Microstructural Analysis of a Silver Plated Brass Trombone

Introduction

Many processing techniques are used to make a trombone. Brass instruments must be built to withstand vibrations at resonant frequencies, corrosive agents such as sweat and saliva, and lubricating greases and oils. This investigation focuses on the processing of a circa 1910 silver plated trombone. The joint between the mouthpiece receiver and a brace was examined.

Procedure

The joint seen in Figure 1B was sectioned, mounted in epoxy then metallographically ground and polished through 0.05 μm colloidal silica. Figure 2 shows the sample etched with 25% diluted potassium dichromate and Figure 5 depicts the silver braze etched with a 50% diluted $NH_4(OH)$/ 30% H_2O_2. Energy dispersive x-ray spectroscopy was performed in a scanning electron microscope using an iridium coating.

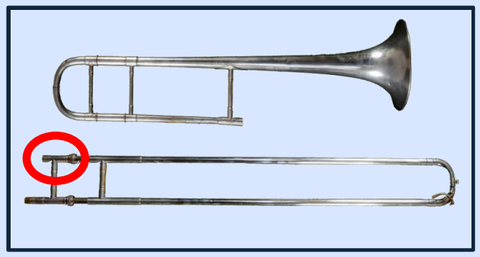


Figure 1A. Macroscopic image of the entire trombone. The area of investigation is circled.

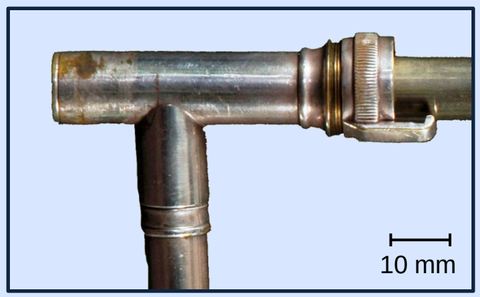


Figure 1B. Macroscopic image of the joint investigated. The region of interest is at the intersection of the main tube (horizontal) and the brace (vertical). The main tube consists of two concentric tubes. The outer tube (③) is visible near the left end of the horizontal tube where the silver plate (④) has corroded through. The inner tube (①) extends to become the stationary portion of the slide – seen protruding at the upper right end of the horizontal tube.

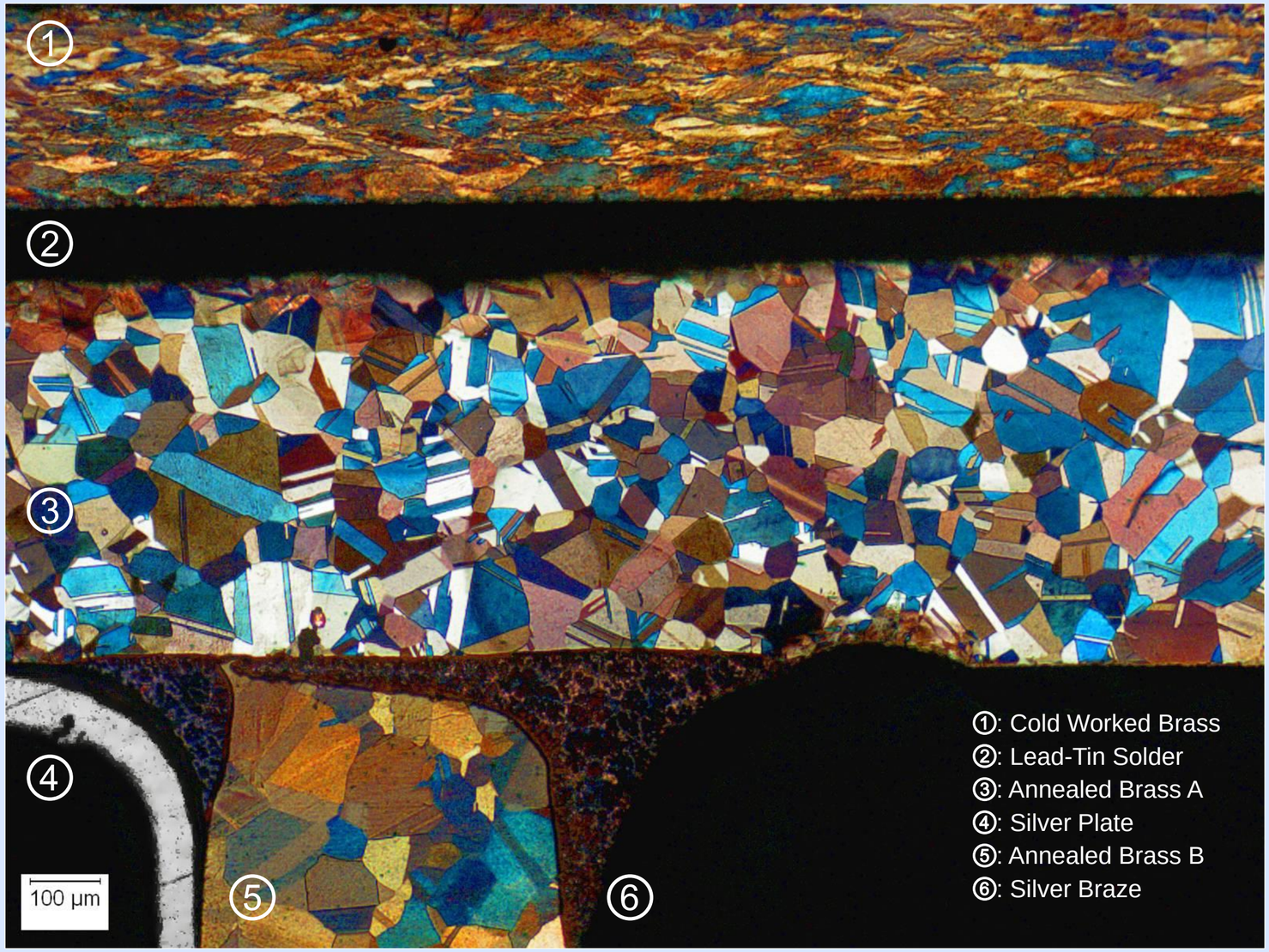
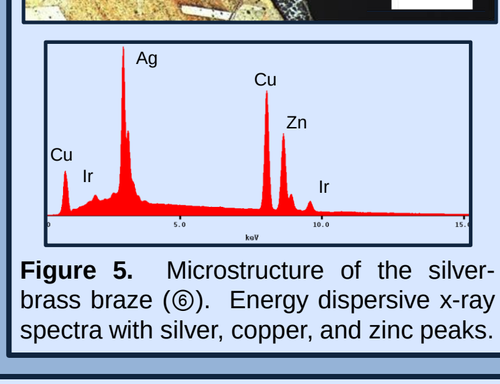


Figure 2. Microstructure of the joint viewed utilizing polarized light illumination. The cold worked section (①) has elongated grains in one direction while the annealed sections (③ and ⑤) exhibit uniform grains with annealing twins. The lead-tin solder (②) is not visible because it was removed by the potassium dichromate etch. Figure 4 is an un-etched image of this region. Figure 5 is region ⑥ etched with 50% diluted $NH_4(OH)$/ 30% H_2O_2.



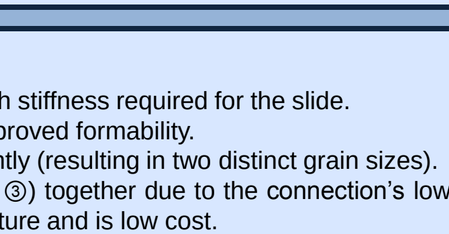


Figure 4. Microstructure of the lead-tin solder (②) and corresponding energy dispersive x-ray spectra with lead and tin peaks.

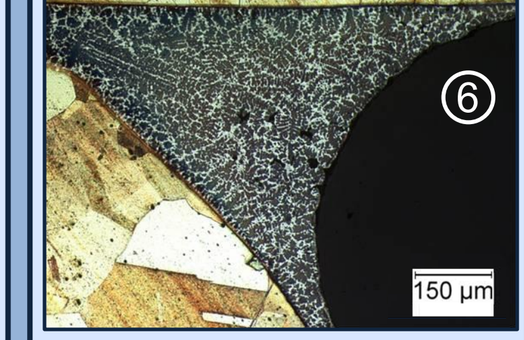


Figure 5. Microstructure of the silver-brass braze (⑥). Energy dispersive x-ray spectra with silver, copper, and zinc peaks.

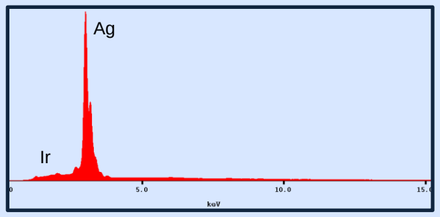


Figure 3. Energy dispersive x-ray spectra of the silver plate (④) with a strong silver peak.

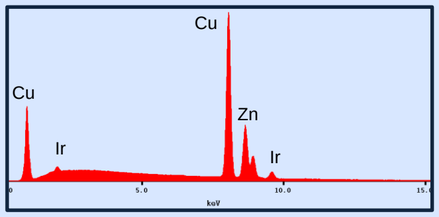


Figure 2A. Energy dispersive x-ray spectra of region ① with copper and zinc peaks.

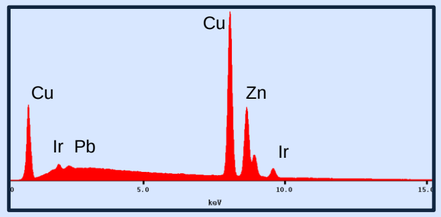


Figure 2B. Energy dispersive x-ray spectra of regions ③ and ⑤ with copper, zinc, and lead peaks.

Processing

Based on this investigation's analysis, the trombone joint was formed in a five step process.

1. The brass tubes (①, ③, and ⑤) were shaped through a drawing process.
2. Regions ③ and ⑤ were annealed to increase ductility. Region ① was not annealed.
3. Regions ① and ③ were fused together using a lead-tin solder (②).
4. The annealed brace (⑤) was connected to the main tube using a silver-brass braze (⑥).
5. The completed assembly was electroplated with silver (region ④).

Conclusions

1. The cold worked tube (①) was not annealed to maintain the high stiffness required for the slide.
2. Lead was added to the annealed brass tubes (③ and ⑤) for improved formability.
3. The annealed brass tubes (③ and ⑤) were heat treated differently (resulting in two distinct grain sizes).
4. Lead-tin solder (②) was used to bond the brass tubes (① and ③) together due to the connection's low stress state. Additionally, the solder has a low working temperature and is low cost.
5. Silver braze (⑥) was used for its improved wetting properties and relatively high hardness.