Phase Transformation and Microstructure - The Jominy Bar
Isothermal Transformation Diagram (Fe-Fe₃C)
Complete Isothermal Transformation Diagram for Eutectoid Composition
“Slow Cooling” - Pearlite

course  fine

Figure 11.6 Photomicrographs of (a) coarse pearlite and (b) fine pearlite. 3000×. (From K. M. Ralls, et al., An Introduction to Materials Science and Engineering, p. 361. Copyright © 1976 by John Wiley & Sons, New York. Reprinted by permission of John Wiley & Sons, Inc.)
“Fast Cooling” – Bainite and Martensite*

Bainite

Martensite

*photos under electron microscopy
Complete Isothermal Transformation Diagram for 4340 Steel Alloy
Continuous Cooling vs. Isothermal Diagrams

Effective shift in the start/stop times for the reaction
Continuous Cooling Diagrams and Microstructure (Eutectoid Steel)
Continuous Cooling Diagrams and Microstructure – 4340 Steel Alloy
Hardness vs. Microstructure & Carbon Content

- Fine pearlite
- Coarse pearlite
- Spheroidite
- Martensite
- Tempered martensite (tempered at 371°C)
- Fine pearlite

Graphs showing the relationship between hardness, microstructure, and carbon content.
TTT Diagram and Hardenability

1095
TTT Diagram and Hardenability

4140
Ni-Cr-Mo Steels: 4340

TTT Diagram and Hardenability

4340
The ASTM Jominy Bar Test

- ASTM Standard A255
- Standard measure for hardenability of steel
- 25.4mm Diameter, 100mm Long Test Specimen
- Specimen heated above austenitic temperature (~800°C) for > 1 hour
- Specimen end quenched with water jet
Estimated Cooling Rates within Jominy Bar
Experimental Results – Plumpton & Harris (2002)

Microstructure

Quenched End
~800x
Experimental Results - Plumpton & Harris (2002)

Microstructure

3/4L from Quenched End

~800x
Experimental Results - Plumpton & Harris (2002)

Hardness Curves

Rocwell C Hardness vs. Distance from Quenched End