



Metallurgical Laboratory Failure Analysis

MET 06-[REDACTED]

Date: [REDACTED]
Customer: [REDACTED]
Part Name: [REDACTED]
Part No.: [REDACTED]
Drawing No.: [REDACTED] [REDACTED]
NSN: [REDACTED]
Serial Nos./Production Lot: [REDACTED]
Manufacturer: [REDACTED]
Material and Treatment: Shield Assembly Silver Braze, Brazing Operation
Prepared By: [REDACTED]
Investigation: Metallurgical Evaluation of Braze Quality

1 INTRODUCTION

External examination of the braid/connector brazing for the subject shield assembly indicated that the brazing may not meet drawing requirements (Drawing Nos. [REDACTED] [REDACTED] respectively). The requirements per Shield Assy. Drawing No. [REDACTED], Note 3 are for a continuous circumferential fillet braze at the inner and outer mating edges of the braid/connector mating surfaces using Silver Alloy AMS 4771.

A destructive metallurgical analysis of three Serial Numbers [REDACTED] was initiated on [REDACTED] [REDACTED] 2006.

2 MICROSTRUCTURAL ANALYSIS

Three braid/adaptor end-connector shield assemblies (one for each serial number) were longitudinally sectioned to reveal the mating surfaces. The sections cleaned ultrasonically to remove sectioning debris, mounted in conductive plastic mounts, and prepared using standard metallographic techniques to a final finish of 1 μm diamond. The polished sections were analyzed by scanning electron microscopy and energy dispersive spectroscopy. In order to ensure that metallographic artifacts did not influence the interfaces and their analysis, the interfaces and microstructures were evaluated for evidence of damage. Regions of good interfacial bond were noted as well as clear dendritic patterns within the braze regions indicating that the metallographic preparation did not adversely influence the braze evaluation. A region of good interface bonding between the braze and adaptor is shown in Figure 1. Note that the figure also shows a clear dendritic solidification pattern in the braze material.

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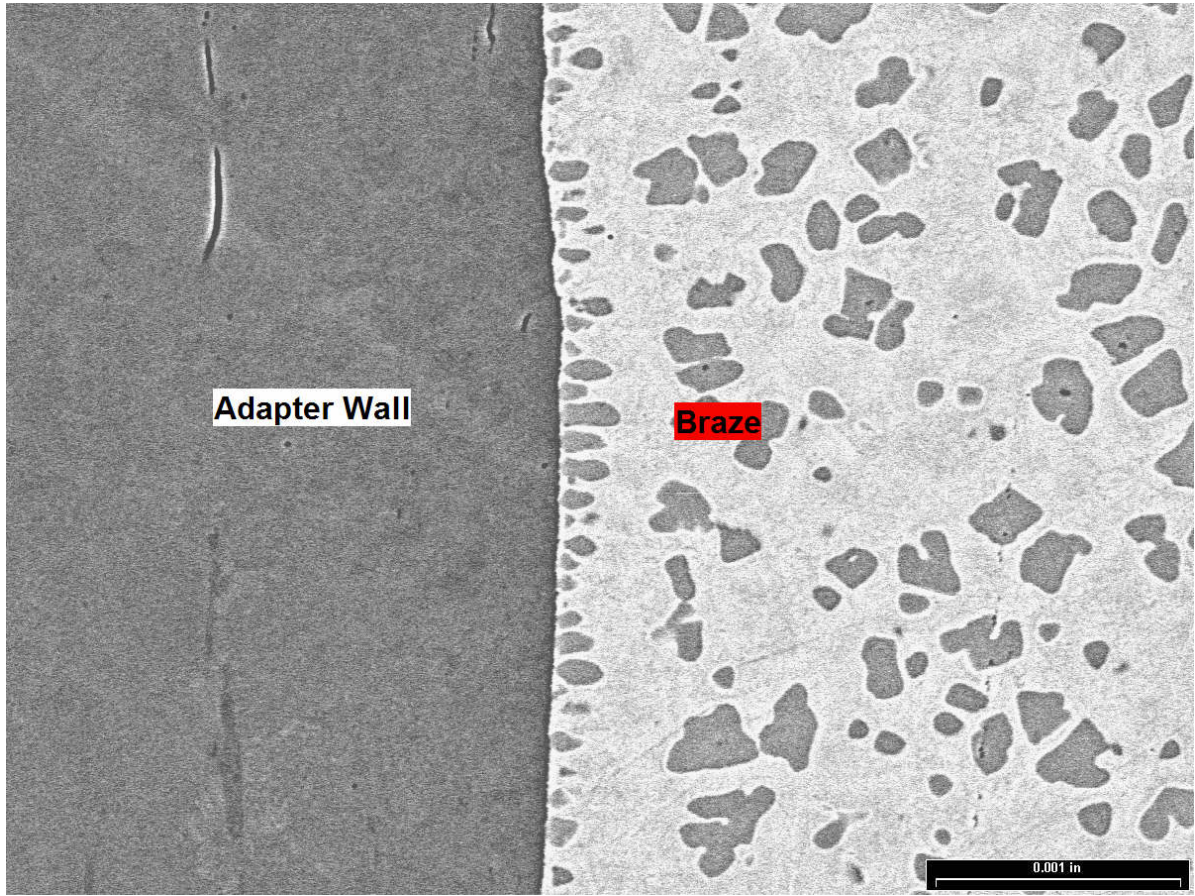


Figure 1 Region of good interface bonding between the braze and the adapter wall. Braze also shows copper-rich dendrites in a silver-rich matrix with denuded zones around the primary dendrites. Indicates a high quality of metallographic preparation.

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Nomenclature

The adapter-side end (interface) was termed as the inner joint while the braid-side end was termed the outer joint, as shown in Figure 1.

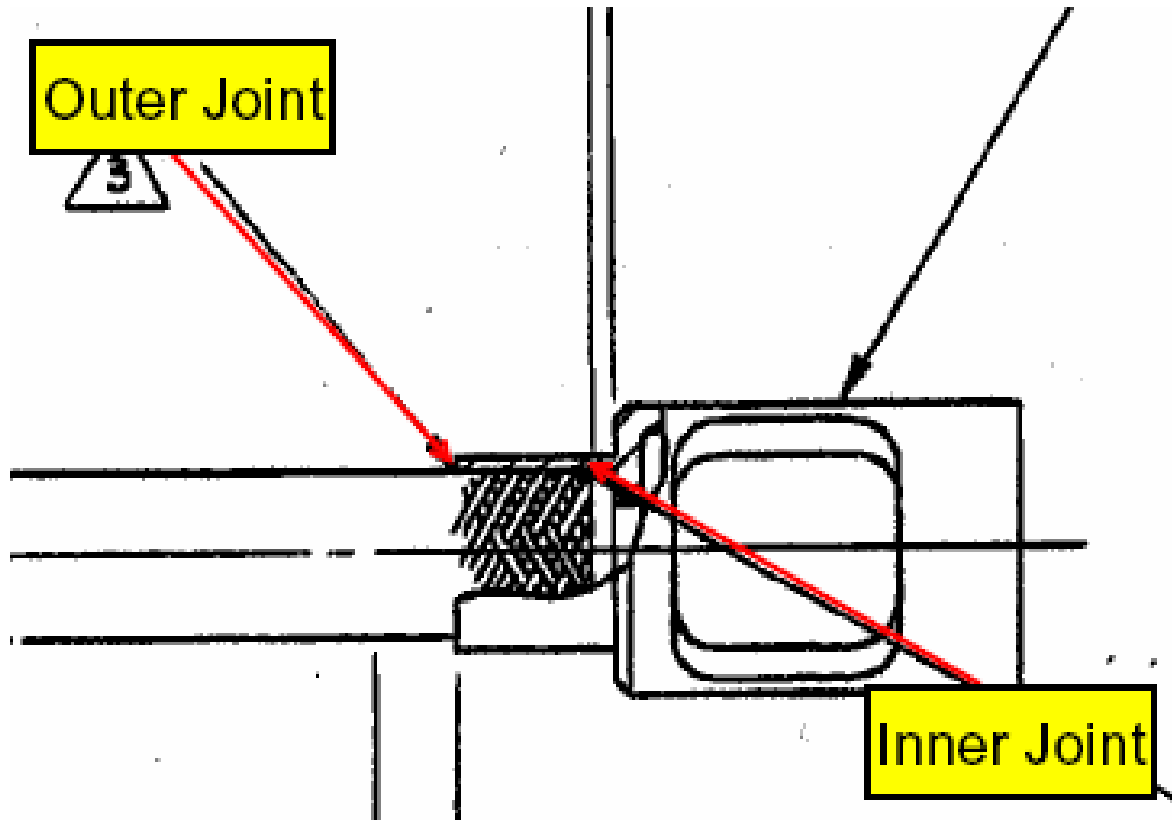


Figure 2 Nomenclature used in the metallurgical analysis descriptions.

Results of the metallographic section evaluations are presented individually for each serial number. The braze composition was analyzed qualitatively for constituents by energy dispersive spectroscopy (EDS). The results indicated that the braze contained a significantly smaller amount of cadmium compared with the requirements of AMS 4771. A quantitative analysis with appropriate standards is planned to confirm these findings.

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Braze Joint Characterization for Serial No. 0251

The characterization indicated that

1. The amount of braze was insufficient for the joint volume.
2. Braze material was missing from a significant length of the joint, particularly near the outer end.
3. At the braze/adapter interface, there were regions of disbond, indicating deficient metallurgical bonding.

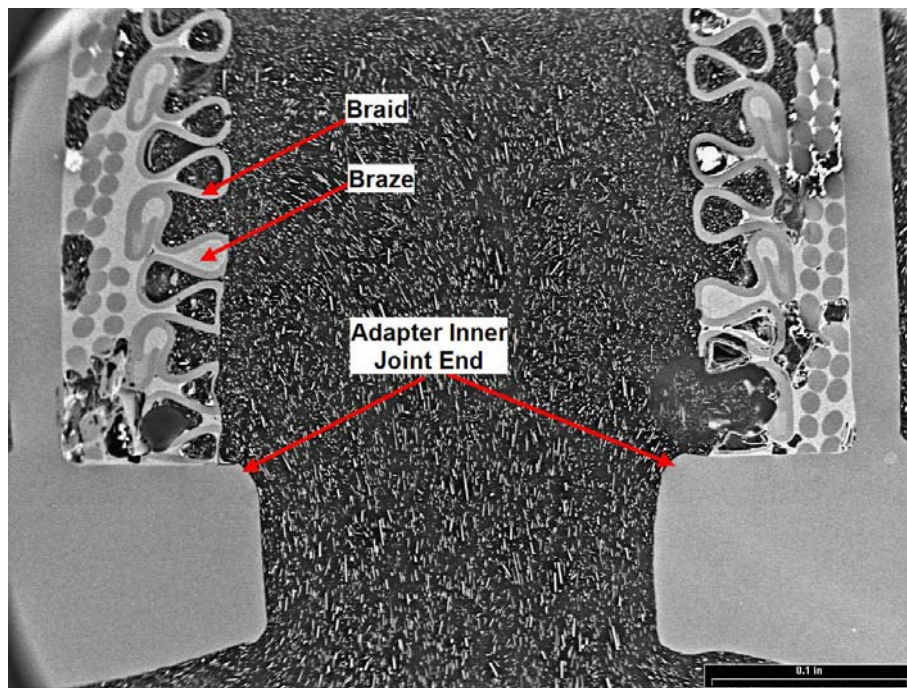


Figure 3 Overview of inner joint.

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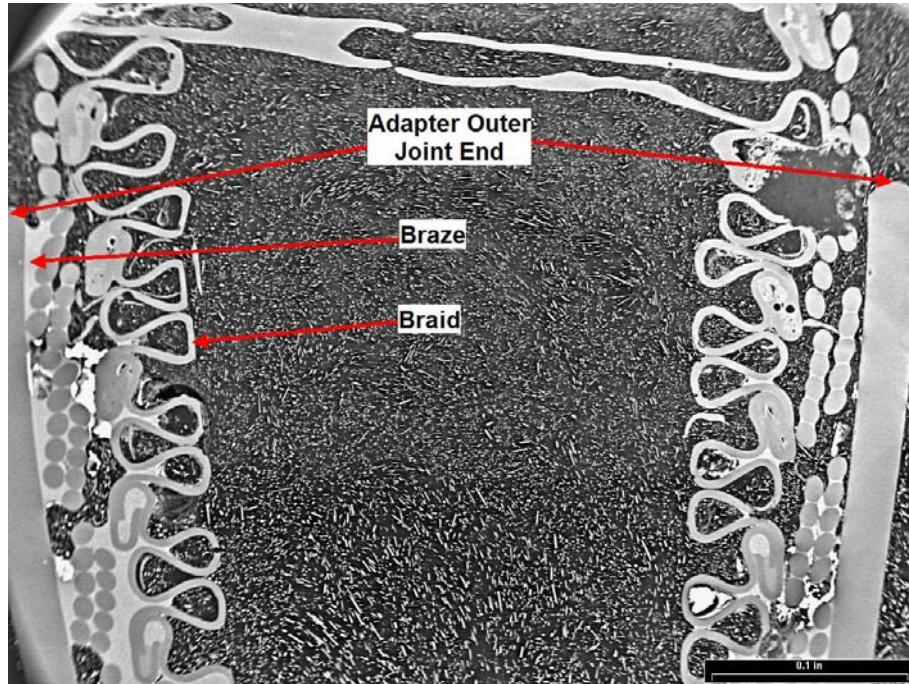


Figure 4 Overview of outer joint.

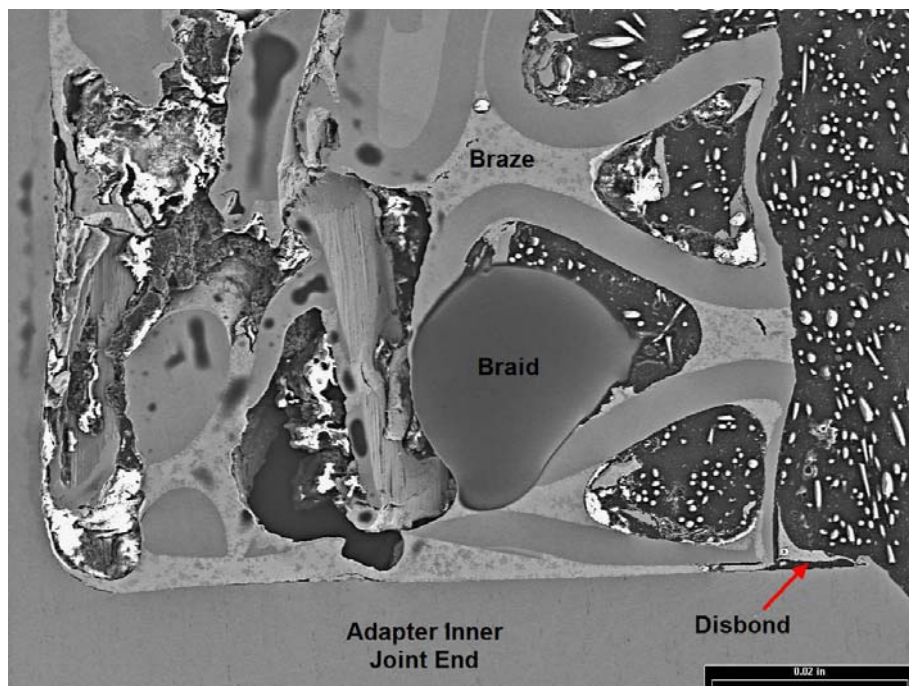


Figure 5 Inner joint detail.

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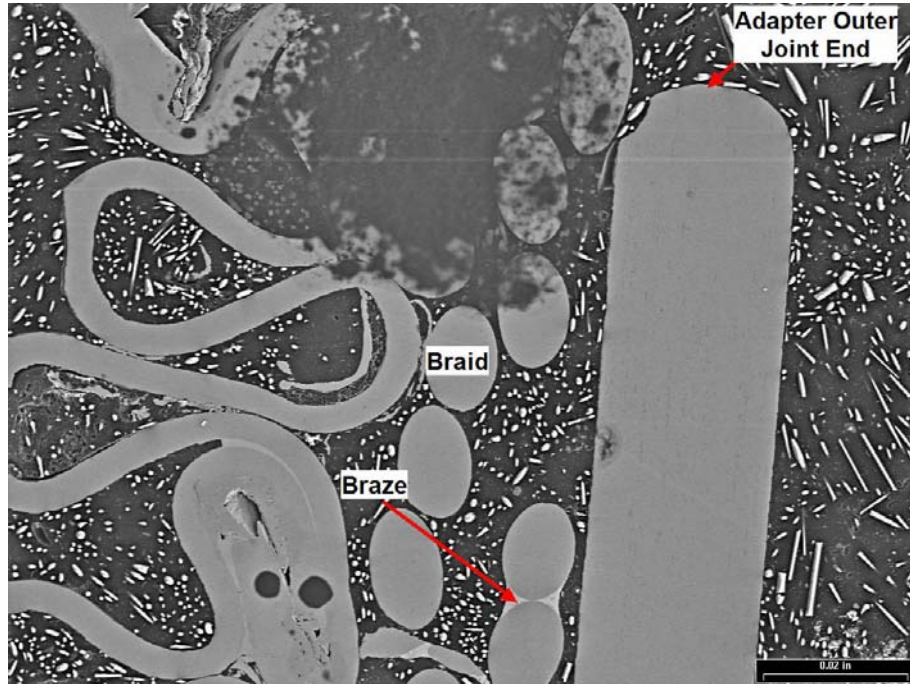


Figure 6 Outer joint detail.

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Braze Joint Characterization for Serial No. ████

The characterization indicated that

1. The amount of braze was insufficient for the joint volume.
2. Braze material was missing from a significant length of the joint, particularly near the outer end.
3. At the braze/adapter interface, there were significant regions of disbond, indicating deficient metallurgical bonding.

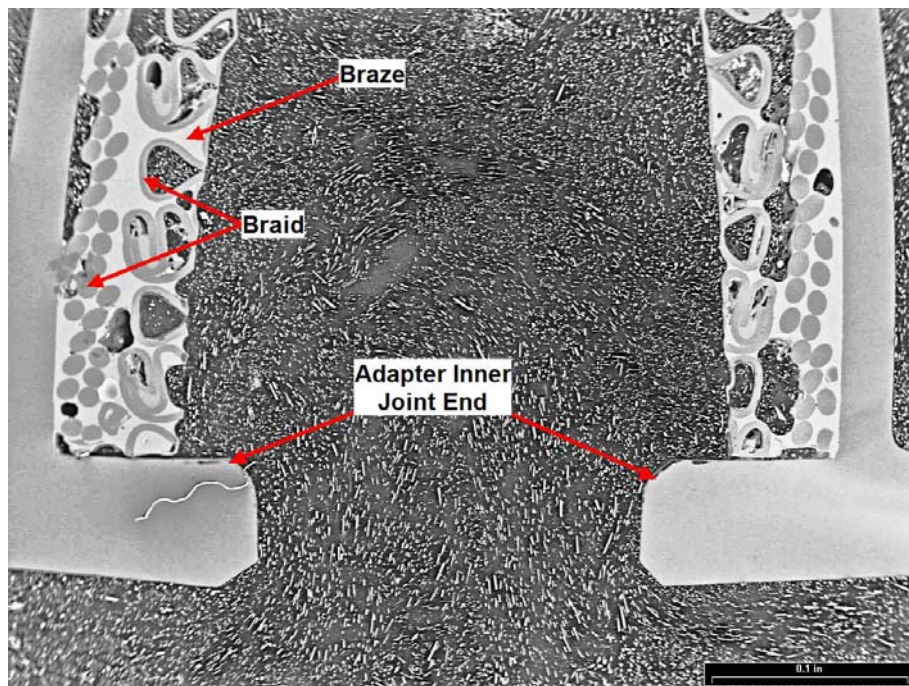


Figure 7 Overview of inner joint.

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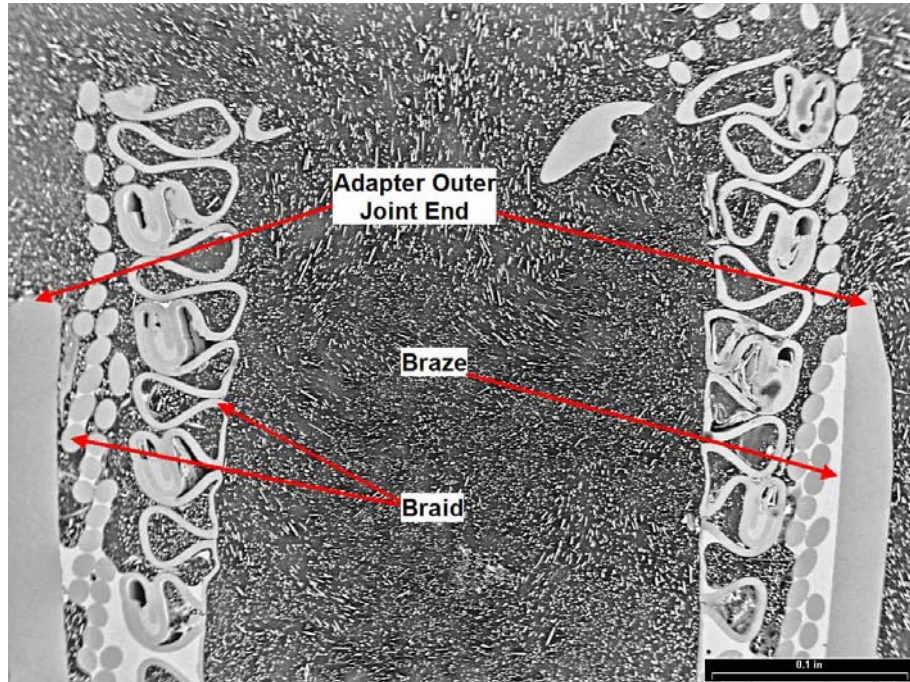


Figure 8 Overview of outer joint.

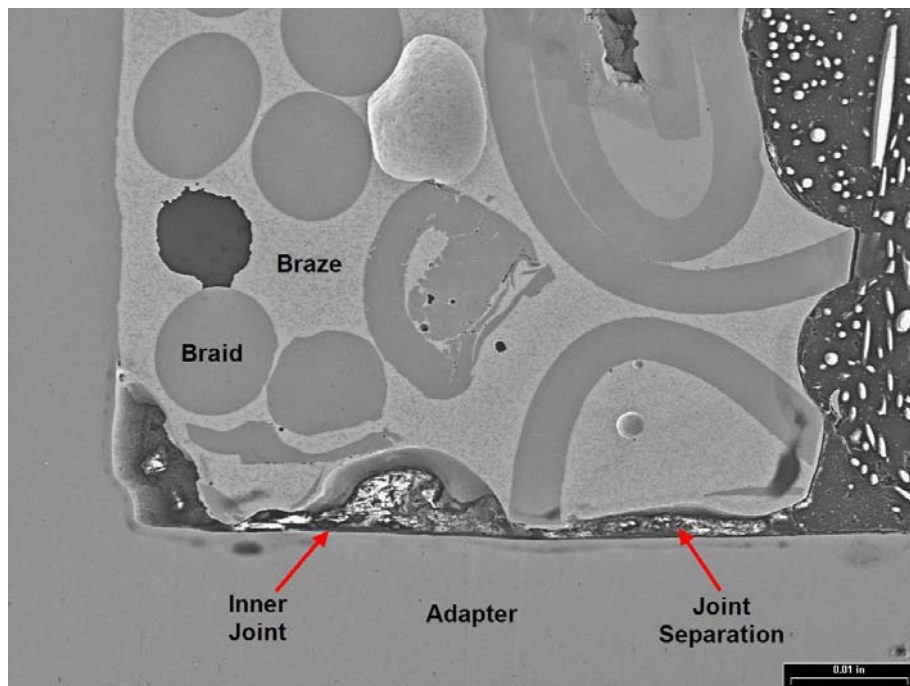


Figure 9 Inner joint detail.

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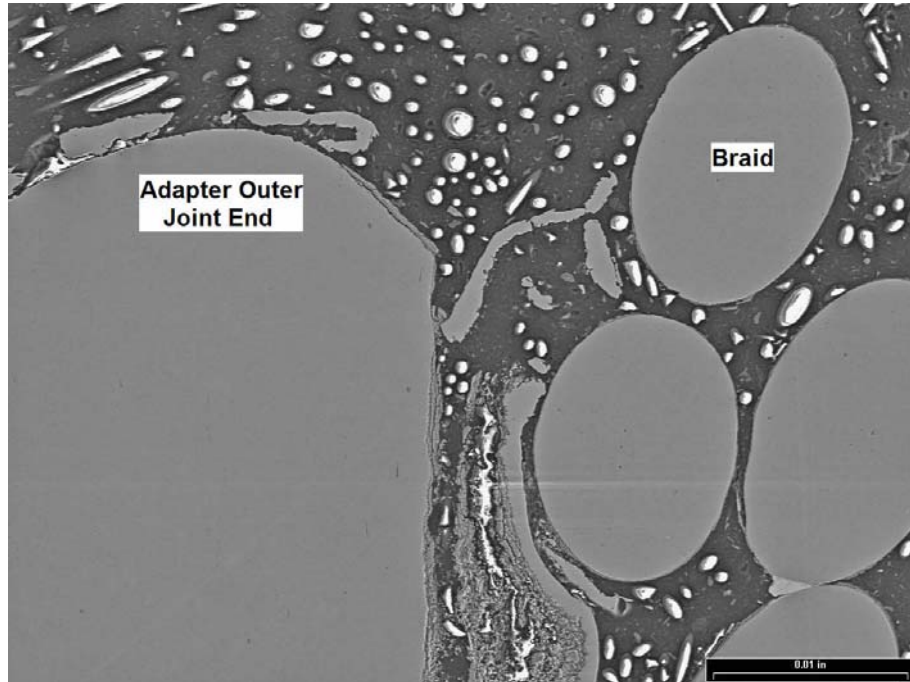


Figure 10 Outer joint detail.

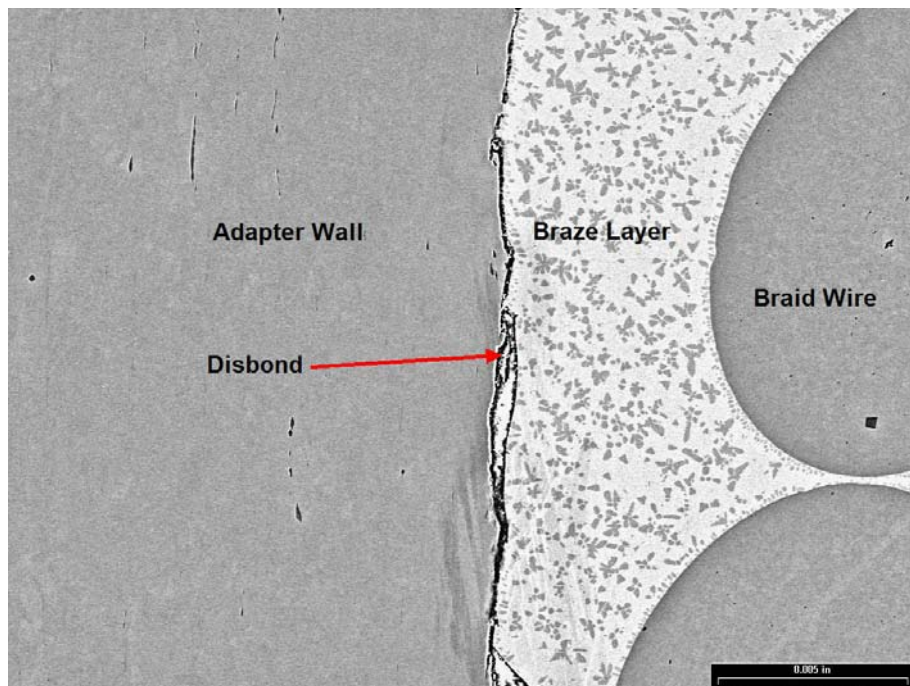


Figure 11 Interface disbond detail.

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Braze Joint Characterization for Serial No. ████

The characterization indicated that

1. The amount of braze was insufficient for the joint volume.
2. Braze material was missing from a significant length of the joint, particularly near the outer end.
3. At the braze/adaptor interface, there were significant regions of disbond, indicating deficient metallurgical bonding.

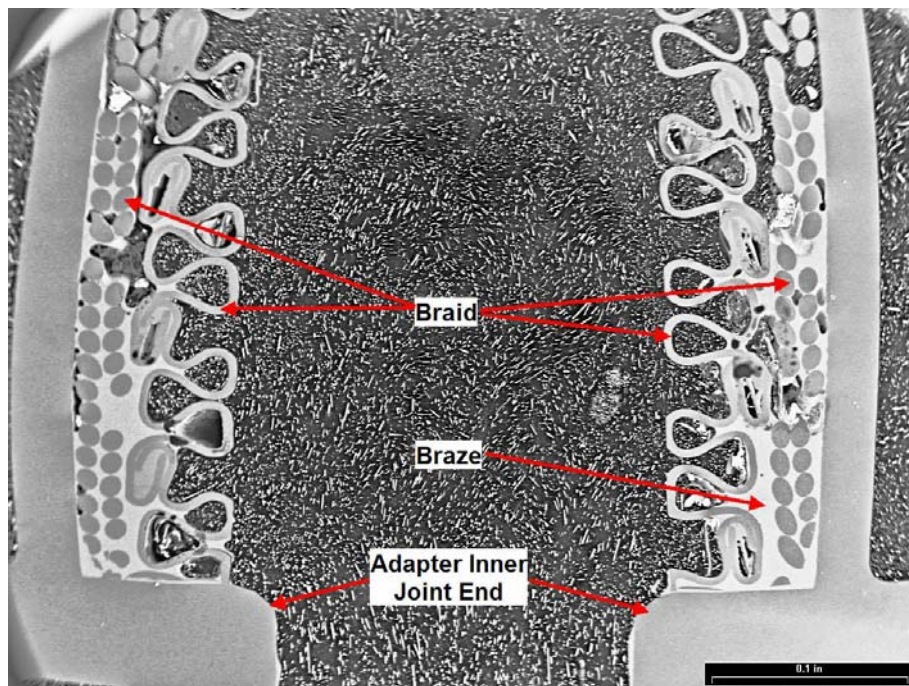


Figure 12 Overview of inner joint.

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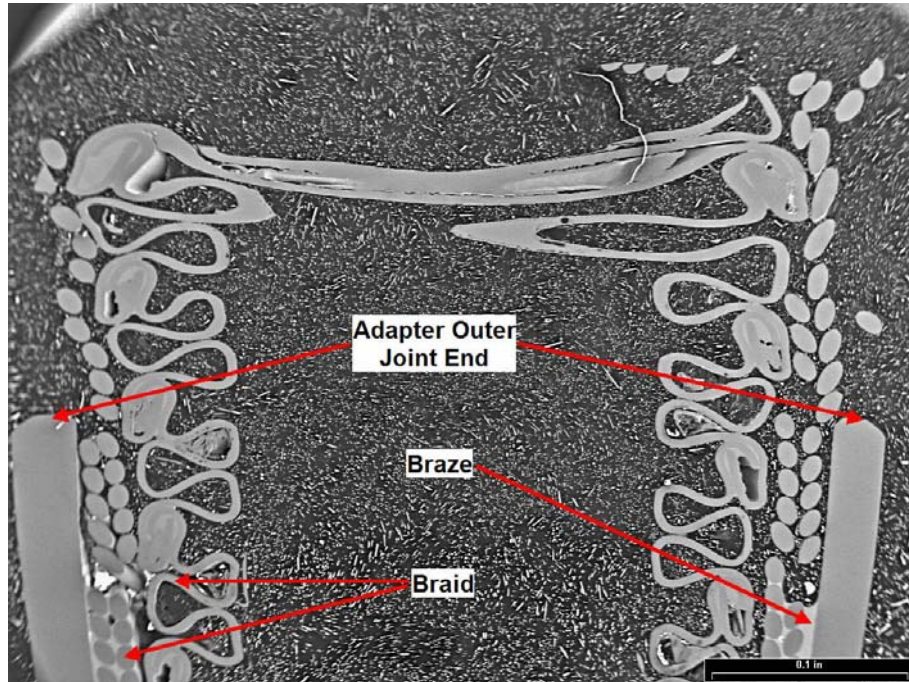


Figure 13 Overview of outer joint.

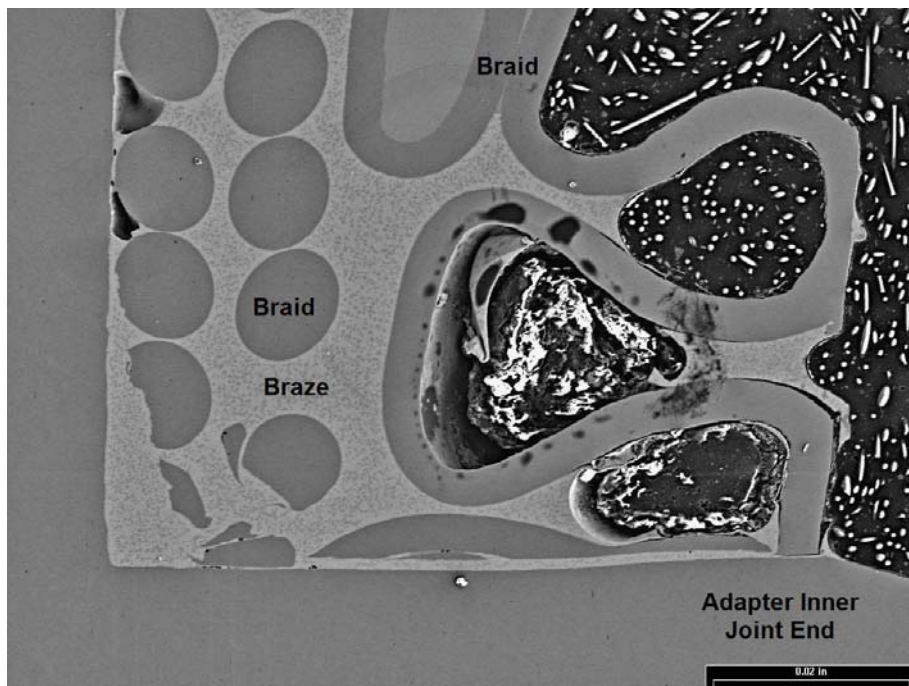


Figure 14 Inner joint detail.

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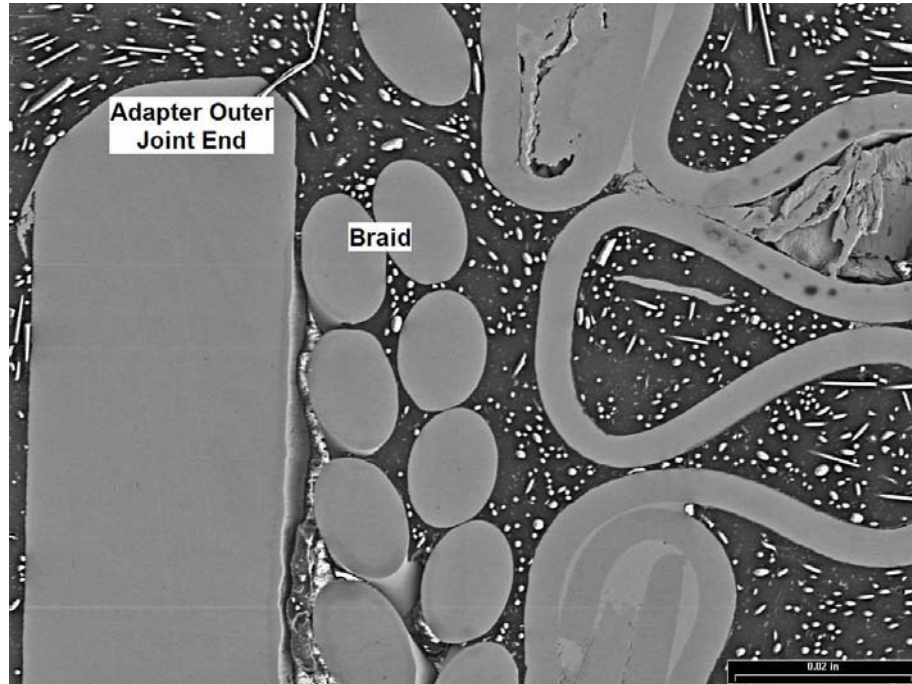


Figure 14 Outer joint detail.

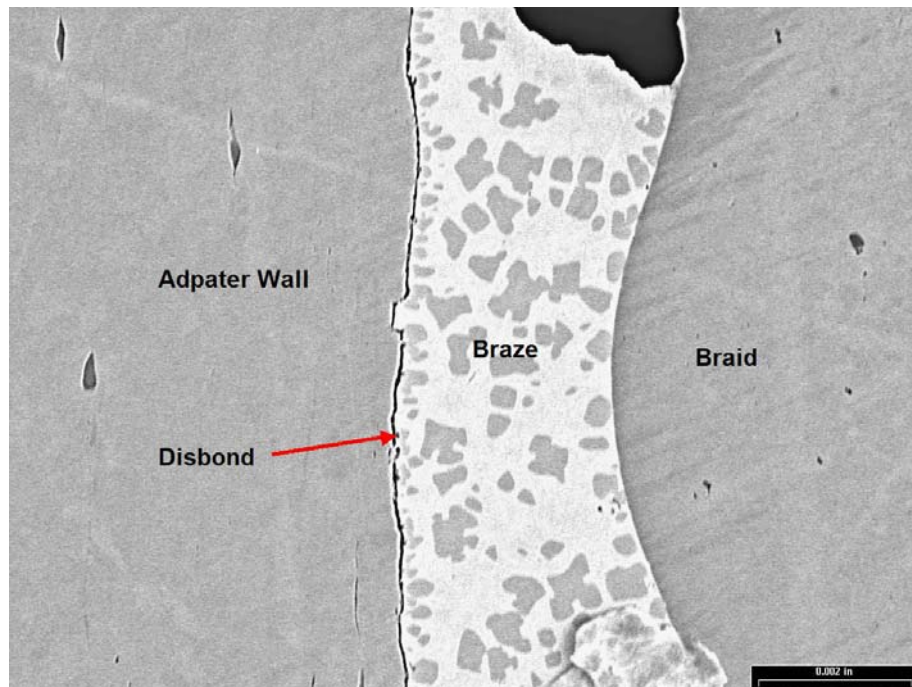


Figure 15 Interface disbond detail.