



Johnson Matthey  
Metal Joining



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# 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 ISO17672.  
Special products conform to proprietary Johnson Matthey specifications.

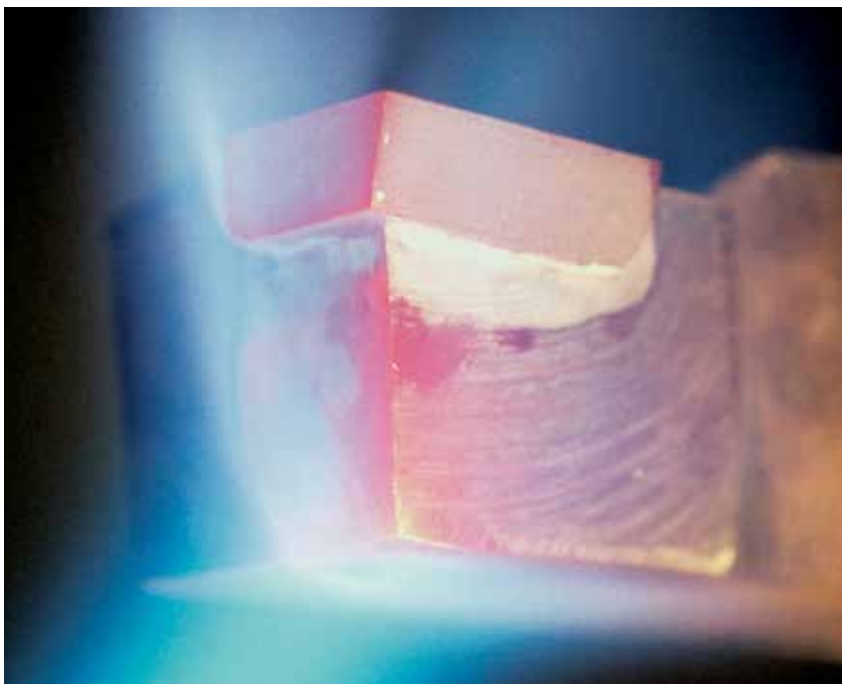
#### Uses for the Products

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

- ▶ Tungsten carbide and tungsten carbide backed poly-crystalline diamond
- ▶ 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 aluminium 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 20mm. These products are all best utilized by pre-placing in the joint as foil.




	Description						Product Forms
<b>Argo-braze™ 64</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>	<b>Mn</b>	<b>In</b>	 Cd Free
	64	26	-	2	2	6	
	<b>Melting Range °C</b>			730 - 780			
	<b>AMS/AWS A5.8</b>			-			
	<b>EN1044: 1999</b>			-			
<b>ISO 17672:2010</b>			-				
<b>Argo-braze™ 502</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>	<b>Mn</b>	<b>In</b>	 Cd Free
	50	20	28	2	-	-	
	<b>Melting Range °C</b>			660 - 705			
	<b>AMS/AWS A5.8</b>			4788, BAg-24			
	<b>EN1044: 1999</b>			-			
<b>ISO 17672:2010</b>			Ag 450				
<b>Argo-braze™ 49H</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>	<b>Mn</b>	<b>In</b>	 Cd Free
	49	16	23	4.5	7.5	-	
	<b>Melting Range °C</b>			680 - 705			
	<b>AMS/AWS A5.8</b>			BAg-22			
	<b>EN1044: 1999</b>			AG502			
<b>ISO 17672:2010</b>			Ag 449				
<b>Argo-braze™ 40</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>	<b>Mn</b>	<b>In</b>	 Cd Free
	40	30	28	2	-	-	
	<b>Melting Range °C</b>			670 - 780			
	<b>AMS/AWS A5.8</b>			BAg-4			
	<b>EN1044: 1999</b>			-			
<b>ISO 17672:2010</b>			Ag 440				

# ARGO-BRAZE™

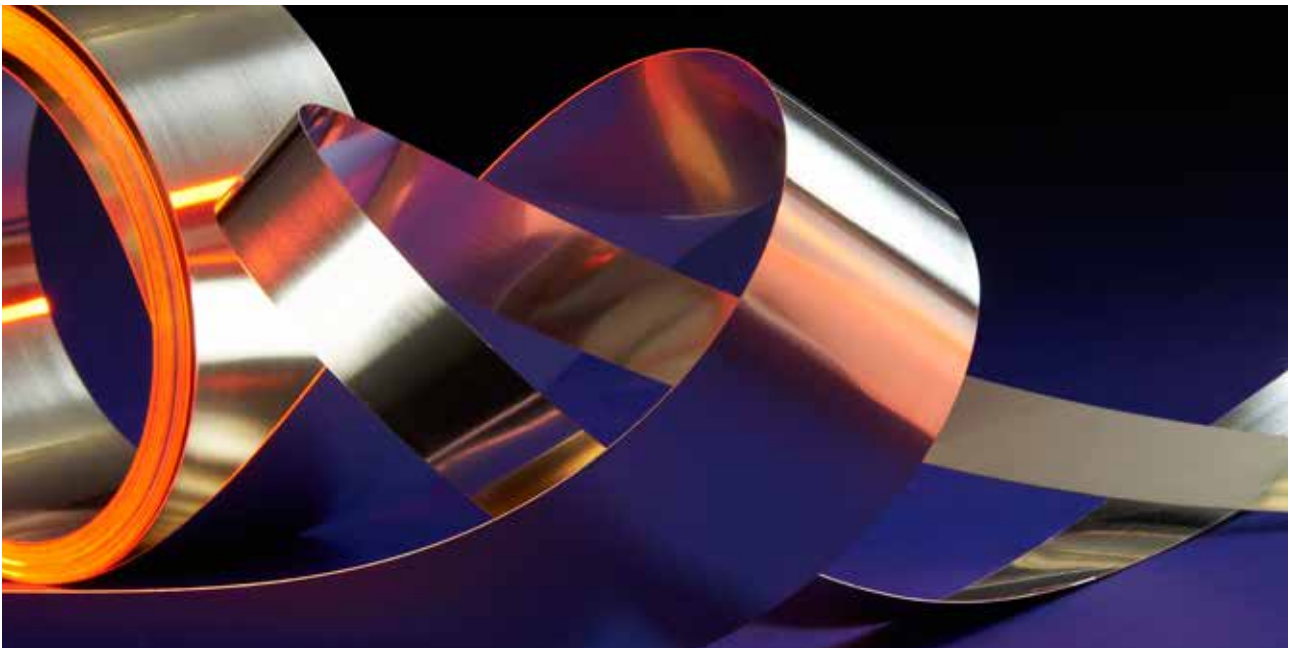
## PRODUCTS

### 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 20mm.

	Description						Product Forms
<b>Argo-braze™ 502 Tri-foil</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>	<b>Mn</b>	<b>In</b>	
	50	20	28	2	-	-	
	<b>Melting Range °C</b>		660 - 705				
	<b>AMS/AWS A5.8</b>		4788, BAg-24				
	<b>EN1044: 1999</b>		-				
<b>ISO 17672:2010</b>		Ag 450*					
<p>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 20mm 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.</p>							
<b>Argo-braze™ 49 LM Tri-foil</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>	<b>Mn</b>	<b>In</b>	
	49	27.5	20.5	0.5	2.5	-	
	<b>Melting Range °C</b>		670 - 710				
	<b>AMS/AWS A5.8</b>		-				
	<b>EN1044: 1999</b>		-				
<b>ISO 17672:2010</b>		-					
<p>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 20mm 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.</p>							
<b>Argo-braze™ 40 Tri-foil</b>	<b>Ag</b>	<b>Cu</b>	<b>Zn</b>	<b>Ni</b>	<b>Mn</b>	<b>In</b>	
	40	30	28	2	-	-	
	<b>Melting Range °C</b>		670 - 780				
	<b>AMS/AWS A5.8</b>		BAg-4				
	<b>EN1044: 1999</b>		-				
<b>ISO 17672:2010</b>		Ag 440*					
<p>Argo-braze™ 40 Tri-foil can be used for the brazing of tungsten carbide provided that the higher liquidus of 780°C 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.</p>							

\*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

Grades of tungsten carbide with low levels of cobalt (< 6%) are more difficult to wet.

Tungsten carbide containing titanium, tantalum and other species of carbides.

Grades of tungsten carbide containing free graphite are more difficult to wet.

##### Recommendations for Specific Issues

▶ Argo-braze™ filler metals containing both nickel and manganese are recommended for improved wetting.

▶ 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.

▶ 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

The brazing temperature must be kept below 750°C to avoid degradation of the diamond. Although this is a time/temperature issue.

##### Recommendations for Specific Issues

▶ In this instance a filler metal such as Silver-flo™ 55 or Silver-flo™ 452 is selected thus ensuring that the brazing temperature remains below 750°C. Silver-flo™ 452 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

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.





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.

##### Recommendations for Specific Issues

▶ 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.

▶ A controlled heating method coupled with a specialised flux, such as Easy-flo™ 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

		Silver-flo™ 55 Silver-flo™ 452 (See Silver-flo™ 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 <10mm		<b>Recommended</b> If improved wetting is not required	<b>Recommended</b> If improved wetting is required	<b>Recommended</b> Where percussive impact is a factor
Tungsten Carbide pieces Between 10 and 20mm		Cracking may occur	<b>Recommended</b> Provides a thicker joint	<b>Recommended</b> Not always necessary
Tungsten Carbide pieces >20mm		Cracking may occur	Cracking may occur	<b>Recommended</b> Unless geometry prevents its use
Poly-crystalline diamond pieces Any size		<b>Recommended</b> If improved wetting is not required	<b>Recommended</b> Not always necessary	<b>Recommended</b> 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  $\frac{1}{3}$  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 minimise stress and cracking

Joint design plays an important role in minimising 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 Silver-flo™ 55 are recommended for joint gaps of 0.05-0.125mm and are often satisfactory for brazing carbide with a length of up to ~10mm. 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 0.1-0.25mm), such as Argo-braze™ 502 or Argo-braze™ 49H, is

recommended for carbide pieces of between 10-20mm 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 20mm 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 Easy-flo™ Flux Powder or Paste and Easy-flo™ 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. Easy-flo™ 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

<input checked="" type="checkbox"/>	Readily available
<input type="checkbox"/>	Made to order

### Standard Forms of Supply

<input checked="" type="checkbox"/>	<input type="checkbox"/>	Foil
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Paste
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Powder
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Preform
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Ring
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Rod
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Flux Coated Rod
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Strip
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Wire
<input checked="" type="checkbox"/>	<input type="checkbox"/>	Cadmium-Free

  
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