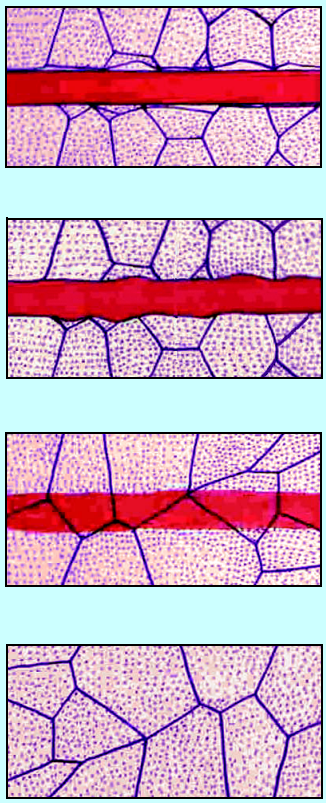
CHAPTER 17

DIFFUSION BRAZING



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INTRODUCTION

Diffusion brazing (DFB) is a modification of the normal brazing process that changes the properties of the brazed joint. It can augment the joint strength, increase ductility, reduce the hardness of the brazing filler metal in the joint, and markedly increase the joint remelt temperature.

The term *diffusion brazing* is defined by the American Welding Society's *Standard Welding Terms and Definitions,* AWS A3.0:2001, as "a brazing process that produces coalescence of metals by heating them to brazing temperature and by using a brazing filler metal or *in-situ* liquid phase. The brazing filler metal may be distributed by capillary attraction or may be placed or formed at the faying surfaces. The brazing filler metal is diffused with the base metal to the extent that the joint properties have been changed to approach those of the base metal. Pressure may or may not be applied."[1,2]

It should be noted that the term *diffusion bonding* is often erroneously used to refer to the two diffusion processes, namely, diffusion welding and diffusion brazing. The term *diffusion brazing* is used to refer to either solid-state diffusion or diffusion using a liquid brazing filler metal. Thus, when the term *diffusion bonding* is used, it is unclear whether the author or speaker is referring to *diffusion brazing* or *diffusion welding*. The American National Standard *Standard Welding Terms and Definitions*, AWS A3.0:2001, defines the term *diffusion bonding* as "a nonstandard term for diffusion brazing and diffusion welding."[3] Thus, to communicate to the reader or listener which process being discussed, the proper term should be used for each process.

Diffusion brazing differs from diffusion welding in that in diffusion brazing a liquid brazing filler metal in the joint diffuses with the base metal. In diffusion welding, no liquid phase exists. Diffusion welding is a solid-state process in which diffusion occurs between two base metals or between two base metals and a thin, solid sheet of base metal, referred to as a *diffusion aid*.

PROCESS DESCRIPTION

During diffusion brazing, the brazing filler metal is distributed throughout the joint by means of capillary action. As shown in Figure 17.1, the brazing filler metal is subsequently diffused with the base metal at an appropriate temperature and with sufficient time to produce the desired physical properties in the resulting joint. During the diffusion brazing cycle, the brazing filler metal isothermally solidifies at the brazing/diffusion temperature.

In Figure 17.1(A), the brazing filler metal has been placed in the joint. In Figure 17.1(B), brazing distributes the brazing filler metal within the joint by capillary action. In Figure 17.1(C), as the diffusion time or the temperature or both are increased, the boron diffuses into the base metal, increasing the ductility, strength, and the remelt temperature. In Figure 17.1(D), with full diffusion, the base metal and brazing filler metal interdiffuse with base metal grains forming throughout the joint, leaving the equivalent of a solid-state joint.

When viewed metallographically, a diffusion brazed joint shows a substantial change in the microstructure of the brazing filler metal. When the diffu-

1. American Welding Society Committee on Definitions, 2001, *Standard Welding Terms and Definitions,* AWS A3.0:2001, Miami: American Welding Society, p. 10.

2. At the time of the preparation of this chapter, the referenced standards were valid. If a standard is cited without a date of publication, it is understood that the latest edition of the document referred to applies. If a standard is cited with the date of publication, the citation refers to that edition only, and it is understood that any future revisions or amendments to the code or standard are not included; however, as standards undergo frequent revision, the reader is encouraged to consult the most recent edition.

3. See Reference 1.