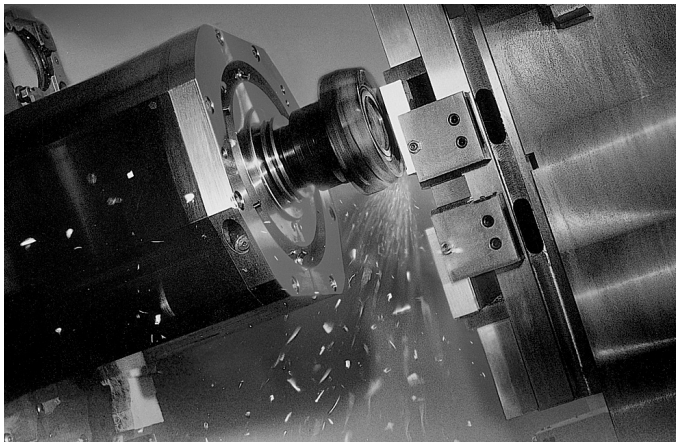


Chapter 28

Nontraditional Machining Techniques

LEARNING OBJECTIVES

After studying this chapter, students will be able to:

- Describe several nontraditional machining techniques.
- Explain how nontraditional machining techniques differ from traditional machining processes.
- Summarize how to perform several nontraditional machining techniques.
- List the advantages and disadvantages of several of the nontraditional machining techniques.

INSTRUCTIONAL MATERIALS

Text: pages 511–524
Test Your Knowledge Questions, pages 523–524
Workbook: pages 147–150
Instructor's Resource: pages 349–360
Guide for Lesson Planning
Research and Development Ideas
Reproducible Masters:
28-1 Ultrasonic Machining
28-2 Impact Machining
28-3 Electron Beam Welding
28-4 Laser Beam Machining
28-5 Test Your Knowledge Questions
Color Transparency (Binder/CD only)

GUIDE FOR LESSON PLANNING

Have the class read and study the chapter. Using the reproducible masters as overhead transparencies and/or handouts, review the assignment, and discuss the following:

- The chemical milling process.
- Advantages and disadvantages of chemical milling.
- The chemical blanking process.
- Advantages and disadvantages of chemical blanking.
- Hydrodynamic machining (HDM).
- Ultrasonic machining.
- Ultrasonic-assist machining.
- Impact machining.
- Electron beam machining (EBM).
- Laser beam machining.

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.

chemical blanking
chemical machining
chemical milling
electron beam machining
etchant
hydrodynamic machining
impact (slurry) machining
laser beam machining

ultrasonic machining
water-jet cutting

Review Questions

Assign *Test Your Knowledge* questions. Copy and distribute Reproducible Master 28-5 or have students use the questions on pages 523–524 and write their answers on a separate sheet of paper.

Workbook Assignment

Assign Chapter 28 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 file for the shop technical library on chemical milling and chemical blanking techniques. Secure literature from manufacturers of chem-milling and chem-blanking equipment and clippings from the various technical magazines.
2. Secure samples of work produced by the chemical machining techniques.
3. Develop and produce equipment that will permit you to demonstrate chemical milling. Prepare a paper on the process with photographs and submit it to one of the professional industrial education magazines.
4. Conduct a series of chemical milling experiments. Use the etchant for an equal time on different metals. Prepare a report on your experiment. List the depth of etch and what effect heat and cold have on etching rate. Develop a table showing times required to achieve equal etch depths on various metals, quality of surface finish, amount of undercut, and how it can be controlled.
5. Secure information on the use of water-jet machining.
6. Secure samples of work that have been machined using ultrasonic techniques. If the samples are small enough, mount them on a display panel. Include a sketch showing the machining technique used.
7. Gather information on other uses of ultrasonics. Prepare a bulletin board display.
8. Demonstrate how ultrasonic sound waves can be measured. Borrow a transducer and oscilloscope from the science department.
9. Construct an ultrasonic-assist. Experiment with it on the lathe.
10. Design and construct an impact machining device. Demonstrate it on various materials. Prepare an evaluation of your work.
11. Prepare a bulletin board display featuring electron beam machining. Use material from technical magazines and manufacturers' literature or brochures.
12. Prepare a research paper on electron beam machining and welding techniques. Include the history of its development and how the atomic energy, electronics, and aerospace industries use its unique characteristics.
13. Prepare a research paper on use of the laser by industry. Use illustrations from magazines. **Safety Note:** Because of the inherent dangers of using the laser, it is *not* recommended that an attempt be made to design and construct a laser capable of cutting metal.

TEST YOUR KNOWLEDGE ANSWERS, Pages 523–524

1. Chemical machining shapes metal by a selective removal of metal.

   Chemical blanking involves the total removal of metal in selected areas.
2. chem-milling, contour etching
3. In order: cleaning, masking, scribing and stripping, etching, rinsing and solvent stripping, and inspection.
4. a. Not to be etched.
5. Refer to Section 28.1.2.
6. It uses water, with abrasives added at times, under very high pressure to cut materials.
7. Slurry, impact, drilling, reaming, honing, milling, and EDM techniques use ultrasonics.
8. infrasonic
9. ultrasonic
10. special, abrasives
11. d. All of the above.
12. It is slow, the surface finish is dependent on the size of the abrasive grit used, and the deepest cut possible is 1″ (25 mm).
13. 0.001″ (0.025 mm)
14. Student answers will vary but may include the following: slicing and cutting germanium and silicon wafers; machining complex shapes in nonconductive and semiconductive materials; shaping virtually unmachinable space-age materials; improving cleaning power of chemical solvents; detecting flaws in

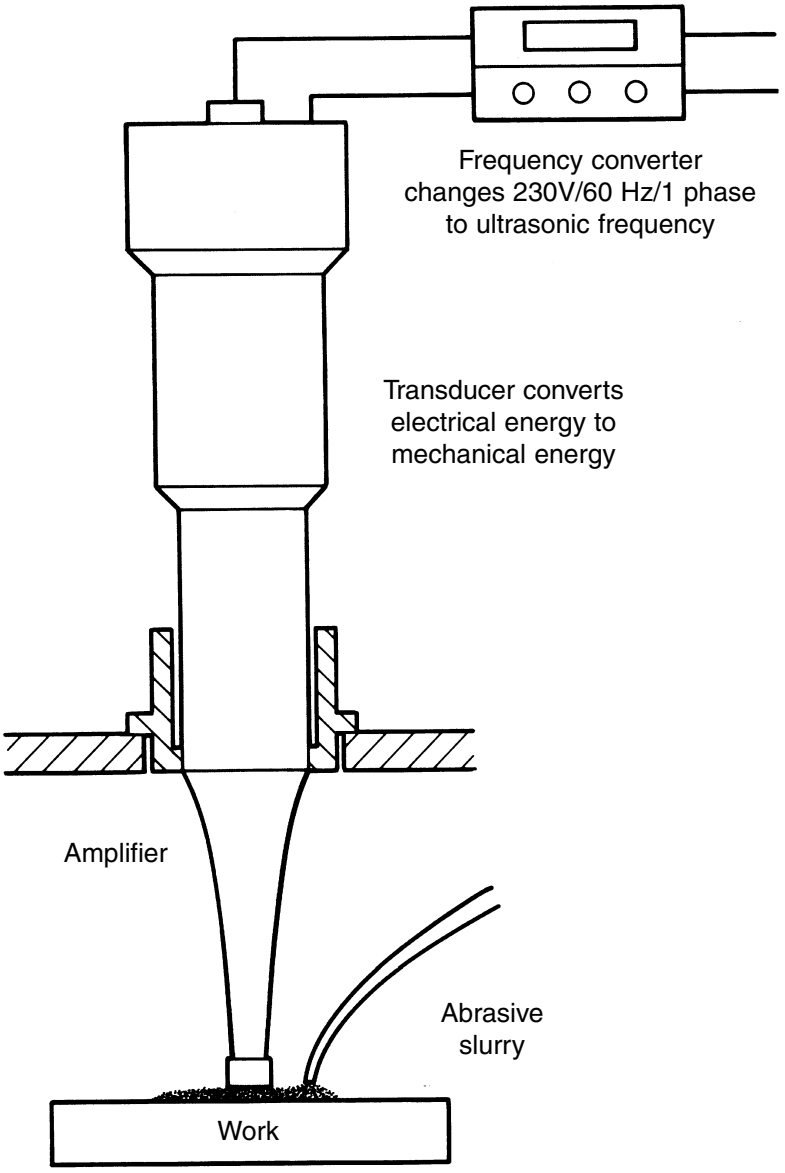
nondestructive testing; welding metals to nonmetals; decontaminating work that has been exposed to radioactive solutions and gases.

15. d. All of the above.
16. 0.0002" (0.005 mm)
17. a. Thermal.
18. d. All of the above.
19. Movement of the worktable and deflection of the electron beam.
20. Laser stands for Light Amplification by Stimulated Emission of Radiation
21. Evaluate individually. Refer to Section 28.5.

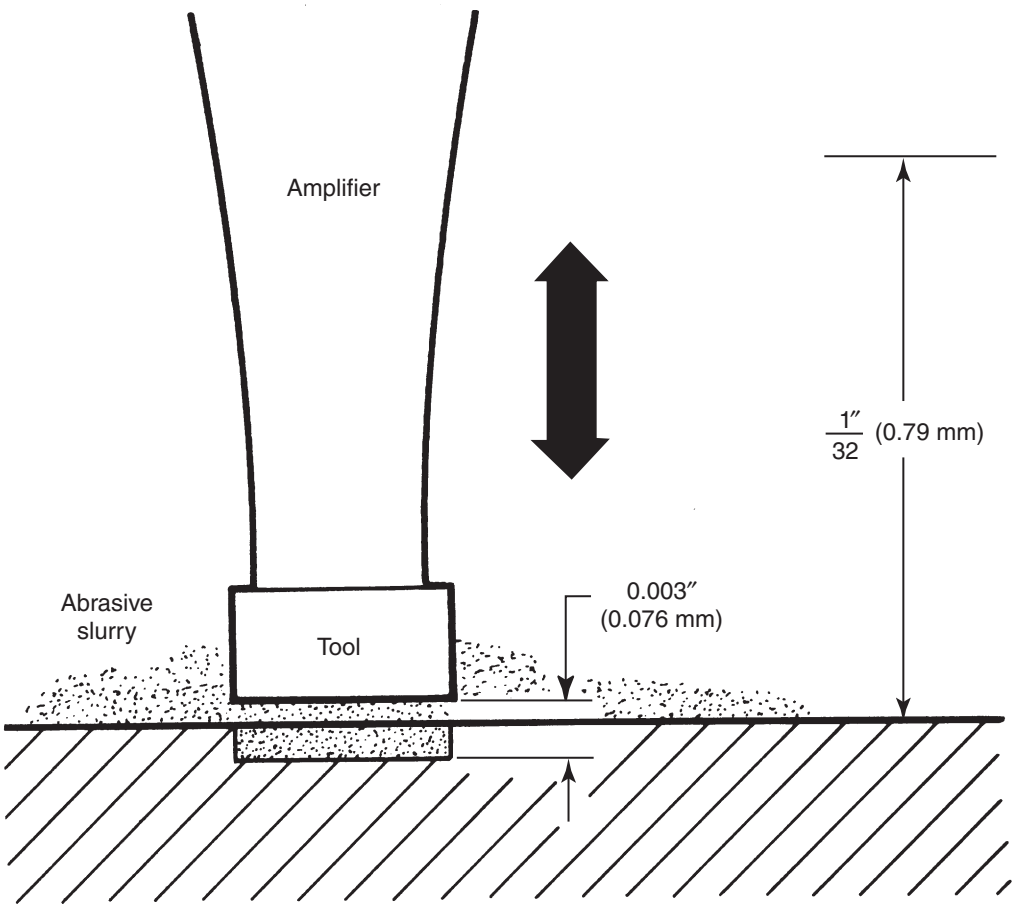
WORKBOOK ANSWERS, Pages 147–150

1. Chemicals, usually in an aqueous (with water) solution, are employed to etch away selected portions of the metal to produce an accurately contoured part.
2. masks, coating material
3. Student answers will vary, evaluate individually. Refer to Section 28.1.1.
4. Student answers will vary, evaluate individually. Refer to Section 28.1.1.
5. Chemical blanking involves complete removal of metal from certain areas by chemical action. It is a variation of chemical milling.
6. Any three of the following: tooling costs are low, no burrs are produced, new designs can be produced quickly, ultrathin metal foils can be worked, metal characteristics have no significant effect on the process.
7. water-jet
8. To shape composites of a tough fabric-like material bonded together into three-dimensional shapes called layups.
9. metals, nonmetallic
10. d. All of the above.
11. Ultrasonic-assist machining applies sound waves to the tool or metal as it is cutting or being cut. The process reduces tool forces and almost completely eliminates tool chatter.
12. c. 25,000
13. beam
14. high vacuum
15. 0.0005" (0.0125 mm)
16. a. off longer than it is on
17. Cut geometry is controlled by movement of the worktable in the vacuum chamber and by employing the deflection coil to bend the beam of electrons to the desired cutting path.
18. intense, microns
19. 75,000°F (41 650°C)
20. b. concentrates heat in localized areas

Ultrasonic Machining

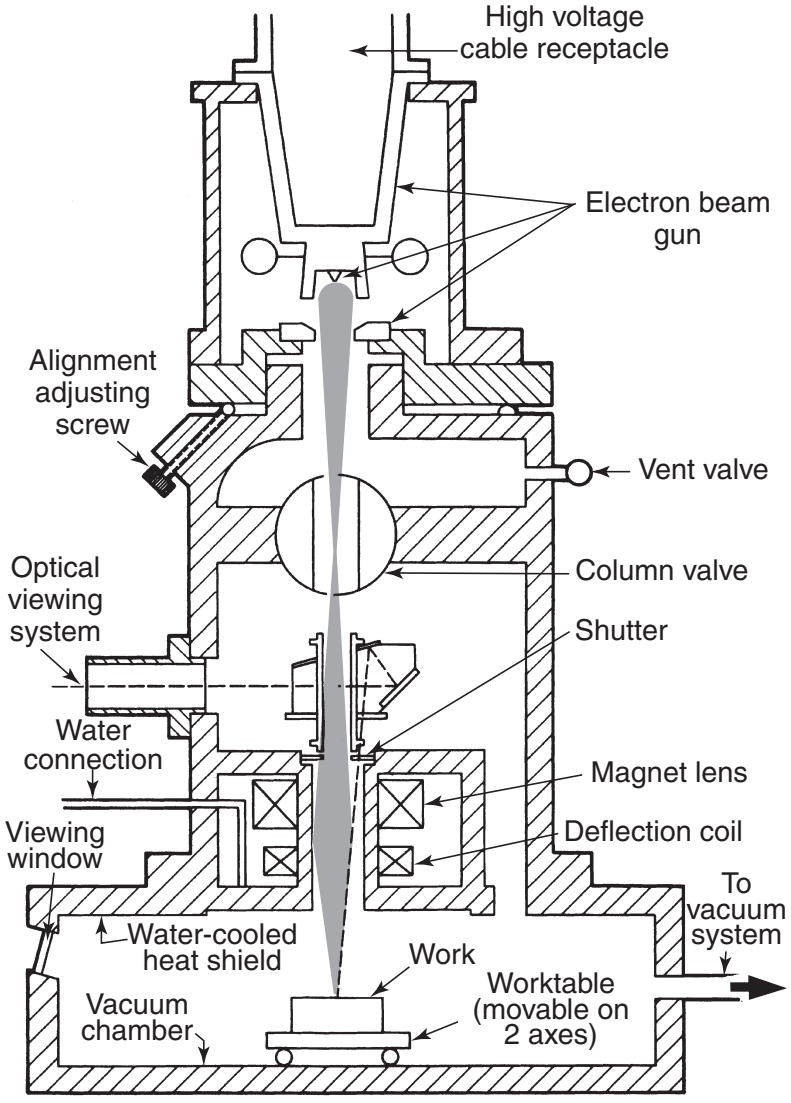


Impact Machining



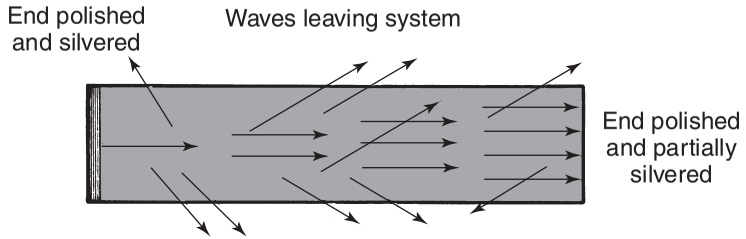
Tool motion in ultrasonic (impact) machining is slight, only 0.003″ (0.076 mm). the 1/32″ (0.79 mm) measurement is used to indicate scale.

Electron Beam Welding

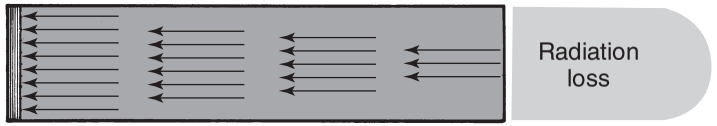


Cross-sectional view of an electron beam microcutter-welder.

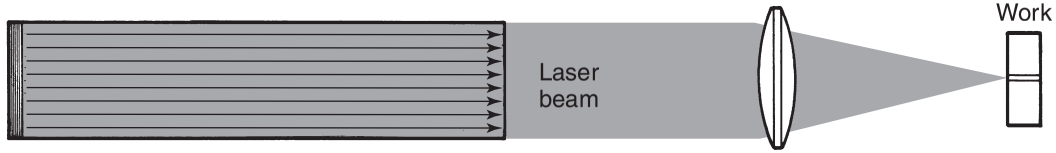
Laser Beam Machining



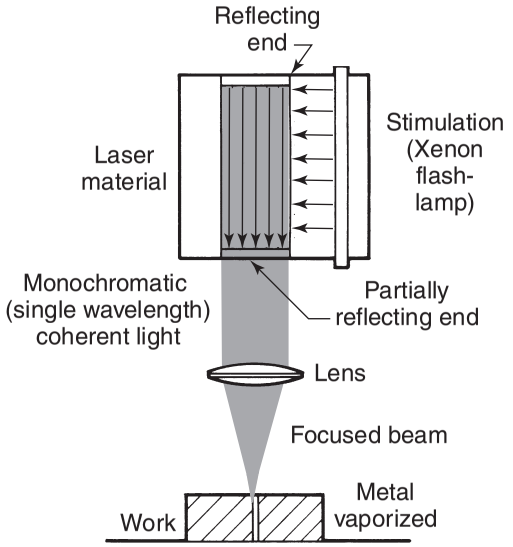
A—The ends of a ruby rod are flattened so they are parallel and silvered to form mirrors. A mirror at one end is made to reflect only part of the light so the beam can escape when there is a buildup in energy between the two mirrors.



B—Soon after chromium atoms in the ruby crystal are pumped by a flashlamp to a higher energy level, they drop to another level, and stimulated emission takes place. Waves moving at angles to the crystal's axis leave the system, but those traveling along the axis grow by stimulated emission of photons.



C—Parallel waves are reflected back and forth between the mirrors and the wave system grows in intensity. A pale red glow indicates a certain amount of light being lost at the mirror, but beyond a critical point, the waves intensify enough to overcome this loss. An intense red beam flashes out of the partially silvered end of the crystal.



A flashlamp capable of producing an intense light is employed to "pump" a laser into a high level of excitement.

Nontraditional Machining Techniques

Name: _____ Date: _____ Score: _____

1. Chemical machining falls into two categories. Briefly describe each of them. _____

_____

_____

_____

2. Chemical milling is also known as _____ or _____. 2. _____

_____

3. List the six major steps in chemical milling. _____

_____

_____

4. A mask protects the portion of a chemically milled job that is: 4. _____
   a. Not to be etched.
   b. To be etched.
   c. To be cleaned.
   d. All of the above.
   e. None of the above.
5. List the five major steps in chemical blanking.

_____

_____

_____

_____

_____

6. Briefly describe water-jet machining. _____

_____

_____

7. What machining processes use ultrasonics? _____

_____

8. Sound waves below 20 cycles per second are called _____ . 8. _____
9. Sound waves above 20,000 cycles per second are called _____ . 9. _____
10. Impact machining makes use of a _____ tool that forces _____ against the work to do the cutting. 10. _____

_____

Name: _____

11. Impact machining is one of the very few commercially feasible methods for machining which types of materials? 11. _____
    a. Hard.
    b. Brittle.
    c. Frangible.
    d. All of the above.
    e. None of the above.
12. What are three disadvantages of impact machining? _____

    _____

    _____

13. With impact machining, tolerances of _____ can be maintained on hole size and geometry in most materials. 13. _____

14. List five areas where the science of ultrasonics has found industrial applications.

    _____

    _____

    _____

    _____

    _____

15. The development of the electron beam machine was the direct result of the special needs of what industry? 15. _____
    a. Electronics.
    b. Atomic energy.
    c. Aerospace.
    d. All of the above.
    e. None of the above.
16. Holes as small as _____ in diameter can be drilled using the electron beam technique. 16. _____
17. The electron beam machine is basically a source of what type of energy? 17. _____
    a. Thermal.
    b. Sonic.
    c. Fluid.
    d. All of the above.
    e. None of the above.
18. The electron beam technique cuts material by: 18. _____
    a. Alternately heating and cooling the area to be cut.
    b. Vaporizing the material.
    c. Making use of a pulsing technique.
    d. All of the above.
    e. None of the above.

Name: _____

19. List two methods employed to control the shape of the cut with EBM. _____

_____

20. What does *LASER* stand for? _____

_____

21. Describe how a laser operates. _____

_____

_____

_____