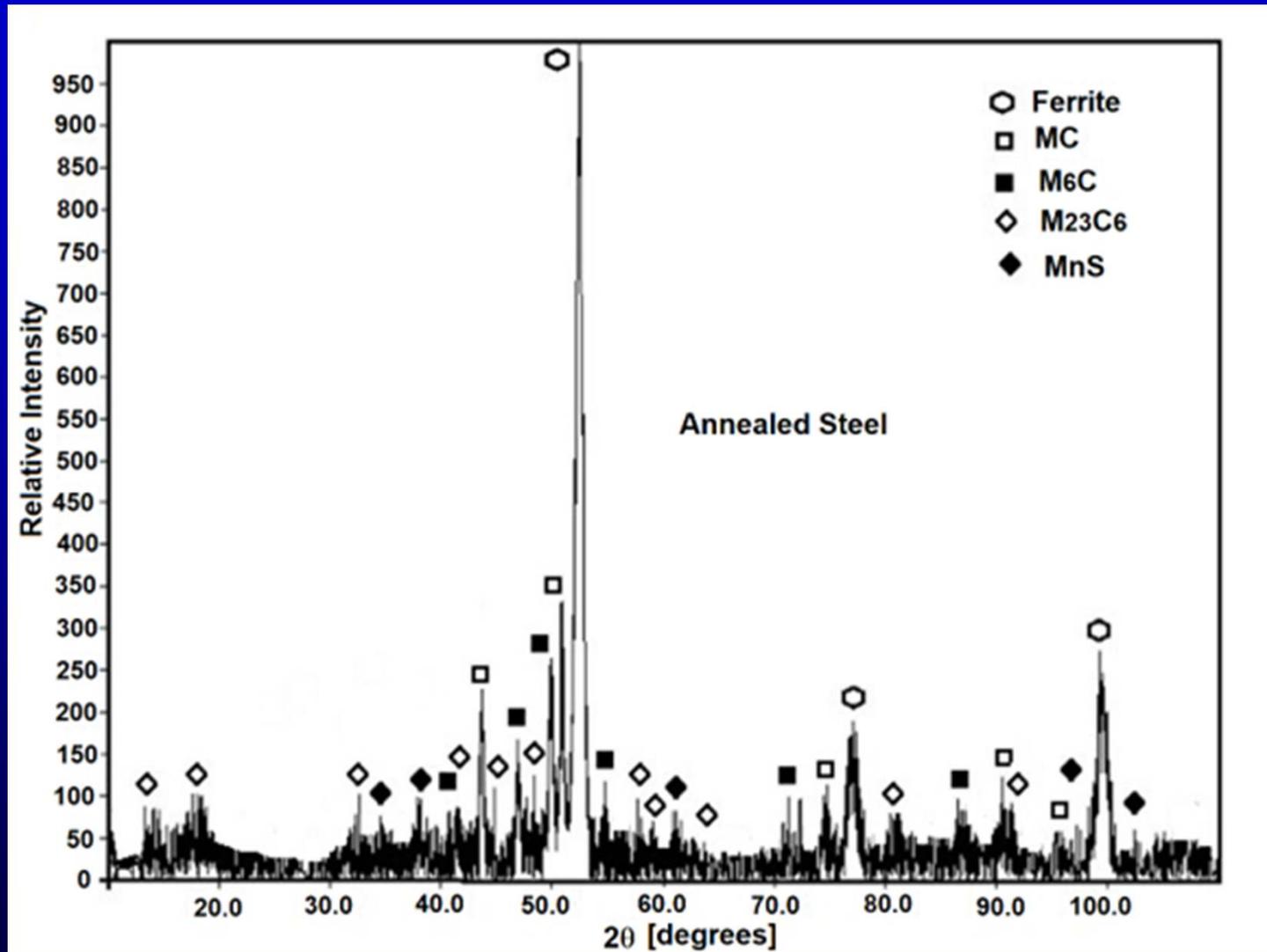
Elemento	C	Mn	Si	S	Cr	Mo	V	W
% peso	1.47	0.57	0.30	0.22	4.42	5.41	4.05	5.59

Fracción de fases vs. T

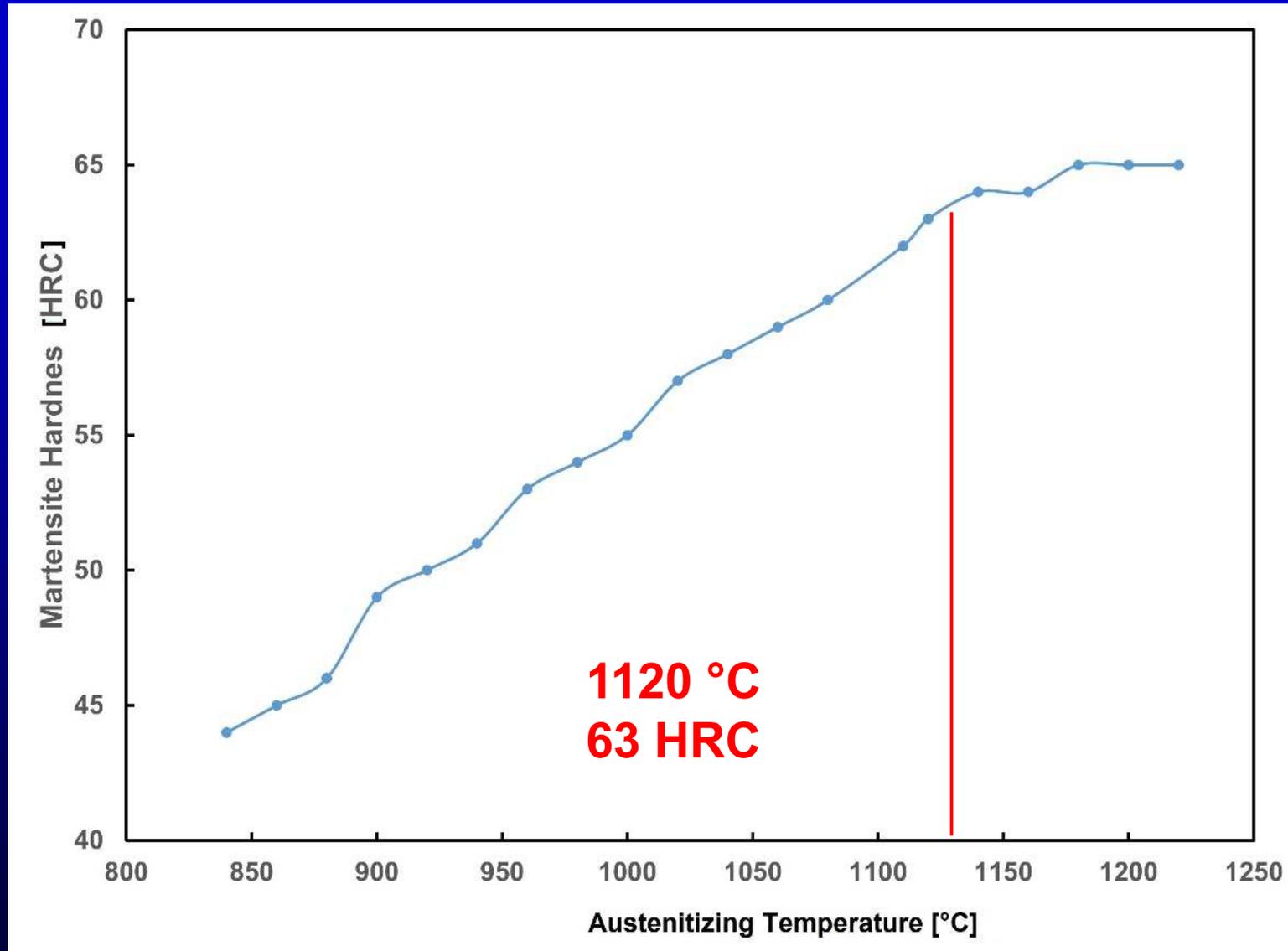


TC-One axis

DRX del Acero AISI M4 Recocido

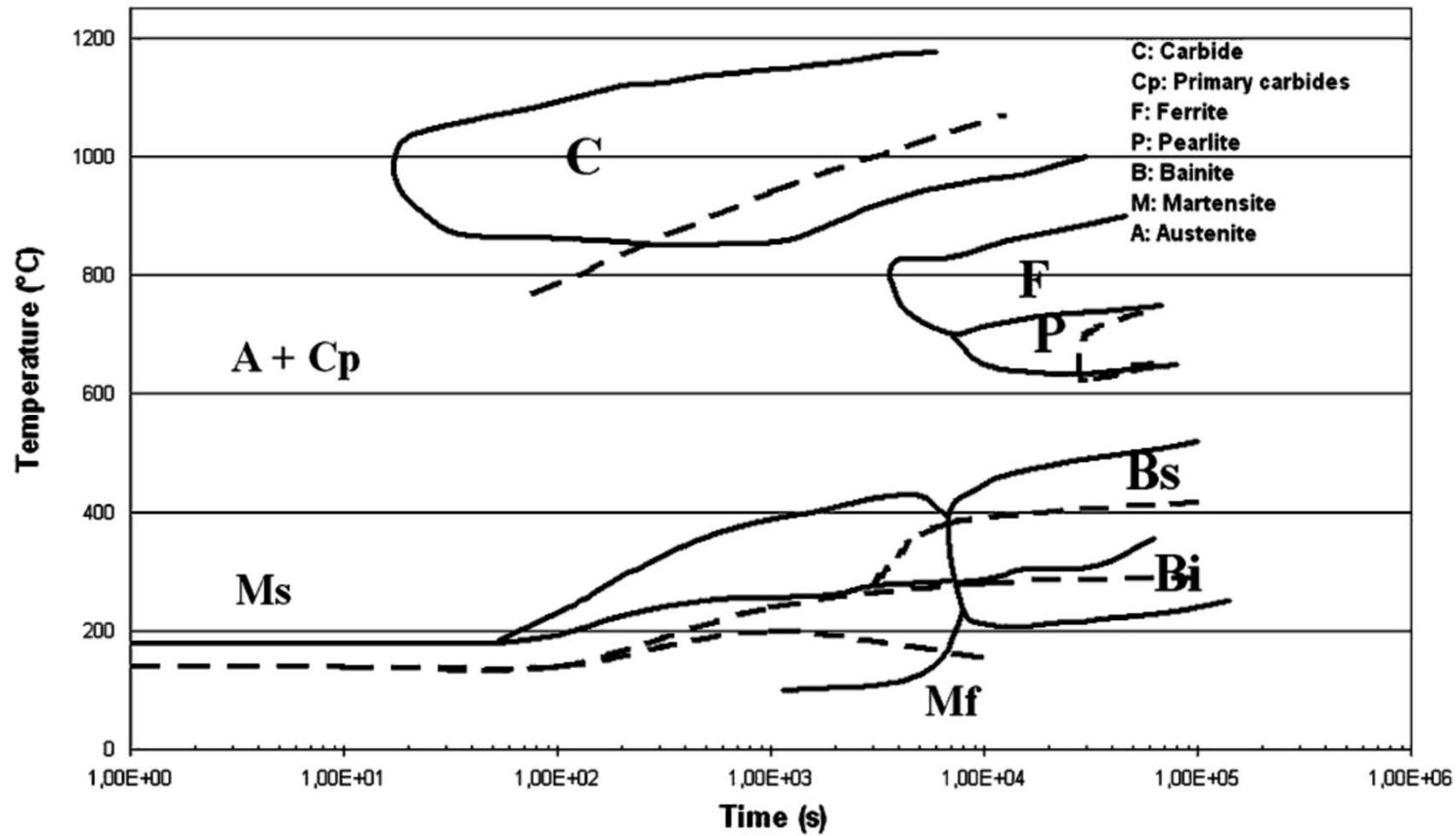


Dureza HRC vs. Temperatura de Austenitización



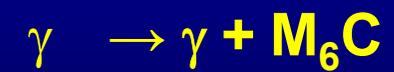
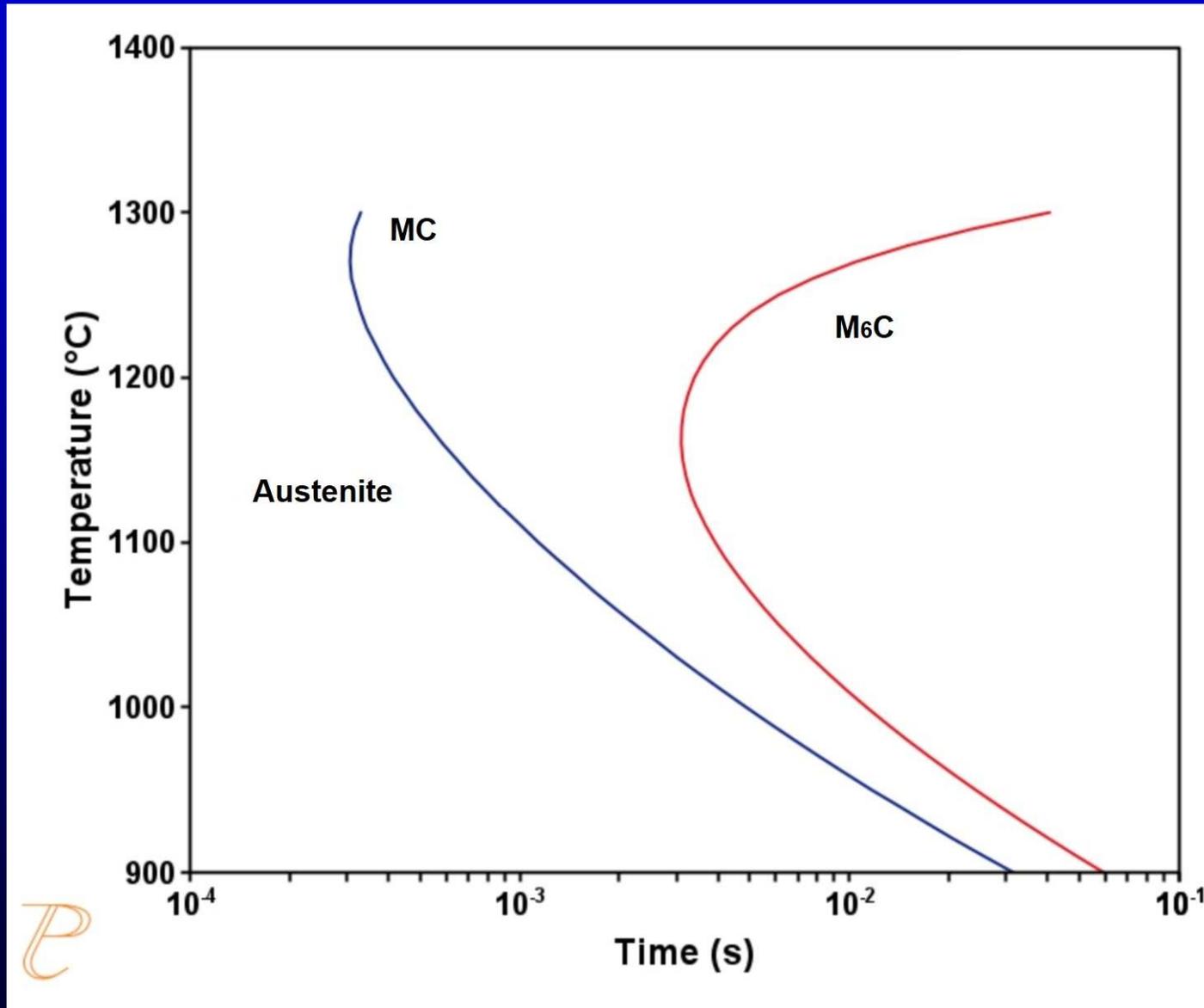
Single Point

CCT del Acero AISI M4 a 1220 °C



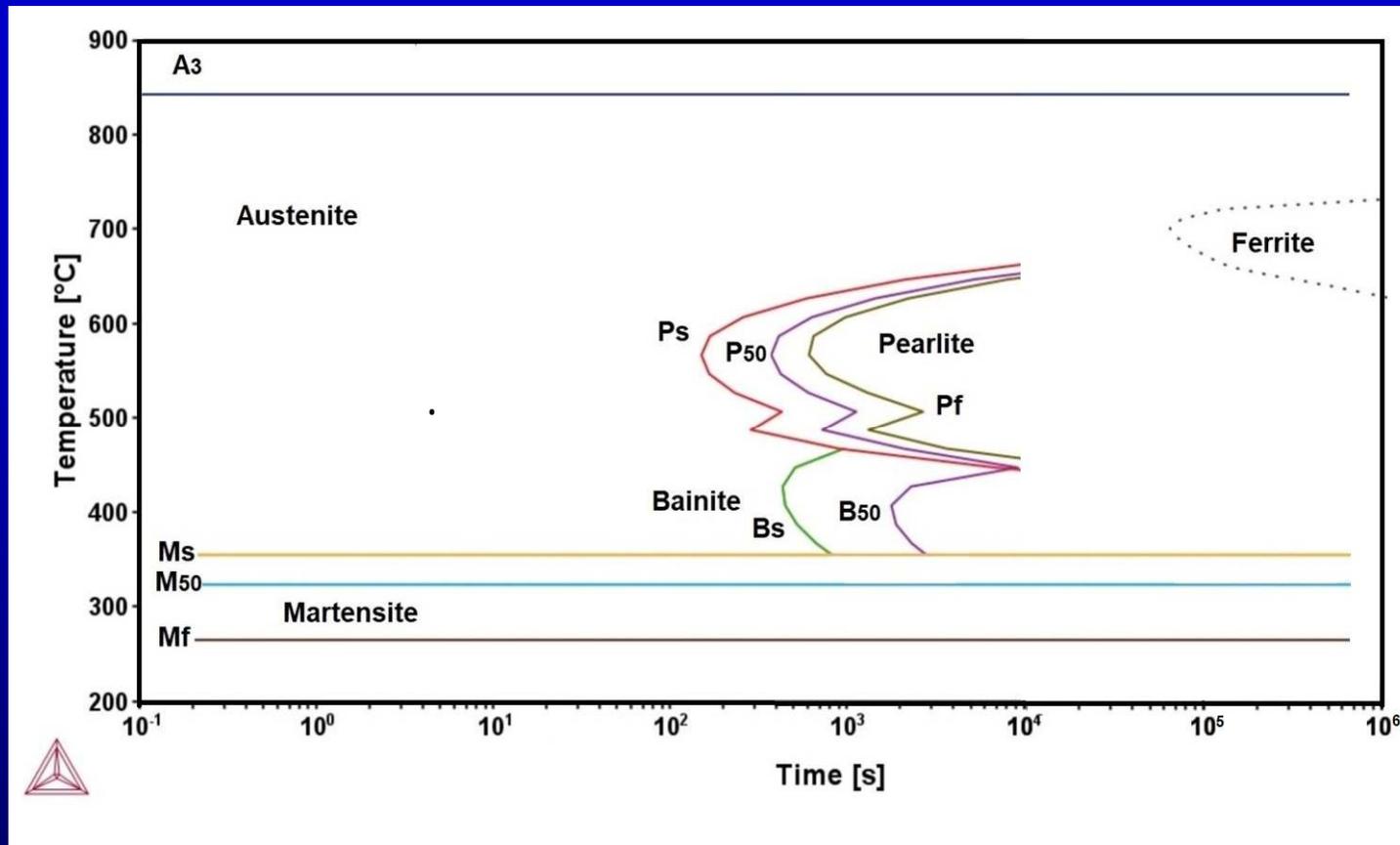
JMEPEG (2008) 17:864–869
DOI: 10.1007/s11665-008-9238-0

Precipitación Intergranular de Carburos Primarios



PRISMA

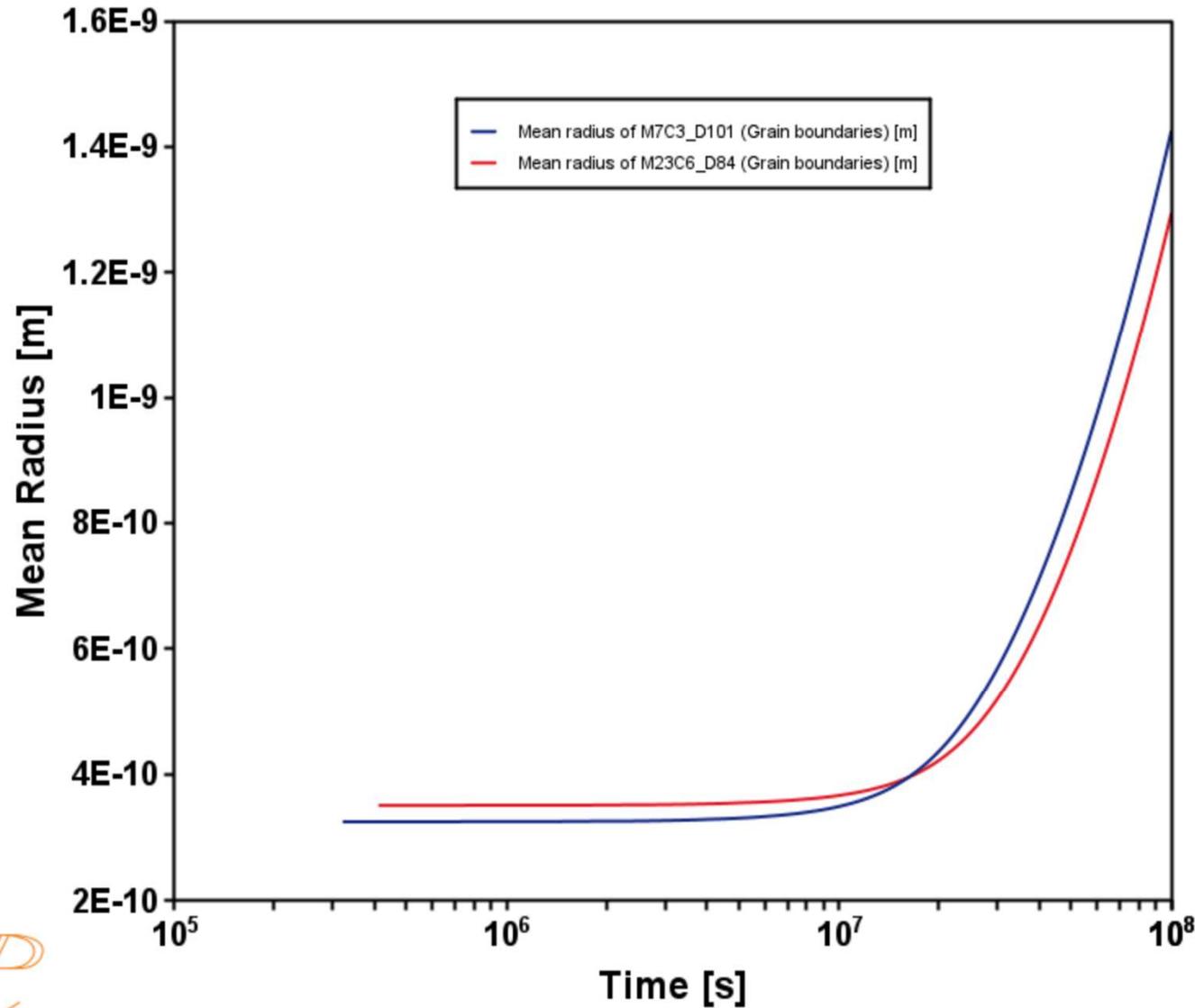
Diagrama TTT del Acero AISI M4



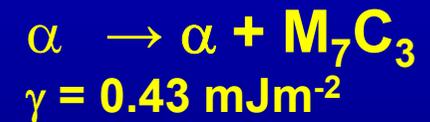
Property Models
TTT Steel

PRISMA

Precipitación Intergranular a 400 °C



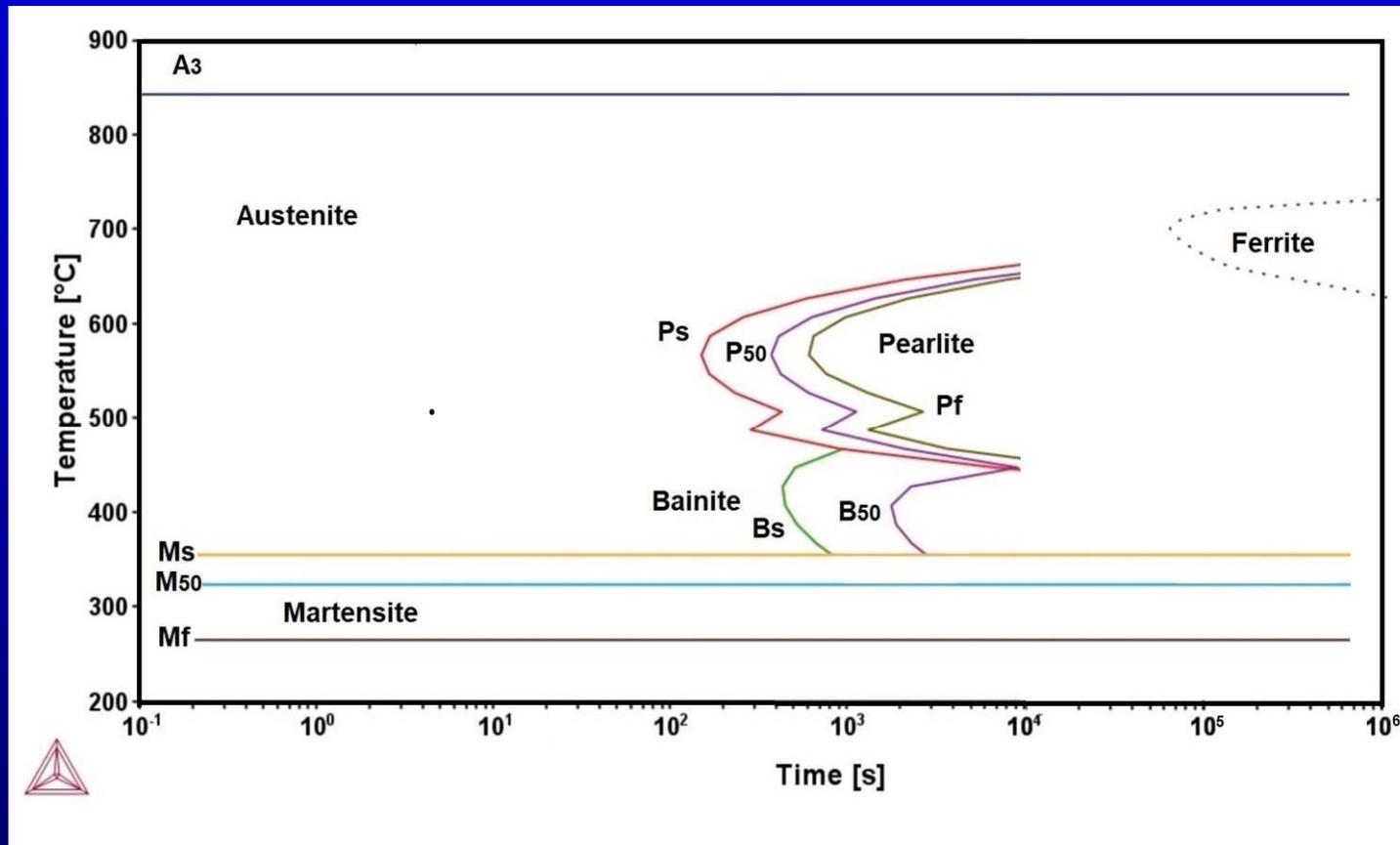
Composición de ferrita α a 800 °C



P

PRISMA

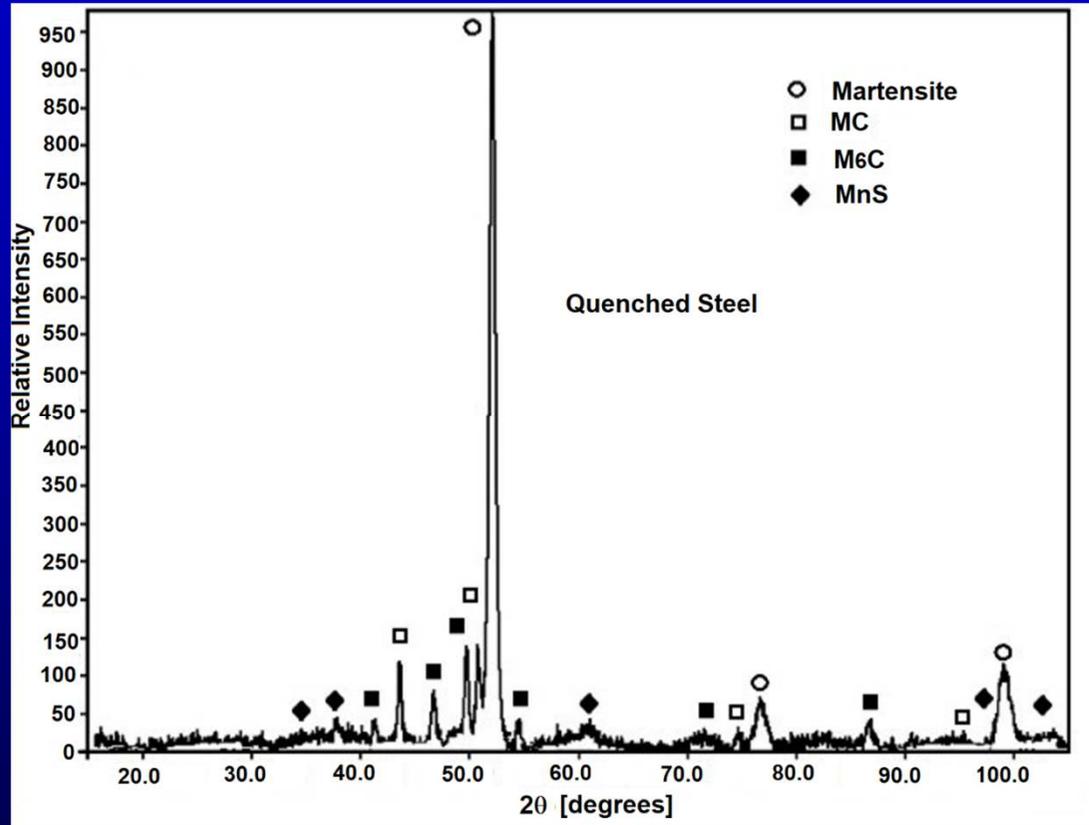
Diagrama TTT del Acero AISI M4



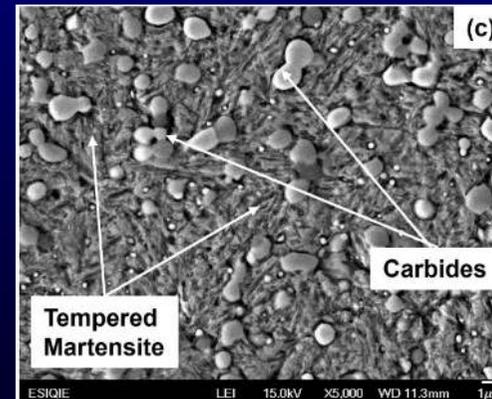
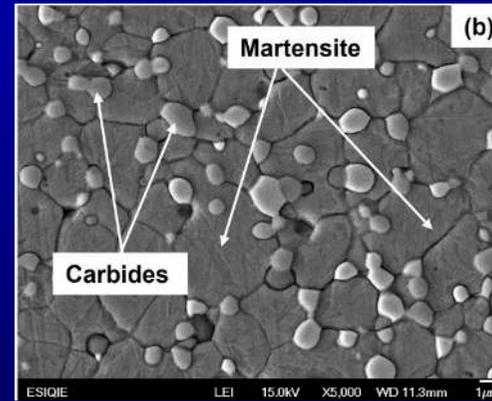
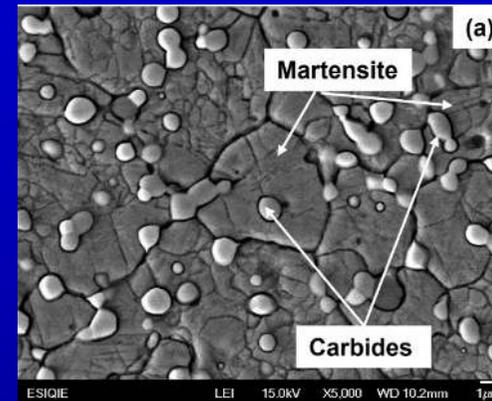
Property Models
TTT Steel

PRISMA

DRX del Acero AISI M4 Templado



Micrografías MEB



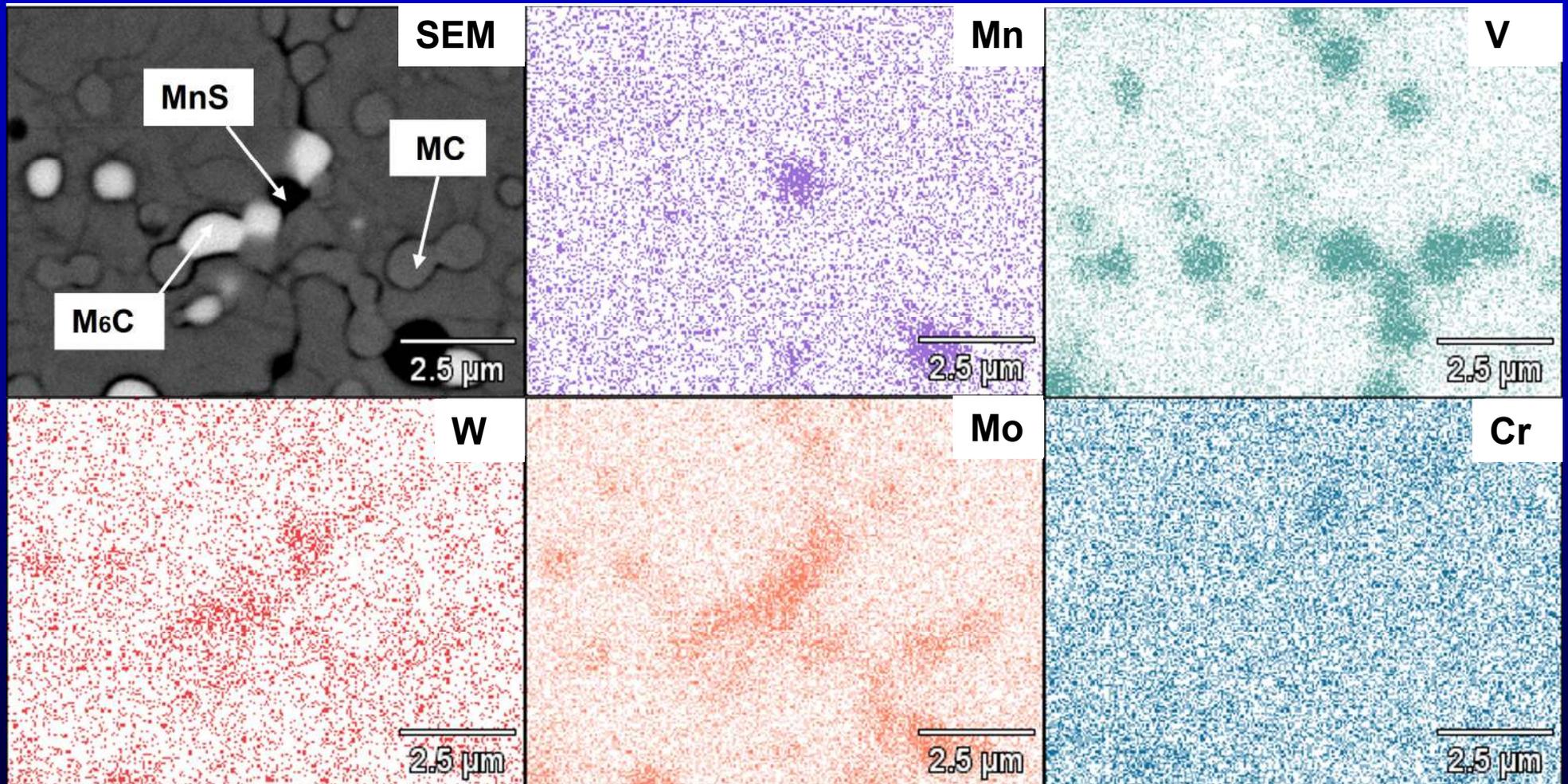
Normalizado
63 HRC

Templado
63 HRC

Templado-
Revenido a
550 °C 3h

57 HRC

Micrografías MEB y Mapeos Elementales del Acero Templado



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