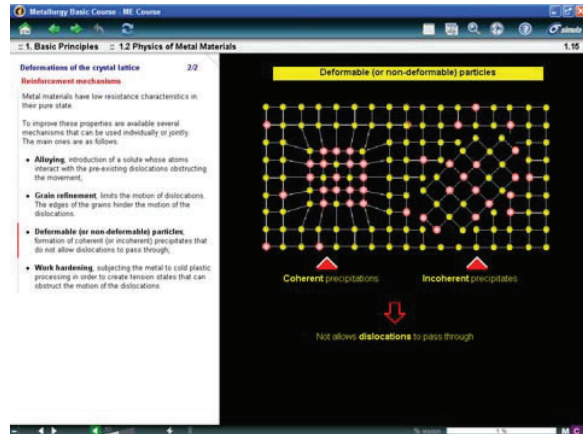


ME - METALLURGY BASIC COURSE

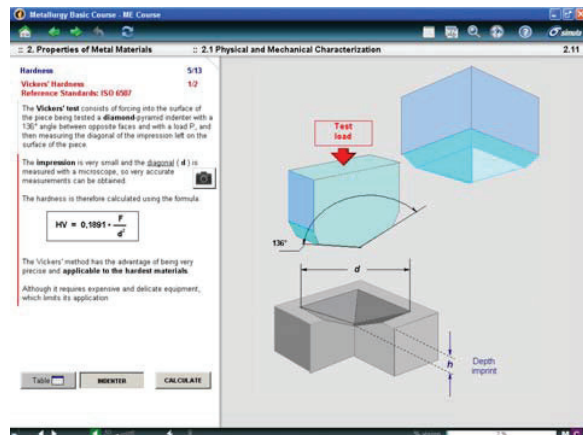
1. BASIC PRINCIPLES

- 1.1 Chemical Systems
- 1.2 Physics of Metal Materials
- 1.3 Phase Diagram
- 1.4 Phase Diagram of Binary Metal Alloys
- 1.5 Process Metallurgy
- 1.6 Heat Treatments
- Self-evaluation Tests



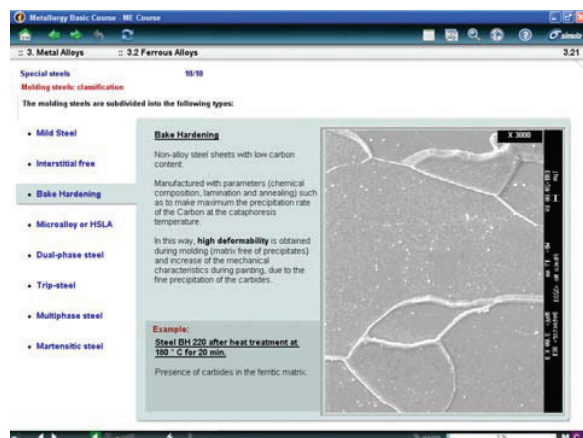
2. PROPERTIES OF METAL MATERIALS

- 2.1 Physical and mechanical characterization
- 2.2 Sample preparation
- 2.3 Test procedures and reference standards
- 2.4 Test results and suitability for use
- Self-evaluation Tests



3. METAL ALLOYS

- 3.1 Introduction
- 3.2 Ferrous Alloys
- 3.3 Non-Ferrous Alloys
- Self-evaluation Tests



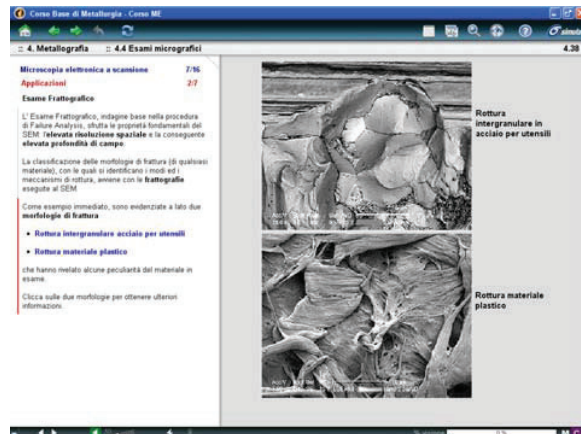
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Lenexa, KS 66214-1560 USA

Phone: 913-685-0675, Fax: 913-685-1125
e-mail: sales@ndtsupply.com, www.ndtsupply.com



4. METALLOGRAPHY

- 4.1 Metallographic Techniques
 - 4.2 Sample Preparation
 - 4.3 Preparation Techniques
 - 4.4 Micrographic Examinations
 - 4.5 Characteristic Structures of Ferrous Materials
 - 4.6 Test Procedures and Reference Standards
 - 4.7 Test Results and Suitability for Use of Materials
 - 4.8 Non-destructive Testing
-
- Self-evaluation Tests



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e-mail: sales@ndtsupply.com, www.ndtsupply.com



METALLURGY BASIC COURSE: DETAILED INDEX

1. BASIC PRINCIPLES ([>>> ME](#))

1.1 Chemical Systems

- Homogeneous and heterogeneous systems
- Chemical-physics of metallurgical processes

1.2 Physics of Metal Materials

- Structure of matter
- Solidification metals and alloys
- Crystal lattices
- Solid solutions
- Deformations of the crystal lattice
- Solid state transformations

1.3 Phase Diagram

- Cooling curve of a pure metal
- Solubility in the liquid state
- Insolubility in the solid state

1.4 Phase Diagram of Binary Metal Alloys

- General rules of interpretation
- Iron-Carbon Diagram
 - Hypoeutectoid steel
 - Hypereutectoid steel
 - Eutectoid steel
 - Hypoeutectic cast iron
 - Hypereutectic cast iron
 - Structural transformations
 - Critical points
- Addition of Elements

1.5 Process Metallurgy

- Metallurgical processes
- Production of Carbon Steels
 - Production of Cast Iron
 - Refining
 - Casting and Solidification
 - Rolling

1.6 Heat Treatments

- Introduction
 - Heat treatment steps
 - Critical points
 - Thermal transformations
 - Cooling rate
 - TTT and CCT Curve (or Bain curve)
 - Steel hardenability
 - Kinetics transformation of the steel structure
 - Austenite
 - Ferrite
-

- Perlite
- Cementite
- Bainite
- Martensite
- Type of thermal treatments
- Heat treatments at temperatures above critical points
 - Full Annealing
 - Isothermal annealing
 - Coalescence annealing
 - Normalisation
 - Quenching
- Treatments without phase variations
 - Tempering
 - Softening annealing
 - Relaxation
- Quench and tempering
- Surface heat treatments
 - Induction hardening
 - Thermochemical diffusion treatments
 - Cementation
 - Nitriding
 - Comparison Cementation-Nitriding

Self-evaluation Tests

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2. PROPERTIES OF METAL MATERIALS ([>> ME](#))

2.1 Physical and mechanical characterization

- Mechanical properties
- Tensile strength
- Hardness
 - Brinell Hardness
 - Vickers Hardness
 - Rockwell Hardness
 - Microhardness
- Resiliency
 - Test equipment
 - Transition ductile-brittle
 - Transition temperature
 - Resilience test
 - Test parameters
 - Izod impact strength test
- Creep (Cold flow)
- Fatigue resistance
 - Fatigue failures
 - Typical aspect of a fatigue fracture
 - Fatigue tests
 - Wohler's curve
 - Fatigue limit
- Surface roughness
 - Roughness parameters
 - Roughness measurement

2.2 Sample preparation

- Sampling for mechanical tests
 - Definitions
 - Preparation and identification of the samples
- Location and preparation of samples
 - Flat products
 - Long products
 - Tubes

2.3 Test procedures and reference standards

- Test procedures and standards
- Test standards
- Measurement uncertainty
 - Possible factors of uncertainty
 - Types of measurement uncertainty
 - Expression of measurement uncertainty

2.4 Test results and suitability for use

- Use of test results
 - Design mechanical parts
 - Mechanical tests
 - Tensile strength
 - Traction stiffness
 - Compressive strength
-

- Hardness measurement
- Resistance to torsion, bending
- Resistance to shear stresses
- Resistance to crack propagation
- Resistance to fatigue
- Resistance to creep
- Environmental effects on mechanical properties
 - Stress Corrosion Cracking
 - Hydrogen Induced Cracking
 - Corrosion Fatigue
 - Resistance to shock
- Manufacturing process
 - Criticality of the transformation
 - Mechanical properties and transformation
 - Controls and Testing
- Failure Analysis and Life Assessment
 - Life assessment
 - Failure analysis

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3. METAL ALLOYS ([>> ME](#))

3.1 Introduction

3.2 Ferrous Alloys

- Steel grades
 - EN designation steels
 - AISI classification
- Classification based on alloy elements
- Classification according to applications
- Structural steels
 - General purpose steel
 - Weldable steels
- Special steels
 - Nitriding steels
 - Cement steels
 - Self tempering steels
 - Tool steels
 - Steels for rolling bearings
 - Spring steels
 - Molding steels

- Stainless steels
- Casting steels
- Cast Irons

3.3 Non-Ferrous Alloys

- Aluminum Alloys
 - Characteristic structures
 - Alloy elements and features
 - Influence of alloying elements
 - Aluminum Industrial Alloys
- Magnesium Alloys
- Titanium Alloys
- Copper Alloys
- Nickel Alloys
- Cobalt Alloys

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4. METALLOGRAPHY ([>> ME](#))

4.1 Metallographic Techniques

4.2 Sample Preparation

- Metallographic sample
- Basic operations
 - Sectioning or cutting
 - Resin encapsulation
 - Grinding
 - Polishing
 - Chemical etching
- Metallographic replicas

4.3 Preparation Techniques

- Ferrous alloys
- Anti-friction alloys
- Aluminum alloys
- Copper alloys
- Magnesium alloys
- Nickel alloys
- Titanium alloys
- Zinc alloys

4.4 Micrographic Examinations

- Optical microscopy
- Scanning Electron Microscopy
 - Components
 - Operation principle
 - Related technique
 - Metallurgical application
 - Evolution of microscopy techniques
 - Evolution of microanalysis techniques

4.5 Characteristic Structures of Ferrous Materials

- Austenite
- Ferrite
- Cementite
- Pearlite
- Martensite
- Bainite
- Graphite

4.6 Test procedures and reference standards

- Test procedures and standards
- Standardization levels

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4.7 Test results and suitability for Use of Materials

- Use of the test results
- Microstructural examinations
 - Band structure classification in laminates
 - Determining average grain size
 - Determination of inclusions in steel
 - Estimating the depth of decarburization

4.8 Non-destructive Testing

- Introduction
- RT - Radiographic Testing
- UT - Ultrasonic Testing
- MT - Magnetic Testing
- PT - Penetrant Testing
- ET - Eddy current Testing
- VT - Visual Testing
- IT - Infrared Thermography
- CT - Computerized Tomography
- Thermal Stress Analysis

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