MTAG Manufacturing Technology Advisory Group

MTAG MODULARIZED CURRICULUM

Introduction to Materials Science

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TECH PREP/MTAG CURRICULUM

Introduction to Materials Science

Lesson Plan

Time Allotment: 4-hours
Prepared By: Gene E. Fusch, Ph.D., Giving special recognition to Edmonds Community College

MODULE DESCRIPTION

This module will introduce materials science. Through classroom and lab activities students will learn about the properties and processing of solid materials used in manufacturing (ceramics, metals, polymers, and composites).

MODULE OBJECTIVE

After completing this module, students should be able to discuss materials used in advanced manufacturing. In particular, students should be able to…

- Define advanced materials
- Discuss properties of materials
- Provide examples of leading-edge and smart materials Identify metals
- Explain the differences between a ferrous and non-ferrous metal
- Define the properties of ceramics and glass
- Identify polymers and composites
- Explain the differences between a polymer and composite
- Make a fiber reinforced composite part
- Demonstrate safe fabrication practices

MTAG COMPETENCIES INTRODUCED

C1.05 Comply with established safety practices
C2.01 Wear protective safety clothing and equipment as required
F2.05 Follow established safety procedures when around machinery and equipment
F5.03 Prepare resources for production
F10.03 List types of chemical and manufacturing processes
F10.04 Differentiate between types of chemical and manufacturing processes

MANUFACTURING SKILLS STANDARDS INTRODUCED (MSSC)

B5 Layout material to prepare it for fabrication
C3 Chemically process product
C6 Apply identification
E2 Stamp/document work performance

PERFORMANCE CRITERIA

- Students will be able to demonstrate safe work practices
- Students will be able to discuss and identify materials and processes
- Students will be able to complete select labs
- Students will be able to complete a report documenting the fabrication process and final result

SEQUENCING

Lesson 1: Introduction to Materials--Properties
Introduce lesson
Introduce materials science
Cover properties starting at the atomic level
Create molecular structures lab
Cover nanotechnology and MEMS
End with smart materials and experiment with Nitinol wire
Assignment: Lab report

Lesson 2: Introduction to Materials--Metals
Review materials and link to metals
Introduce lesson objectives
Discuss the history of metals
Introduce ferrous and non-ferrous metals
Discuss smelting, foundry, and milling metals
Optional lab activity
Discuss labs (if expanded option selected) and review lesson
Assignment: Lab report

Lesson 2-B: Introduction to Materials--Ceramics
Introduce ceramics
Introduce glass
Optional lab activity
Discuss labs (if expanded option selected) and review lesson
Assignment: Lab report

Lesson 3: Introduction to Materials--Polymers
Introduce polymers
Discuss thermoforming and thermosets
Lab activity (select one polymer lab option)
Discuss labs and review lesson
Assignment: Lab report

Lesson 4: Introduction to Materials--Composites
Introduce composites
Explore products made from composites
Compare composites to polymers and metals
Lab activity (select one composite lab option)
Discuss labs and review lesson
Assignment: Lab report

SUPPLIES NEEDED

- LCD Projector and Computer (Option: Overhead Projector)
- White board
- A set of colored markers for the white board
- Selected lab materials:
    - Lab option one: Nitinol
        - Nitinol wire (Instructor note: Nitinol is available from many suppliers that may be located online. Some suppliers may offer free samples that will suffice for this lesson)
        - Alcohol burner or heat source for Nitinol demonstration
        - Safety glasses/goggles
        - Leather or temperature insulating gloves
    - Lab option two: Metal Peening
        - Copper sheets 20-guage or thin enough for peening
        - Ball peen hammers (enough for each group)
        - Small anvil or steel blocks for peening
        - Safety glasses/goggles
        - Leather or other safety gloves
    - Lab option three: Metal Rolling
        - Metal roller
        - Copper pennies or other soft metal material for rolling
        - Safety glasses/goggles
        - Leather or other safety gloves
    - Lab option four: Raku
        - Kiln (Ceramic Type)
        - Clay--preferably Raku clay
        - Oxidized metal glazing
        - Brush to apply glazing
        - Sealed metal container
        - Shredded paper
        - Pail of water
        - Tongs
        - Safety glasses/goggles
        - Leather or other safety gloves
    - Lab option five: Thermoforming--Vacuum Forming
        - Hi-density polyester or other thermoforming polymer sheet
        - Vacuum Thermoforming Machine
        - Sheers (high quality scissors)
        - Mold or selection of molds for thermoforming
        - Safety glasses/goggles

- Lab option six: Thermoforming--Injection Molding
  - Hi-density polyester or other thermoforming pellets, powder, or flakes
  - Injection Molder
  - Mold or selection of molds for injection molder
  - Mold release agent
  - Leather or other safety gloves
  - Safety glasses/goggles
- Lab option seven: Thermosetting Lab (prepare the following items for each student)
  - 20-guage copper strips 3/16" by 2.5"
  - Small waxed-paper or plastic cups
  - Neon light and a 70,000 - 100,000 Ohm resister
  - Resin (or epoxy--follow breathing protection requirements)
  - Resin catalyst (or epoxy hardener--follow breathing protection requirements)
  - Resin mixing containers
  - Stir sticks
  - Soldiering irons
  - Soldier
  - Needle-nose pliers
  - Sheers (high quality scissors)
  - Two 2" or longer nails
  - Safety glasses/goggles
  - Face mask/breathing protection as needed
  - Nitrol, latex (some people have latex allergies) or other protective gloves
- Lab option eight: Basic Composite Lab (minimal supplies)
  - 3-Bread loaf pans per group
  - Dirt
  - Water (16-20 oz refilled water bottles will work as a good water source)
  - Straw
  - Burlap (or other mat product)
  - Safety glasses/goggles
  - Nitrol, latex (some people have latex allergies) or other protective gloves
- Lab option nine: Fiber Reinforced Composite Lab (advanced materials)
  - Composite release film
  - Fiberglass cloth (or other composite cloth)
  - Resin (or epoxy--follow breathing protection requirements)
  - Resin catalyst (or epoxy hardener)
  - Resin mixing containers
  - Stir sticks
  - Plastic spreader
  - Safety glasses/goggles
  - Face mask/breathing protection as needed
  - Nitrol, latex (some people have latex allergies) or other protective gloves

INDEX OF INSTRUCTIONAL MATERIALS

RECOMMENDED STUDENTS PREREQUISITES

Completed the following modules:

- Introduction to Manufacturing
- Safety in Manufacturing

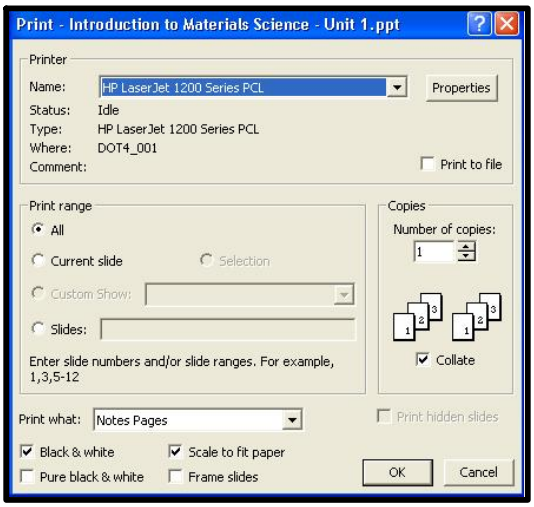
CURRICULUM OVERVIEW

Notes to the teacher:

1. This module comprises 5-parts that can be completed in four one-hour lessons or expanded by adding additional labs from the nine lab options to provide 10-12 hours of instruction.

2. This module includes a PowerPoint presentation for each of the five parts along with in-depth notes-pages detailing the lesson plans. To enhance instruction, teachers should…

   a. Print the notes-pages and use the notes-pages in a notebook to follow while presenting lesson. Using sheet protectors will allow teachers to view two notes pages at once. To print notes pages in PowerPoint, select File, Print, Notes Pages, Pure Black and White, Scale to Fit Paper, and Print.



   b. Either use the PowerPoint Slideshow with a LCD projector and computer (preferred method for animations and detail) or print slides on transparency film for use with an overhead projector.

3. During the teacher's presentation and class discussion, the student will be viewing only the PowerPoint slide (below left), while the teacher will view both the PowerPoint slide on the screen and the lesson plan on the notes page (below center and right).