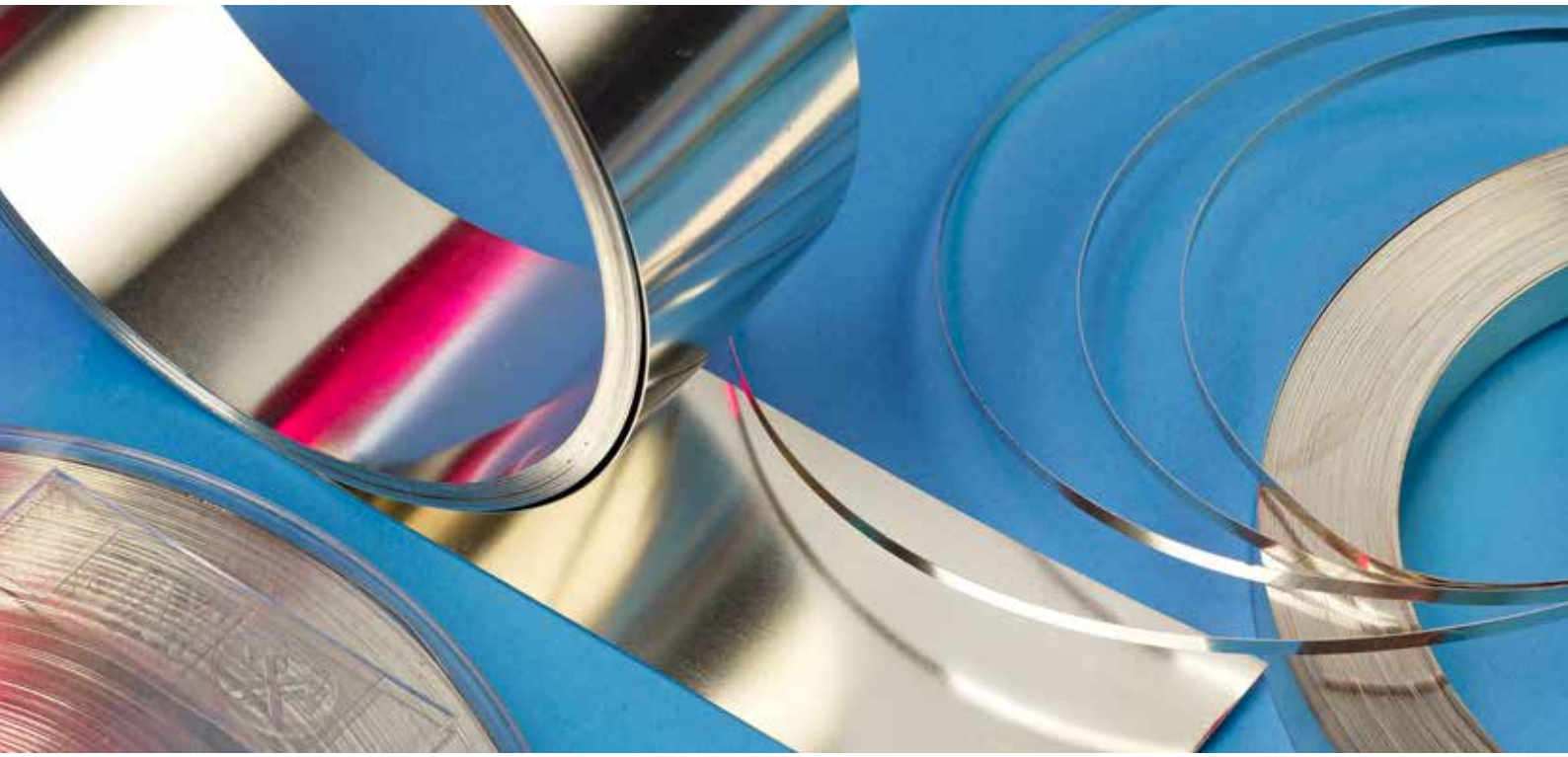
Johnson Matthey
Metal Joining



ARGO-BRAZE™

SILVER BRAZING FILLER METALS FOR TUNGSTEN CARBIDE AND PCD

ARGO-BRAZE™

FOR BRAZING TUNGSTEN CARBIDE AND TUNGSTEN CARBIDE BACKED POLY-CRYSTALLINE DIAMOND PIECES

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PRODUCTS AT A GLANCE

Compositions

Argo-braze™ products have the following compositions:	Alloy System	Ag Cu Zn Ni
	Additional Elements	Mn In

Standard products are supplied to conform to ISO 17672, which supersedes AWS A5.8 and EN 1044, which are listed where applicable.
Special products conform to proprietary Johnson Matthey specifications.

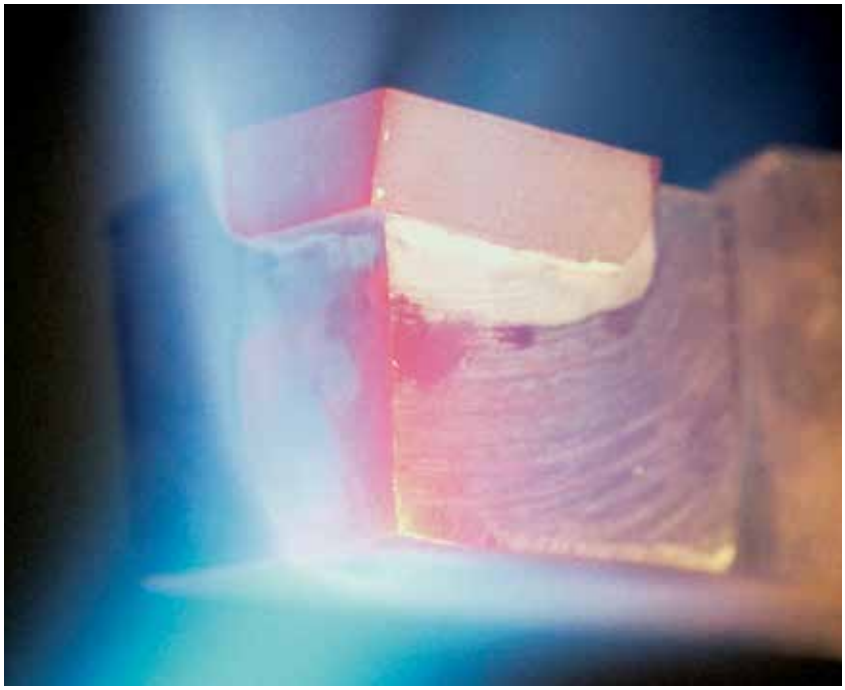
Uses for the Products

These Argo-braze™ products are most commonly used to form joints on a combination of the following materials:

- Tungsten carbide and poly-crystalline diamond (PCD) tools and wear parts including PDC cutters
- Carbon/low alloy, tool and stainless steel*
  Note: *Special considerations apply if stainless steel joints are exposed to water in service
- Other materials such as cast iron and aluminum bronze

Conditions for Use

The Argo-braze™ products are intended for use by brazing in air using a hand torch, fixed burner system, high frequency induction or resistance heating method.
They should be used with a compatible brazing flux. This can be introduced to the joint by applying a separate flux powder or paste, or a brazing paste with a flux binder system.



ARGO-BRAZE™

PRODUCTS

FOR BRAZING TUNGSTEN CARBIDE AND POLY-CRYSTALLINE DIAMOND

These products have been formulated as brazing filler metals for the joining of tungsten carbide or poly-crystalline diamond pieces where the greatest dimension does not exceed 0.8". These products are all best utilized by pre-placing in the joint as foil.

Argo-braze™ 64

Ag	Cu	Zn	Ni	Mn	In
64	26	-	2	2	6

Melting Range °F	1346 - 1436
AMS/AWS A5.8	-
EN1044: 1999	-
ISO 17672:2010	-

Description

Argo-braze™ 64 was developed principally for brazing tungsten carbide tipped components which have to be subsequently treated with a PVD (physical vapor deposition) coating such as titanium nitride. It does not contain elements, such as cadmium or zinc, which can be volatile under coating conditions depending on the process used. Argo-braze™ 64 has reasonable melting and flow characteristics

Product Forms

Argo-braze™ 502

Ag	Cu	Zn	Ni	Mn	In
50	20	28	2	-	-

Melting Range °F	1220 - 1305
AMS/AWS A5.8	4788, BAg-24
EN1044: 1999	-
ISO 17672:2010	Ag 450

Argo-braze™ 502 is particularly recommended for brazing small to medium sized tungsten carbide pieces between 0.4-0.8" in any dimension. The nickel in the filler metal improves wetting on carbide, whilst the absence of manganese gives it preferable flow and appearance when compared to Argo-braze™ 49H. This factor can make it a preferred option with brazing operators. The optimum joint gap is 0.004-0.010".

Argo-braze™ 49H

Ag	Cu	Zn	Ni	Mn	In
49	16	23	4.5	7.5	-

Melting Range °F	1260 - 1290
AMS/AWS A5.8	BAg-22
EN1044: 1999	AG502
ISO 17672:2010	Ag 449

Argo-braze™ 49H filler metal is recommended for brazing small to medium sized tungsten carbide pieces between 0.4-0.8" in any dimension. The manganese and nickel in the alloy improve wetting on difficult to wet grades of tungsten carbide. Argo-braze™ 49H is also widely used for the brazing of poly-crystalline diamond pieces. The optimum joint gap is 0.004-0.010".

Argo-braze™ 40

Ag	Cu	Zn	Ni	Mn	In
40	30	28	2	-	-

Melting Range °F	1240 - 1435
AMS/AWS A5.8	BAg-4
EN1044: 1999	-
ISO 17672:2010	Ag 440

Argo-braze™ 40 can be used for the brazing of tungsten carbide provided that the higher liquidus of 1435°F can be tolerated without causing post braze cracking. This filler metal is a good general purpose gap-filler that is also used to braze steel components where joint gaps cannot be tightly controlled. It is a more economical product compared to the 49% and 50% silver products above. The optimum joint gap is 0.004-0.010".

ARGO-BRAZE™

PRODUCTS

TRI-FOIL PRODUCTS FOR BRAZING TUNGSTEN CARBIDE

These products have been formulated as brazing filler metals for the joining of tungsten carbide or poly-crystalline diamond pieces where the greatest dimension does exceed 0.8".

Argo-braze™ 502 Tri-foil

Ag	Cu	Zn	Ni	Mn	In
50	20	28	2	-	-

Melting Range °F	1220 - 1305
AMS/AWS A5.8	4788, BAg-24
EN1044: 1999	-
ISO 17672:2010	Ag 450*

Description

Argo-braze™ 502 Tri-foil is a composite material with the brazing filler metal on either side of a central copper core. Argo-braze™ 502 Tri-foil is ideal for brazing large carbide pieces of more than 0.8" in any dimension. Tri-foil is designed to artificially thicken a joint, relieving stress and reducing the incidence of cracking. The absence of manganese in this filler metal gives it a preferable appearance when compared to Argo-braze™ 49 LM and allows the tungsten carbide to float more easily during positioning.

Product Forms

Argo-braze™ 49 LM Tri-foil

Ag	Cu	Zn	Ni	Mn	In
49	27.5	20.5	0.5	2.5	-

Melting Range °F	1238 - 1310
AMS/AWS A5.8	-
EN1044: 1999	-
ISO 17672:2010	-

Argo-braze™ 49 LM Tri-foil is a composite material with the brazing filler metal on either side of a central copper core. Argo-braze™ 49 LM Tri-foil is ideal for brazing large carbide pieces of more than 0.8" in any dimension. Tri-foil is designed to artificially thicken a joint, relieving stress and reducing the incidence of cracking. The addition of manganese improves wetting on difficult to wet grades of carbide.

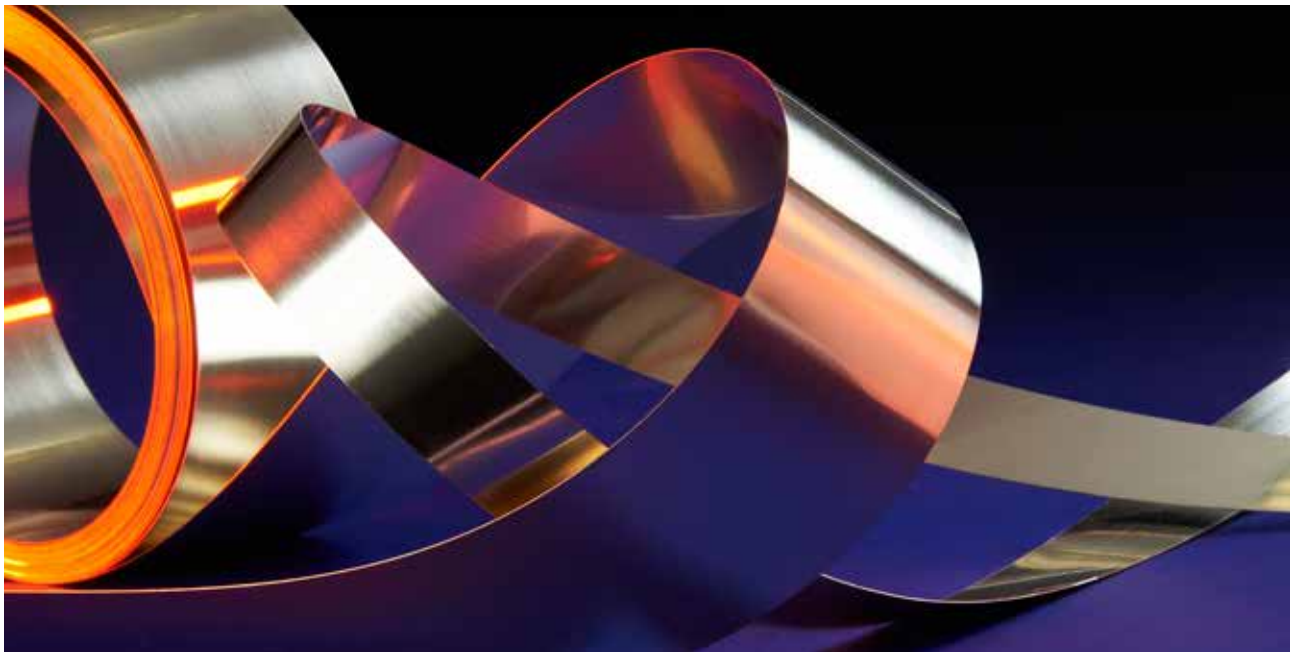
Argo-braze™ 40 Tri-foil

Ag	Cu	Zn	Ni	Mn	In
40	30	28	2	-	-

Melting Range °F	1240 - 1435
AMS/AWS A5.8	BAg-4
EN1044: 1999	-
ISO 17672:2010	Ag 440*

Argo-braze™ 40 Tri-foil can be used for the brazing of tungsten carbide provided that the higher liquidus of 1435°F can be tolerated without causing post braze cracking. Argo-braze™ 40 has a longer melting range than Argo-braze™ 502 and Argo-braze™ 49 LM so it is not as free flowing, however, the lower silver content makes it a more economical option.

*Standards and compositions refer to the brazing filler metal on the outer layers of the tri-foil.



ARGO-BRAZE™

TECHNICAL

RECOMMENDED USES FOR THESE ARGO-BRAZE™ PRODUCTS

These Argo-braze™ brazing filler metals are principally recommended for brazing the following materials:-

Tungsten Carbide

The Argo-braze™ filler metals shown have been specifically designed for brazing standard grades of tungsten carbide with cobalt or nickel contents of between 6 and 12%. They contain nickel and/or manganese, which have been shown to improve filler metal wetting and bonding onto tungsten carbide as well as increasing the joint thickness, which helps to reduce the incidence of cracking in the carbide.

Specific Issues	Recommendations for Specific Issues
Grades of tungsten carbide with low levels of cobalt (<6%) are more difficult to wet.	Argo-braze™ filler metals containing both nickel and manganese are recommended for improved wetting.
Tungsten carbide containing titanium, tantalum and other species of carbides.	Wetting of the brazing filler metal onto the cemented tungsten carbide can be severely restricted or may even be un-brazable if these metal carbides are present at high enough levels. Argo-braze™ filler metals containing manganese may help improve wetting.
Grades of tungsten carbide containing free graphite are more difficult to wet.	Wetting of the brazing filler metal onto this type of cemented tungsten carbide can be restricted. Argo-braze™ filler metals containing manganese are recommended. Grinding or lapping the carbide surface prior to brazing can help improve wetting.

Tungsten Carbide Backed Poly-crystalline Diamond (PCD) Pieces

Argo-braze™ filler metals may be used to braze poly-crystalline diamond pieces to steel components.

Specific Issues	Recommendations for Specific Issues
The brazing temperature must be kept below 1382˚F to avoid degradation of the diamond. Although this is a time/temperature issue.	In this instance a filler metal such as Matti-sil™ 56Sn or Matti-sil™ 45Sn is selected thus ensuring that the brazing temperature remains below 1382˚F. Matti-sil™ 45Sn represents a compromise between brazing temperature and the percentage of silver/cost of the filler metal. Brazing should be done quickly or with the use of a heat sink against the PCD layer.

Steel (including Stainless Steel)

Argo-braze™ filler metals are used to braze tungsten carbide or tungsten carbide backed PCD pieces to different grades of steel including mild, carbon, low alloy and stainless steel. In the case of stainless steel special care should be taken to consider the issues of interfacial corrosion in wet service conditions.

Specific Issues	Recommendations for Specific Issues
Silver brazed joints made on stainless steel can be susceptible to a form of corrosion when the joint is exposed to aqueous environments in service.	To help prevent interfacial corrosion use Johnson Matthey filler metals Argo-braze™ 56 or Argo-braze™ 632. Use of a boron modified flux such as Tenacity™ No.6 can promote interfacial corrosion and so is not recommended.
Because stainless steel is a relatively poor conductor of heat it can readily overheat resulting in flux exhaustion, lack of wetting and oxidation of the steel.	A controlled heating method coupled with a specialized flux, such as Mattiflux™ Stainless Steel Grade or Tenacity™ No.5 should be used. If both overheating of the steel and wetting of the tungsten carbide are a problem then Tenacity™ No 5A may be used. However, this flux can promote interfacial corrosion and so is not recommended on low or nickel-free ferritic and martensitic stainless steels.

PRODUCT SELECTION GUIDE FOR BRAZING TUNGSTEN CARBIDE/PCD

	Matti-sil™ 55Sn Matti-sil™ 45Sn (See Matti-sil™ brochure)	**Argo-braze™ 49H Argo-braze™ 502 Argo-braze™ 40**	**Argo-braze™ 49 LM Tri-foil Argo-braze™ 502 Tri-foil Argo-braze™ 40 Tri-foil**
Tungsten Carbide pieces <0.4″ 	**Recommended** If improved wetting is not required	**Recommended** If improved wetting is required	**Recommended** Where percussive impact is a factor
Tungsten Carbide pieces Between 0.4 and 0.8″ 	Cracking may occur	**Recommended** Provides a thicker joint	**Recommended** Not always necessary
Tungsten Carbide pieces >0.8″ 	Cracking may occur	Cracking may occur	**Recommended** Unless geometry prevents its use
Poly-crystalline diamond pieces Any size 	**Recommended** If improved wetting is not required	**Recommended** Not always necessary	**Recommended** Not commonly used

Due to the relatively high coefficient of thermal expansion of austenitic stainless steel move up one size range.

ARGO-BRAZE™

TECHNICAL

TECHNICAL CONSIDERATIONS FOR BRAZING TUNGSTEN CARBIDE

Dealing with the stresses caused by differential expansion and contraction rates of the parent materials, and wetting of the cemented carbide by the brazing filler metal are two of the main issues to be overcome.

Managing the stresses when brazing tungsten carbide

Cemented tungsten carbides have low coefficients of thermal expansion compared with that of steel (typically ⅓ of the linear coefficient of expansion of steel). This means that they expand and contract less than steel does during heating and cooling. As a result stresses can be built up in the carbide on cooling of the joint. The magnitude of the stresses built up by the differences in expansion will be a function of the size of the piece of carbide being brazed. This can give rise to distortion in the joint and build up of residual stress and ultimately cracking of the tungsten carbide.

1. Joint design to minimize stress and cracking

Joint design plays an important role in minimizing the stresses built up in brazed cemented carbide components. Often stress cracking will occur from corners of the carbide segment and redesigning the component can help.
Increasing the joint clearance will provide a thicker layer of ductile brazing filler metal capable of accommodating the stresses from differential contraction. The use of a tri-foil, spacer wire or creating pips or bumps on the steel component will help to control the joint gap.

On large carbides the use of thin backing materials can lead to cracking because they are not able to withstand the high stresses resulting from contraction on cooling. Thicker backing materials or bodies to hold the carbide can reduce the incidence of failure.
With long lengths of carbides bending or cracking can be a problem. Consideration should be given to the use of multiple pieces of carbide to overcome this.

2. Filler metal selection to help avoid cracking

Conventional free flowing brazing filler metals such as Matti-sil™ 55Sn are recommended for joint gaps of 0.002-0.005" and are often satisfactory for brazing carbide with a length of up to ~0.4". Carbide pieces of a larger size can be stressed to such an extent that cracking occurs on cooling, in a subsequent grinding operation or when the component is in service. For these applications the joint should be thickened.
Using a less free flowing brazing filler metal, which produces a thicker joint (between 0.002-0.005"), such as Argo-braze™ 502 or Argo-braze™ 49H, is recommended for carbide pieces of between 0.4-0.8" in any dimension.
Tri-foil brazing products such as Argo-braze™ 502 Tri-foil or Argo-braze™ 49LM Tri-foil contain a central copper core, which artificially thickens the joint, which both absorbs stresses and 'cushions' the carbide. They are recommended for carbide components of more than 0.8" in any dimension. Argo-braze™ 49LM Tri-foil has also proved itself in service when used on smaller carbide pieces exposed to percussive stress in service.

3. Brazing technique

A heating pattern should be employed, which brings both components to brazing temperature at the same time. Care should be taken to avoid overheating the joint as this will increase stresses arising from differential thermal expansion of the components.

When using foil, once the brazing filler metal is molten it is advisable to move the carbide slightly across the joint area. This can displace trapped gas or flux and often improves the wetting of the brazing filler metal onto the carbide.

4. Cooling and finishing the carbide assembly

Slow uniform cooling of the carbide is always recommended to avoid stressing and possible cracking. Quenching in water is not recommended. Burying the parts in vermiculite for example controls the cooling rate.

It is advisable to avoid thermal stresses during grinding and finishing of the carbide component.

Wetting of brazing filler metals on tungsten carbide

The molten brazing filler metal will more easily wet the carbide if the surface is ground shortly before brazing then degreased and kept clean before applying flux.
The degree of wetting of brazing filler metal onto a tungsten carbide segment will depend on its composition. Tungsten carbides with small additions of titanium or tantalum carbide are more difficult to wet than standard carbides. Wetting can be improved by the use of brazing filler metals containing nickel or both nickel and manganese (e.g. Argo-braze™ 502 or Argo-braze™ 49H).
On carbides which are easy to wet general purpose brazing fluxes such as Mattiflux™ Flux Powder or Paste and Mattiflux™ 100 Flux Paste are recommended. Where the carbides are more difficult to wet fluxes containing boron such as Tenacity™ No.6 Flux Powder and Paste will be more suitable. The addition of boron has been found to improve filler metal wetting. Mattiflux™ Low Temperature Grade Flux Paste is recommended for HF induction heating.

ARGO-BRAZE™

KEY

Elements

Ag	Silver
Cu	Copper
In	Indium
Mn	Manganese
Ni	Nickel
Zn	Zinc

Key to Product Availability

	Readily available
	Made to order

Standard Forms of Supply

	Foil
	Paste
	Powder
	Preform
	Ring
	Rod
	Flux Coated Rod
	Strip
	Wire
Cd Free	Cadmium-Free

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