
**DEFINITIONS OF STEELS WITH SPECIFICATIONS**

- Steels: Definitions
- Steel Specifications

**STEEL PROCESSING**

**IRON CARBON EQUILIBRIUM**

- Iron Carbon Equilibrium Diagram

**CRYSTAL STRUCTURES OF IRON**

- Effects of Carbon
- Crystal Structures in Fe-C Alloys
- Effects of Alloying Elements
- Critical Temperatures
- Crystal Imperfections and Slip

**FERRITE, PEARLITE AND CEMENTITE**

- Eutectoid Transformation
- Pearlite Structure
• Pearlite Transformation Kinetics
• Interphase Precipitation
• Divorced Eutectoid Transformation: Dispersed Carbide Particles in Ferrite
• Proeutectoid Phase
• Proeutectoid Phase Formation

MARTENSITE

• Martensitic Transformation Kinetics
• Crystallography of Martensitic Transformation
• Morphology of ferrous martensites
• Plate martensite

BAINITE

• Bainite Transformation Start Temperatures
• Bainite versus Ferritic Microstructures
• Upper Bainite
• Lower Bainite
• Bainite Formation Mechanisms
• Mechanical Behaviour of Ferrite Carbide Bainites

MICROSTRUCTURES OF FERRITIC

• Classification System for Proeutectoid Ferritic Microstructures
• Cooling Rate Induced Changes in Ferrite
• Classification Systems for Ferritic Microstructures
• Polygonal or Equiaxed Ferrite
• Widmanstatten Ferrite
• Quasi Polygonal or Massive Ferrite
• Bainitic or Acicular Ferrite
• Granular Ferrite or Granular Bainitic Ferrite
• Classification System for Proeutectoid Ferritic Microstructures
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IMPORTANCE OF AUSTENITE IN STEEL

• Austenite Grain Size and Measurement
• Austenite Formation
• Time Temperature Austenitizing Diagrams
• Grain Growth of Austenite
• Effect of Second Phase Particles
• Austenite Grain Size in Aluminium Killed Steels
• Austenite Grain Size Control in Microalloyed Steels
• Hot Deformation of Austenite

PROCESSING EFFECTS ON STEEL

• Types and Origins
• Inclusion Identification and Characterization
• Effect of inclusions on Mechanical Properties
• Solidification Chemical Changes
• Solidification Dendrites and Inter dendritic Segregation
• Hot Work and its Effect on Solidification Structure
• Banded Microstructures
• The Effect of Banding on Mechanical Properties

ISOTHERMAL TRANSFORMATION DIAGRAMS

CONTINUOUS COOLING TRANSFORMATION DIAGRAMS

• Continuous Cooling Transformation and Bar Diameter

FERRITIC MICRO STRUCTURES

• The Ductile to Brittle Transition
• Continuous and Discontinuous Yielding of Ferritic Microstructures
• Aging Phenomena in Ferritic Microstructures
• Grain Size Effects on Strength and Fracture of Ferritic Microstructures
• Dispersion Strengthening of Ferritic Microstructures
• Solid Solution Strengthening of Ferritic Microstructures

LOW CARBON STEELS

• Low Carbon Steel: Hot Rolled Ferrite Pearlite Microstructures
• Low Carbon Steel Processing by Cold
• Rolling & Annealing
• Processing of Cold Rolled and Annealed Sheet Steels for High Formability
• Interstitial Free (IF) Steels

HEAT TREATMENTS

• Annealing
• Normalizing
• Spheroidizing
• Mechanical Properties of FerritePearlite Microstructures

MEDIUM CARBON STEELS

• Processing
• Microalloying Considerations
• Microstructure of Micro alloyed Forging Steels
- Mechanical Properties of Micro alloyed Forging Steels
- Direct Cooled Steels with Nontraditional Bainitic Microstructures

**HIGH CARBON STEELS**

- Rail Steels Structure and Performance
- Patenting: Pearlite Formation for High Strength Steel Wire
- Wire Drawing Deformation of Pearlite for High Strength Steel Wire
- Fracture Mechanisms of Patented and Drawn Steel Wire

**HARNESS AND HARDENABILITY**

- Martensite Strength
- Definitions of Hardenability
- Hardness Distribution
- Factors Affecting Cooling Rates
- Severity of Quench
- Quantitative Hardenability
- Determination of Ideal Size
- Jominy Test for Hardenability

**TEMPERING OF STEEL**

- Mechanical Property Changes
- Alloying Elements and Tempering
- Structural Changes on Tempering
- Matrix Changes during Tempering
- Oxide Colours on Tempered Steels

**TEMPERED CARBON STEELS**

- Dynamic Strain Aging in Martensite
- Mechanical behaviour of Low Temperature Tempered Martensite

**TOUGHNESS AND EMBRITTLEMENT**

- Introduction
- Effects of Primary processing on Toughness
- Hot Shortness Associated with Copper
- Overheating during Heating for Forging
- Aluminium Nitride Embrittlement
- Quench Embrittlement
- Tempered Martensite Embrittlement
- Temper Embrittlement
- Liquid Metal Embrittlement

**RESIDUAL STRESSES, DISTORTION, AND HEAT TREATMENT**

- Origins of Residual Stresses
• Heat Treatments to Reduce Surface Residual Tensile Stresses
• Evaluation and Prediction of Residual Stresses and Distortion

SURFACE HARDENING

• Flame Hardening
• Induction Heating
• Carburizing Processing Principles
• Carburizing properties and Structure
• Carburizing Fatigue and Fatigue and Fracture
• Nitriding
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• Ferritic Nitrocarburizing

STAINLESS STEELS

• Alloy Design and Phase Equilibria
• Austentic Stainless Steels
• Inter granular Carbides in Austenitic Stainless Steels
• Martensite Formation in Austenitic Stainless Steels
• Other Phases in Austenitic Stainless Steels
• Other Austenitic Stainless Steels
• Heat Treatment of Austenitic Stainless Steels
• Ferritic Stainless Steels
• Inter metallic Phases in Ferritic Stainless Steels
• 475oC (885oF)
• Embrittlement in Ferritic Stainless Steels
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TOOL STEELS

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• Classification of Tool Steels
• Tool Steel Alloy Design
• Primary Processing of Tool Steels
• Annealing of Tool Steels
• Stress Relief of Tool Steels
• Hardening of Tool Steels
• Preheating and Austenitizing
• Hardenability and Martensite Formation
• Grain Boundary Carbide Formation
• Tempering of Tool Steels
• Retained Austenite Transformation and Double Tempering in Tool Steels