

Chapter 24

Metal Characteristics

LEARNING OBJECTIVES

After studying this chapter, students will be able to:

- Explain how metals are classified.
- Describe the characteristics of metals.
- Recognize the hazards that are posed when certain metals are machined.
- Explain the characteristics of some reinforced composite materials.

INSTRUCTIONAL MATERIALS

Text: pages 451–466

Test Your Knowledge Questions, page 465

Workbook: pages 131–134

Instructor's Resource: pages 315–322

Guide for Lesson Planning

Research and Development Ideas

Reproducible Masters:

24-1 Tungsten Carbide Tool Coating

24-2 Test Your Knowledge Questions

Color Transparency (Binder/CD only)

GUIDE FOR LESSON PLANNING

Before studying the chapter, have the class define the term *metal* in their own words. Is there a definition that will describe all metals? Have samples of as many different metals as possible. They should be identical in size. Permit the class to handle them, feel their weights (the weights of two aluminum alloys will differ slightly), and note how the metals differ in color.

Have the class read and study all or part of the chapter. Review the assignment and discuss the following:

- The classification of metals.
- Determining whether a metal is a ferrous or a nonferrous metal.
- Identifying an alloy from a base metal.
- Types of ferrous metals.
- Alloying elements added to ferrous metals to improve their properties.
- Why coatings are put on tungsten carbide cutting tools. Use Reproducible Master 24-1.
- Stainless steels.
- The AISI/SAE codes for identifying the physical characteristics of steel.
- Color coding of steel.
- The spark test for determining the grade of steel.
- Nonferrous metals.
- The metal known as aluminum.
- Magnesium and the precautions that must be taken when machining it.
- Titanium and how it is machined.
- Copper-based alloys.
- Precautions that must be taken when machining beryllium copper.

- High temperature metals.
- Rare metals.
- Honeycomb and composites.
- How to handle metal safely in the shop/lab.

Technical Terms

Review the terms introduced in the chapter. New terms can be assigned as a quiz, homework, or extra credit. The following list is also given at the beginning of the chapter.

alloy

Aluminum Association Designation System

base metal

carbon content

ductility

ferrous

honeycomb

nonferrous

red hardness

tungsten carbide

Review Questions

Assign *Test Your Knowledge* questions. Copy and distribute Reproducible Master 24-2 or have students use the questions on page 465 and write their answers on a separate sheet of paper.

Workbook Assignment

Assign Chapter 24 of the *Machining Fundamentals Workbook*.

Research and Development

Discuss the following topics in class or have students complete projects on their own.

1. Prepare a display showing specimens of ferrous, nonferrous, high temperature, and rare metals. Label them according to type, classification, and use.
2. Many terms are used to describe the various properties of metals. Research the meanings of the following terms as they pertain to metals.

Machinability Ductility

Malleability Elasticity

Brittleness Hardness

Toughness Tensile Strength

Yield Point Elongation

Stress Plasticity

3. Secure samples of honeycomb. Prepare a report explaining why it is difficult to

machine by conventional methods. Include some of the techniques employed to machine the material.

4. Secure samples of composites. Prepare a report on how they are made and shaped.
5. Contact firms manufacturing high-temperature metals and request printed material as well as photographs for your shop technical library.
6. Show a film or video on how aluminum is made. Discuss the details of the film with the class.
7. Show a film or video on steel making. Prepare a quiz to be given after the presentation and discussion.
8. Secure copies of trade magazines dealing with metals and other materials.

TEST YOUR KNOWLEDGE ANSWERS, Page 465

1. Any order: ferrous metals, nonferrous metals, high temperature metals, rare metals.
2. ferrous
3. b. Cast iron has a hard surface scale.
4. iron, carbon
5. By the amount of carbon they contain measured in percentage or in points.
6. black oxide scale
7. sulphur, lead
8. harder, stronger, tougher
9. alloy
10. corrosion
11. Any order: austenitic, martensitic, ferritic.
12. nonferrous
13. lightest
14. strong, half, heavy
15. copper
16. zinc
17. tin
18. The fine dust generated by machining and filing can cause severe respiratory damage.
19. high-temperature
20. Honeycomb structures give existing metals greater strength and rigidity while reducing weight. Sections of thin material (aluminum, stainless steel, titanium, and nonmetals like Nomex[®] fabric) are bonded together to form a structure that is similar in appearance to the wax comb that bees create to store honey.

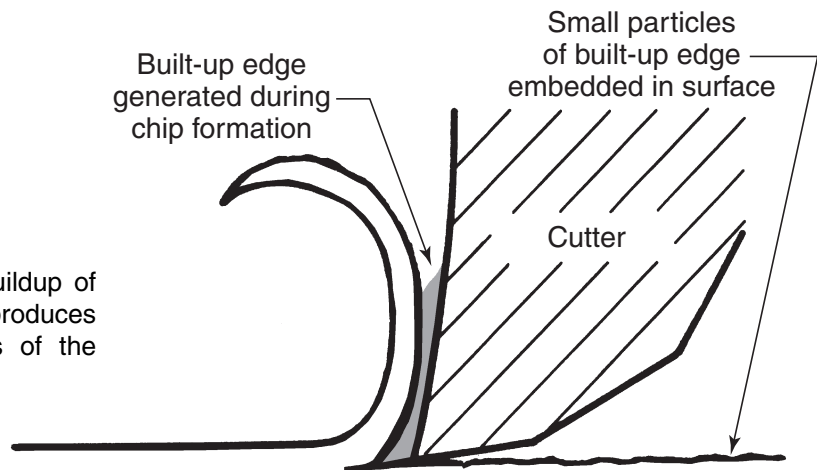
21. Composites use fibers of both conventional and uncommon materials, in both pure and alloy forms. Fibers such as pure iron, graphite, boron, and fiberglass are bonded together in a special plastic matrix under heat and pressure. These materials are generally lighter, stronger, and more rigid than many conventional metals.

WORKBOOK ANSWERS, Pages 131–134

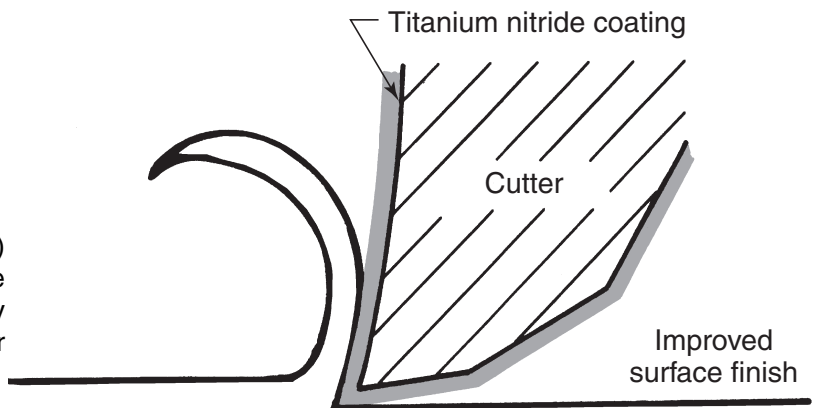
1. ferrous
2. A metal that contains no alloying metals.
3. A mixture of two or more metals.
4. b. 0.30, 30
5. d. All of the above.
6. b. smooth bright finish
7. c. 0.60 to 1.50, 60 to 150
8. d. All of the above.
9. They are more costly to produce because of the increased number of special operations that must be performed in their manufacture.
10. c. Chromium
11. b. Manganese
12. a. Nickel
13. Steels found in devices that are used to cut, shear, or form materials. It may be either carbon or alloy steel. Steels in the lower carbon range are used for tools subject to shock. Steels in the higher carbon range are used when tools with keen cutting edges are required.
14. It is the hardest human-made metal.
15. Magnesium
16. Evaluate individually. Refer to Section 24.2.7.
17. e. All of the above.
18. nonferrous
19. You must know what alloy is used because each alloy requires a different procedure.
20. It indicates the degree of hardness of an alloy.
21. They are extremely strong and corrosion-resistant under most conditions; the alloys are lighter than most commercially available metals; they can be shaped and formed easily; they are readily available in a multitude of sizes, shapes, alloys, and tempers.
22. Magnesium chips are highly flammable and burn at very high temperatures. It is a low-level radioactive material.
23. Water-base cutting fluids.
24. A respirator-type face mask must be worn; special procedures must be followed when cleaning machines used to machine the alloy.
25. Student answers will vary but may include two of the following: strong as steel, weighs only half as much as steel, extremely resistant to corrosion, most titanium alloys are capable of continuous use at temperatures up to about 800°F.
26. Metal with high strength for extended periods of time at elevated temperatures.
27. c. Tungsten
28. It has a very high strength-to-weight ratio and rigidity-to-weight ratio.
29. They are generally lighter, stronger, and more rigid than many conventional metals.
30. Different types of fibers are bonded together in a plastic matrix under heat and pressure.

Tungsten Carbide Tool Coating

Uncoated cutting tools acquire a buildup of material on the cutting edge, which produces a “ragged” surface finish as parts of the buildup flake off.



Tools coated with titanium nitride (TiN) and titanium carbide (TiC) resist the buildup from chips, run cooler, stay sharp longer, and produce a better surface finish.



Metal Characteristics

Name: _____ Date: _____ Score: _____

1. What are the four main categories of metals? _____

2. Iron and steel are classified as _____ metals. 2. _____
3. Carbide cutting tools are recommended for machining cast iron because: 3. _____
 - a. Cast iron is hard and brittle.
 - b. Cast iron has a hard surface scale.
 - c. Cast iron is difficult to machine.
 - d. All of the above.
 - e. None of the above.
4. Carbon steel is an alloy of _____ and _____. 4. _____

5. How are carbon steels classified? _____

6. Hot rolled steel is characterized by the _____ on its surface. 6. _____
7. The machinability of carbon steel is improved if _____ or _____ is added as an alloying element. 7. _____

8. Nickel, chromium, molybdenum, vanadium, and tungsten are used to make steel _____, _____, and _____. 8. _____

9. Drills, reamers, some milling cutters, and similar tools are usually made from _____ steel. 9. _____
10. The chief characteristic of stainless steel is its resistance to _____. 10. _____
11. List the three basic groups of stainless steel. _____

12. Aluminum, magnesium, and titanium are _____ metals. 12. _____
13. Magnesium is the _____ of the structural metals. 13. _____
14. Titanium is a metal that is as _____ as steel but only _____ as _____. 14. _____

Name: _____

15. Brass and bronze are _____-based alloys. 15. _____

16. Brass is an alloy of copper and _____. 16. _____

17. Bronze is an alloy of copper and _____. 17. _____

18. Why must a machinist take special precautions when working beryllium copper? _____

19. Nickel-based alloys, molybdenum, tantalum, and tungsten are classified as _____ metals. 19. _____

20. What is the structural material known as honeycomb? _____

21. What are composites?
