

## BRAZING &amp; SOLDERING TODAY

# Testing Options for Silver-Free Brazing Alloys

*Brazed joints using a silver-free brazing alloy were evaluated to find its potential for reducing production costs*

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Silver-free filler metals can significantly decrease production costs in brazing carbon steel, stainless steel, and copper alloys. The costs of new silver-free braze alloys introduced into the industry during the last two decades (Refs. 1–6) are about half of standard alloys such as BCuP-5 (containing 15% silver), and  $\frac{1}{4}$  to  $\frac{1}{2}$  of silver-rich brazing alloys such as BAg-7 or BAg-24 (containing 56% and 50% silver, correspondingly). The mechanical properties of brazed joints manufactured using a new silver-free brazing alloy were evaluated in 2017. The evaluated alloy has the composition Cu-34Zn-7.3Sn-1.4Ni wt-% and a melting range of 780° to 830°C (1436° to

1526°F). This filler metal exhibited shear strength of steel or brass brazed joints comparable to, and sometimes higher than, standard silver-based filler metals. The application of silver-free braze alloys can cut production costs in the manufacture of refrigerators, boilers, acetylene and propane torches, agricultural machines, automobile oil and pneumatic tubing, thermal sensors, mining equipment, and more. Strength and microstructure of brazed joints made by this silver-free filler metal are discussed to find out its area of application and potential in reducing production costs compared to silver-based alloys that are currently more common in the United States industry.

## Brazing Materials and Evaluation of Brazed Joints

The shear strength and microstructure of brazed joints manufactured using a new silver-free filler metal TiBraze211 containing 34%Zn, 7–7.5%Sn, 1.3–1.5%Ni, and Cu wt-% in the balance were evaluated. The melting range of this alloy is 780°–830°C (1436°–1526°F), and the brazing temperature is 850°–900°C (1436°–1526°F). The strengths of joints brazed by other silver-free alloys P14, LOK59, and MBF2005 (Metglas Inc.), as well as silver-based standard filler metals BAg-7, BAg-22, BAg-24, and BAg-34, were tested and determined earlier (Refs. 5–8).

Carbon Steel 1018, Stainless Steel 304, Copper 110, and Yellow Brass C260 were used as base metals in the form of 8-mm-round rods brazed to 25 × 25 × 3.12 mm coupons — Fig. 1.

Brazing was performed in air by heating with a propane torch. The black, boron-modified, fluoroborate flux 601B/3411 (Superior Flux Mfg. Co.) was deposited inside the joints before heating.

Three to five specimens of every base/braze metal combination were fabricated and subjected to mechanical testing to determine the shear strength of brazed joints and to evaluate their ductility or brittle behavior — Figs. 1, 2.

Polished cross-sections of brazed joints were etched using the following etchant solution:

1) 10% acetic acid in ethanol for 10–30 s,

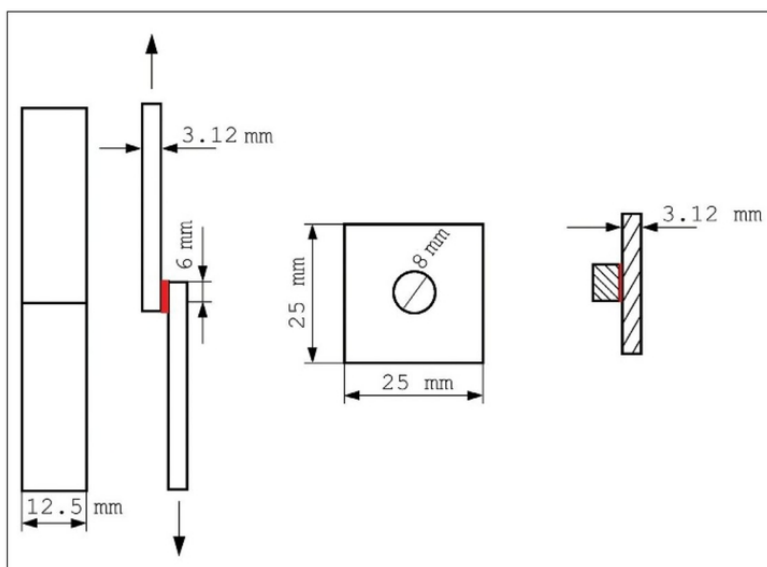


Fig. 1 — Specimens used for measuring shear strength of brazed joints: design (Ref. 9) for the compression test. Position of a brazed joint to be tested is colored in red.