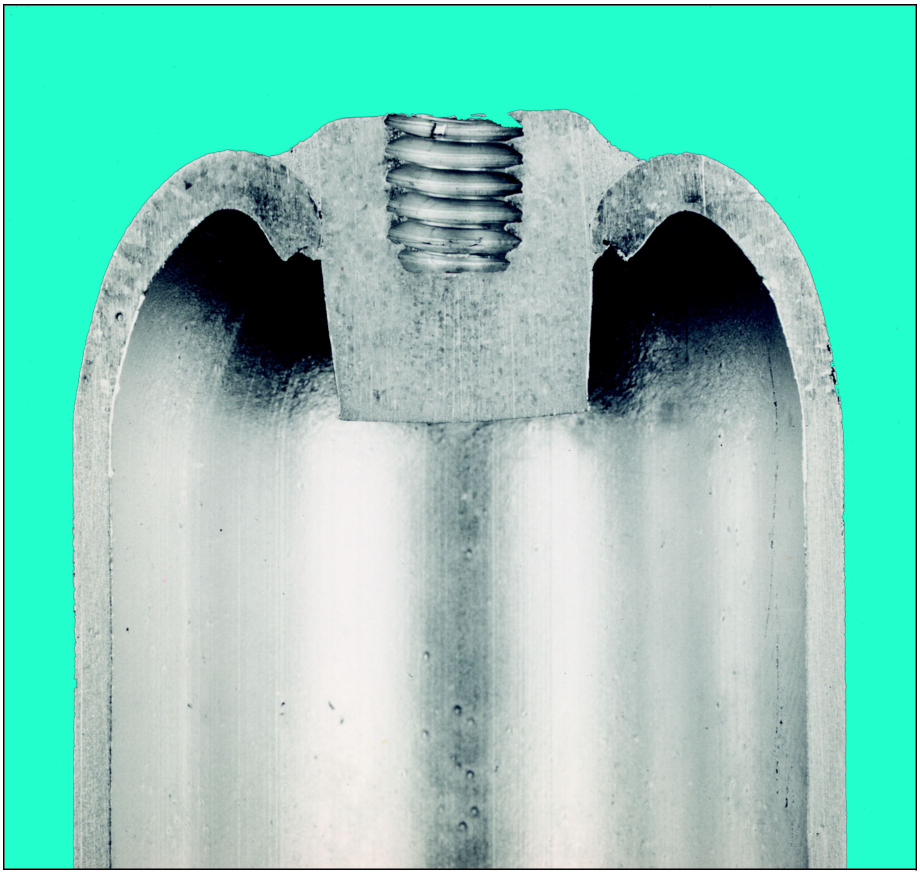
CHAPTER 27

MAGNESIUM AND MAGNESIUM ALLOYS



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INTRODUCTION

The brazing techniques used for the joining of magnesium and magnesium alloys are similar to those used for aluminum (see Chapter 20, "Aluminum Brazing"). Furnace, torch, and dip brazing processes can be employed, although the latter process is the most widely used.

This chapter examines the physical and mechanical properties of magnesium, its alloys, and magnesium matrix composites, the brazing processes used to join them, joint design, precleaning and surface preparation, fixturing, brazing filler metals and fluxes, postbraze cleaning, corrosion resistance, inspection, and safe practices.[1]

CHARACTERIZATION AND BRAZEABILITY OF BASE METALS

Magnesium is the lightest and one of the cheapest structural metals. Magnesium alloys are attractive for application in various structures in the automotive and aerospace industries because of their low density (approximately 0.063 pounds per cubic inch [lb/in.^{3}] 1.75 grams per cubic centimeter [g/cm^3]) in combination with relatively high tensile strength—33 kips per square inch (ksi) to 42 ksi [228 megapascal (MPa) to 290 MPa]—heat resistance up to 840°F (450°C); and oxidation resistance up to 930°F (500°C). They also find extensive use in textile and printing machines in which lightweight magnesium components are used to minimize inertial forces when they operate at high speed.[2]

The composition and physical properties of brazeable magnesium alloys are presented in Table 27.1. Because of their low solidus temperatures, other magnesium alloys cannot be brazed with commercial brazing filler metal AWS BMg-1; they require the application of other brazing filler metals of the Mg-Al-Zn system having a lower brazing temperature range.

The typical mechanical properties of brazeable magnesium alloys are shown in Table 27.2. The temperatures involved in brazing reduce the properties of work-hardened (tempered) magnesium sheet alloys to the annealed temper level. Torch brazing reduces properties only in those areas heated for brazing; furnace and dip brazing reduce the properties of the entire structure. The properties of cast or extruded alloys or of annealed sheet alloys are not greatly affected by the heat of brazing. Table 27.3 illustrates the minor reduction in the strength of annealed sheet alloys after exposure to various brazing temperatures.

The brazing of magnesium is a complex process due to the highest chemical activity among all structural metals. Complex oxide film containing magnesium oxide and magnesium hydroxide is formed on the surface of the base metal at heating in air. This chemically stable film is reduced neither in conventional active gaseous atmospheres nor in vacuum up to 10^{-5} torr (10^{-5} mm-Hg [10^{-3} Pa]). Additionally, magnesium hydroxide is decomposed to hydrogen and water during heating at 572°F to

1. This chapter was originally prepared by Lloyd Lockwood for the *Brazing Manual*, 2nd edition (1963).

2. Avedesian, M. M., and H. Baker, 1999, *Magnesium and Magnesium Alloys*, Materials Park, Ohio: ASM International.