



Johnson Matthey  
Inspiring science, enhancing life



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# SILVER-FLO™

SILVER BRAZING FILLER METALS

# SILVER-FLO™

## SILVER BRAZING FILLER METALS

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### PRODUCTS AT A GLANCE

#### Compositions

Silver-flo™ products have the following compositions:

Alloy System

Ag Cu Zn

Additional Elements

Sn Si

Standard products are supplied to conform to ISO17672. Special products conform to proprietary Johnson Matthey specifications.

Note: Products of this type are commonly referred to as silver solders

#### Uses for the Products

Silver-flo™ products are most commonly used to form joints on a combination of the following materials:

- ▶ Copper and copper alloys including brass, bronze, nickel silver and aluminium-bronze
- ▶ Steel (mild / tool and stainless) Note: Special considerations apply if stainless steel joints are exposed to water in service
- ▶ Tungsten carbide and poly-crystalline diamond

#### Conditions for Use

The Silver-flo™ products are primarily intended for use by brazing in air using a hand torch, fixed burner system, high frequency induction or resistance heating.

They should be used with a compatible brazing flux. This can be introduced to the joint by applying a separate flux powder or paste, by using a flux coated brazing rod or as a brazing paste with a built-in flux binder system.



# SILVER-FLO™

## PRODUCTS

### STANDARD FILLER METALS

These products represent the most widely used silver brazing filler metals.









Specification	Description	Properties	Product Forms																									
<b>Silver-flo™ 55</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>55</td> <td>21</td> <td>22</td> <td>2</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">630-660</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG103</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 155</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	55	21	22	2	-	<b>Melting Range °C</b>		630-660			<b>EN1044: 1999</b>		AG103			<b>ISO 17672:2010</b>		Ag 155			<p>Silver-flo™ 55 is an easy to use, general purpose silver brazing filler metal. It has a low brazing temperature, short melting range and is free flowing when molten, producing neat joints with small fillets. Silver-flo™ 55 is a cadmium-free replacement for the high silver (38-50%) cadmium containing filler metals. It can be used on most common engineering metals.</p>	<p><b>1</b> Flow</p> <p>0.05-0.15mm</p> <p>-50°C / 200°C</p> <p>390-145</p> <p>Yes / </p>	   
Ag	Cu	Zn	Sn	Si																								
55	21	22	2	-																								
<b>Melting Range °C</b>		630-660																										
<b>EN1044: 1999</b>		AG103																										
<b>ISO 17672:2010</b>		Ag 155																										
<b>Silver-flo™ 56</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>56</td> <td>22</td> <td>17</td> <td>5</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">618-652</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG102</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 156</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	56	22	17	5	-	<b>Melting Range °C</b>		618-652			<b>EN1044: 1999</b>		AG102			<b>ISO 17672:2010</b>		Ag 156			<p>Silver-flo™ 56 has very similar properties to Silver-flo™ 55. It has a low brazing temperature, short melting range and is free flowing when molten, producing neat joints with small fillets. Originally conforming to the US standard AWS A5.8 BAg-7, it can be used as a cadmium-free replacement for the high silver (38-50%) cadmium containing filler metals.</p>	<p><b>1</b> Flow</p> <p>0.05-0.15mm</p> <p>-50°C / 200°C</p> <p>410-165</p> <p>Yes</p>	   
Ag	Cu	Zn	Sn	Si																								
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<b>EN1044: 1999</b>		AG102																										
<b>ISO 17672:2010</b>		Ag 156																										
<b>Silver-flo™ 452</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>45</td> <td>27</td> <td>25.5</td> <td>2.5</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">640-680</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG104</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 145</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	45	27	25.5	2.5	-	<b>Melting Range °C</b>		640-680			<b>EN1044: 1999</b>		AG104			<b>ISO 17672:2010</b>		Ag 145			<p>Silver-flo™ 452 is a general purpose filler metal with 45% silver bridging the gap in properties and cost between high silver 55/56% filler metals and the medium silver 38/40% filler metals. It has the lowest silver content to braze PCD segments below 750°C without degrading the diamond layer. It has good flow properties, but a slightly higher brazing temperature than the high silver content filler metals.</p>	<p><b>2</b> Flow</p> <p>0.05-0.15mm</p> <p>-50°C / 200°C</p> <p>420-185</p> <p>Yes</p>	   
Ag	Cu	Zn	Sn	Si																								
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<b>Silver-flo™ 40</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>40</td> <td>30</td> <td>28</td> <td>2</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">650-710</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG105</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 140</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	40	30	28	2	-	<b>Melting Range °C</b>		650-710			<b>EN1044: 1999</b>		AG105			<b>ISO 17672:2010</b>		Ag 140			<p>Silver-flo™ 40 offers a good combination of properties. It has a medium brazing temperature, melting range, flow characteristics and silver content. Silver-flo™ 40 is widely used as a general purpose silver brazing filler metal as well as for joining copper and its alloys to steel in HVAC&amp;R applications.</p>	<p><b>2</b> Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>450-155</p> <p>No</p>	   
Ag	Cu	Zn	Sn	Si																								
40	30	28	2	-																								
<b>Melting Range °C</b>		650-710																										
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<b>Silver-flo™ 38</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>38</td> <td>32</td> <td>28</td> <td>2</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">660-720</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">-</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 138</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	38	32	28	2	-	<b>Melting Range °C</b>		660-720			<b>EN1044: 1999</b>		-			<b>ISO 17672:2010</b>		Ag 138			<p>Silver-flo™ 38 has similar properties to Silver-flo™ 40. It has a medium brazing temperature, melting range, flow characteristics and silver content. Silver-flo™ 38 is favoured in different global regions to Silver-flo™ 40 where it is also used in general purpose and HVAC&amp;R applications.</p>	<p><b>2</b> Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>430-175</p> <p>No</p>	   
Ag	Cu	Zn	Sn	Si																								
38	32	28	2	-																								
<b>Melting Range °C</b>		660-720																										
<b>EN1044: 1999</b>		-																										
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<b>Silver-flo™ 302</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>30</td> <td>36</td> <td>32</td> <td>2</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">665-755</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG107</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 130</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	30	36	32	2	-	<b>Melting Range °C</b>		665-755			<b>EN1044: 1999</b>		AG107			<b>ISO 17672:2010</b>		Ag 130			<p>Silver-flo™ 302 has a long melting range and poor flow characteristics, which make it an ideal choice for applications where fillet build ups are required or close tolerance joint gaps are not present. It is used for brazing steel, copper and copper alloy tubes and fittings in HVAC&amp;R and automotive applications. It is a popular choice as a flux coated rod for site work.</p>	<p><b>3</b> Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>460-135</p> <p>No</p>	   
Ag	Cu	Zn	Sn	Si																								
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<b>Silver-flo™ 252</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>25</td> <td>40</td> <td>33</td> <td>2</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">680-760</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG108</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 125</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	25	40	33	2	-	<b>Melting Range °C</b>		680-760			<b>EN1044: 1999</b>		AG108			<b>ISO 17672:2010</b>		Ag 125			<p>Silver-flo™ 252 has a long melting range and poor flow characteristics, which make it an ideal choice for applications where fillet build ups are required or close tolerance joint gaps are not present. Like Silver-flo™ 302 it may be used for brazing steel, copper and copper alloy tubes and fittings in HVAC&amp;R and automotive applications.</p>	<p><b>3</b> Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>460-135</p> <p>No</p>	   
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# SILVER-FLO™

## PRODUCTS

### FILLER METALS FOR SPECIAL APPLICATIONS

These cadmium-free filler metals have been designed for use in specialised applications.

Specification	Description	Properties	Product Forms																									
<b>Silver-flo™ 60</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>60</td> <td>26</td> <td>14</td> <td>-</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">695-730</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG202</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">-</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	60	26	14	-	-	<b>Melting Range °C</b>		695-730			<b>EN1044: 1999</b>		AG202			<b>ISO 17672:2010</b>		-			<p>Silver-flo™ 60 is a filler metal specified for use on cupro-nickel and nickel alloys (in particular 70:30 cupro-nickel). It has a brazing temperature above the stress relieving temperature of many of these types of metals thus preventing liquid metal stress cracking as a result of intergranular penetration. It is resistant to dezincification.</p>	<p>1 Flow</p> <p>0.05-0.20mm</p> <p>-50°C / 200°C</p> <p>420-155</p> <p>Yes</p>	 <p>Cd Free</p>
Ag	Cu	Zn	Sn	Si																								
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<b>Silver-flo™ 56S</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>56</td> <td>22</td> <td>16.75</td> <td>5</td> <td>0.25</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">618-652</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">-</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">-</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	56	22	16.75	5	0.25	<b>Melting Range °C</b>		618-652			<b>EN1044: 1999</b>		-			<b>ISO 17672:2010</b>		-			<p>Silver-flo™ 56S is a Johnson Matthey proprietary filler metal which has a small addition of silicon, is very free flowing and produces smooth neat joints with small fillets. It is not recommended on carbon steel components that are subject to high impact or fatigue stress in service.</p>	<p>1 Flow</p> <p>0.05-0.15mm</p> <p>-50°C / 200°C</p> <p>410-165</p> <p>Yes</p>	 <p>Cd Free</p>
Ag	Cu	Zn	Sn	Si																								
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<b>Melting Range °C</b>		618-652																										
<b>EN1044: 1999</b>		-																										
<b>ISO 17672:2010</b>		-																										
<b>Silver-flo™ 453S</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>45</td> <td>25</td> <td>26.8</td> <td>3</td> <td>0.2</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">640-680</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">-</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">-</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	45	25	26.8	3	0.2	<b>Melting Range °C</b>		640-680			<b>EN1044: 1999</b>		-			<b>ISO 17672:2010</b>		-			<p>Silver-flo™ 453S has a small addition of silicon and produces smooth neat joints with small fillets making it popular for hand torch brazing of decorative brass components. Like other high silver content silicon containing filler metals it is not recommended for use on carbon steel components that are subject to high impact or fatigue stress in service.</p>	<p>1 Flow</p> <p>0.05-0.15mm</p> <p>-50°C / 200°C</p> <p>420-185</p> <p>Yes</p>	 <p>Cd Free</p>
Ag	Cu	Zn	Sn	Si																								
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<b>ISO 17672:2010</b>		-																										
<b>Silver-flo™ 44</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>44</td> <td>30</td> <td>26</td> <td>-</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">675-735</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG203</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">Ag 244</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	44	30	26	-	-	<b>Melting Range °C</b>		675-735			<b>EN1044: 1999</b>		AG203			<b>ISO 17672:2010</b>		Ag 244			<p>Silver-flo™ 44 has a medium brazing temperature, melting range, flow and silver content. Although it is not preferred to the more common Silver-flo™ 40 or 38 it has found use in marine applications because it is resistant to dezincification. It is also used as a medium temperature filler metal for copper alloy tubes where joint gaps are variable and a fillet is desirable.</p>	<p>2 Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>545-185</p> <p>Yes</p>	 <p>Cd Free</p>
Ag	Cu	Zn	Sn	Si																								
44	30	26	-	-																								
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<b>Silver-flo™ 43</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>43</td> <td>37</td> <td>20</td> <td>-</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">690-775</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">-</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">-</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	43	37	20	-	-	<b>Melting Range °C</b>		690-775			<b>EN1044: 1999</b>		-			<b>ISO 17672:2010</b>		-			<p>Silver-flo™ 43 has a medium brazing temperature, long melting range, and poor flow characteristics. It is not commonly used but has found use in the shipbuilding industry and in marine applications because it is the lowest silver content filler metal, which is resistant to dezincification. It is a good fillet forming and gap filling filler metal.</p>	<p>3 Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>400-165</p> <p>Yes</p>	 <p>Cd Free</p>
Ag	Cu	Zn	Sn	Si																								
43	37	20	-	-																								
<b>Melting Range °C</b>		690-775																										
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<b>Silver-flo™ 24</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>24</td> <td>43</td> <td>33</td> <td>-</td> <td>-</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">740-800</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">-</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">-</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	24	43	33	-	-	<b>Melting Range °C</b>		740-800			<b>EN1044: 1999</b>		-			<b>ISO 17672:2010</b>		-			<p>Silver-flo™ 24 has been incorporated into aviation / aerospace industry standards and is consequently used in the manufacture of components for applications in this field. It is also used as the first alloy in a two-step silver brazing operation, where the second joint is made with Silver-flo™ 55.</p>	<p>2 Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>470-155</p> <p>No / </p>	 <p>Cd Free</p>
Ag	Cu	Zn	Sn	Si																								
24	43	33	-	-																								
<b>Melting Range °C</b>		740-800																										
<b>EN1044: 1999</b>		-																										
<b>ISO 17672:2010</b>		-																										
<b>Silver-flo™ 20</b> <table border="1"> <tr> <td>Ag</td> <td>Cu</td> <td>Zn</td> <td>Sn</td> <td>Si</td> </tr> <tr> <td>20</td> <td>44</td> <td>35.85</td> <td>-</td> <td>0.15</td> </tr> <tr> <td colspan="2"><b>Melting Range °C</b></td> <td colspan="3">776-815</td> </tr> <tr> <td colspan="2"><b>EN1044: 1999</b></td> <td colspan="3">AG206</td> </tr> <tr> <td colspan="2"><b>ISO 17672:2010</b></td> <td colspan="3">-</td> </tr> </table>	Ag	Cu	Zn	Sn	Si	20	44	35.85	-	0.15	<b>Melting Range °C</b>		776-815			<b>EN1044: 1999</b>		AG206			<b>ISO 17672:2010</b>		-			<p>Silver-flo™ 20 is a high melting point silver brazing filler metal that has a comparatively narrow melting range providing reasonable flow properties when molten. It can be used when colour matching to brass is required.</p>	<p>3 Flow</p> <p>0.075-0.2mm</p> <p>-50°C / 200°C</p> <p>330-145</p> <p>No</p>	 <p>Cd Free</p>
Ag	Cu	Zn	Sn	Si																								
20	44	35.85	-	0.15																								
<b>Melting Range °C</b>		776-815																										
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# SILVER-FLO™

## PRODUCTS

### LESS COMMON / REFERENCE FILLER METALS

These cadmium-free Silver-flo™ filler metals have been included for reference purposes. Their use is limited to niche or specialised applications.

	Specification	Description	Properties	Product Forms
<b>Silver-flo™ 45</b>	Ag Cu Zn Sn 45 25 30 -	Melting Range °C EN1044: 1999 ISO 17672: 2010 680-700 - -	1 Flow 0.05-0.15 -50 / 200°C Yes	
<b>Silver-flo™ 34</b>	Ag Cu Zn Sn 34 36 27.5 2.5	Melting Range °C EN1044: 1999 ISO 17672: 2010 630-730 AG106 Ag 134	3 Flow 0.075-0.2 -50 / 200°C No	
<b>Silver-flo™ 33</b>	Ag Cu Zn Sn 33 33.5 33.5 -	Melting Range °C EN1044: 1999 ISO 17672: 2010 700-740 - -	1 Flow 0.075-0.2 -50 / 200°C No	
<b>Silver-flo™ 30</b>	Ag Cu Zn Sn 30 38 32 -	Melting Range °C EN1044: 1999 ISO 17672: 2010 695-770 AG204 Ag 230	3 Flow 0.075-0.2 -50 / 200°C No	
<b>Silver-flo™ 25</b>	Ag Cu Zn Sn 25 40 35 -	Melting Range °C EN1044: 1999 ISO 17672: 2010 700-790 AG205 Ag 225	2 Flow 0.075-0.2 -50 / 200°C No	
<b>Silver-flo™ 18</b>	Ag Cu Zn Si 18 45.75 36 0.25	Melting Range °C EN1044: 1999 ISO 17672: 2010 784-816 - -	2 Flow 0.075-0.2 -50 / 200°C No	
<b>Silver-flo™ 16</b>	Ag Cu Zn Sn 16 50 34 -	Melting Range °C EN1044: 1999 ISO 17672: 2010 790-830 - -	2 Flow 0.075-0.2 -50 / 200°C No	

### FLUX SELECTION FOR THE SILVER-FLO™ PRODUCTS



For brazing in air it is necessary to use a silver brazing flux in conjunction with the Silver-flo™ filler metals. Silver brazing flux can be applied as a powder, paste, a flux-coated rod or via a brazing paste that contains a flux.

When selecting a flux to match the specific requirements of the application the following points need to be considered:

- ▶ The working range of the flux should be approximately 50°C higher than the liquidus temperature of the filler metal
- ▶ Special Johnson Matthey fluxes have been formulated to improve wetting of the filler metal on certain parent materials (e.g. tungsten carbide, stainless steel)
- ▶ Specific heating methods can give better results if the flux is matched with the heating process
- ▶ Other factors such as the heating time and mass of the components can influence flux selection

Johnson Matthey offers a wide range of fluxes, which can lead to improved joint quality. For more information on fluxes see our flux brochure.



# SILVER-FLO™

## PRODUCTS

### RECOMMENDED USES AND TECHNICAL CONSIDERATIONS

#### Steel (including Stainless Steel)

Silver-flo™ filler metals are ideal for use on steel including carbon and low alloy grades. They can also be used to braze stainless steel, however, care should be taken over the issue of interfacial corrosion in joints exposed to wet service conditions.

##### Specific Issues for Steel and Stainless Steel

Silver-flo™ filler metals containing silicon can be used to braze steel assemblies but can form a brittle intermetallic layer, which might fail under high impact or fatigue stress in service.

Stainless steel tends to overheat causing flux exhaustion, heavy oxidation and lack of wetting.

Silver brazed joints made on stainless steel components can be susceptible to a form of corrosion when the joint is exposed to a wet or aqueous service environment.

##### Recommendations

High silver silicon containing filler metals are not recommended where steel components are subject to high impact or fatigue stress in service - a Silver-flo™ filler metal that does not contain silicon should be specified.

A lower melting point, free flowing product such as Silver-flo™ 56 or Silver-flo™ 55 and a flux such as Easy-flo™ Stainless Steel Grade or Tenacity™ No.5 are recommended.

Interfacial corrosion occurs in silver brazed stainless steel joints exposed to aqueous environments. Special filler metals such as Argo-braze™ 56 or Argo-braze™ 632 are recommended.

#### Copper and Copper Alloys

Silver brazing is a widely used way of joining a range of copper alloys. Brasses are very successfully brazed with Silver-flo™ filler metals. Aluminium bronze, aluminium containing brasses and nickel-silver can be brazed with certain precautions.

##### Specific Issues for Free Machining Brass

When brazing leaded brasses filler metal wetting becomes impaired resulting in poor penetration, which in turn results in the formation of joints containing a high percentage of voids. The degree of voiding may also result in joint leak tightness issues. Joints also show reduced mechanical properties - particularly poor ductility. Leaded brasses are also susceptible to thermal cracking.

High zinc brasses will melt or deform if heated too close to their melting point.

Decorative brassware requires colour matching of the filler metal or neat brazed joints.

##### Recommendations

The problem occurs mostly in brasses with more than 2% lead content. If possible a lower lead content brass should be used. The lower melting filler metals, such as Silver-flo™ 56 or Silver-flo™ 55 are recommended. Additional flux should be used and joint gaps should be opened up to allow for reduced filler metal flow. Joints should be tested to prove that they are of a satisfactory quality.

The use of a filler metal with a liquidus of below 800°C or more than 16% silver content is recommended to avoid damaging the brass during brazing.

Neater more presentable joints are achieved with Silver-flo™ 55 or Silver-flo™ 453S than with lower silver, more brass-coloured products such as Silver-flo™ 24, 20, 18 and 16.

##### Specific Issues for Aluminium Bronze

Brazing of aluminium containing copper alloys directly to carbon steel will result in a brittle joint that will fail.

Standard silver brazing fluxes are not effective on alloys with more than 2% aluminium.

##### Recommendations

Creating a physical barrier by nickel plating the aluminium containing copper alloy component or by using an Argo-braze™ tri-foil will prevent the migration of aluminium through the molten brazing filler metal to the steel where it would cause a brittle joint.

A special flux - Easy-flo™ Aluminium Bronze Grade Flux is recommended for brazing these materials.

#### Nickel Alloys and Cupro-Nickel

These metals can be brazed with Silver-flo™ filler metals provided precautions to avoid stress cracking are taken.

##### Specific Issues for Nickel Alloys and Cupro-Nickel

Nickel alloys and cupro-nickel are susceptible to liquid metal stress cracking as a result of silver brazing with lower temperature filler metals.

##### Recommendations

This cracking is due to intergranular penetration of the filler metal in the parent metal grain boundaries. Stress relieving the components can eliminate the problem, however, if this is not possible Silver-flo™ 60 is recommended to help overcome this issue.

#### Tungsten Carbide and Poly-crystalline Diamond (PCD) Segments

The high silver content Silver-flo™ products are used to braze tungsten carbide or PCD segments to steel.

##### Specific Issues for Tungsten Carbide and PCD

Filler metal wetting and the build up of stress in the tungsten carbide due to the brazing process are important considerations.

PCD will begin to degrade at temperatures above 750°C.

##### Recommendations

Lower melting Silver-flo™ products, such as Silver-flo™ 56 or Silver-flo™ 55, are suitable for use on small pieces of tungsten carbide (less than 10mm in any dimension). Less easy-to-wet grades and/or larger pieces often require a special Argo-braze™ product.

For this reason the lower melting, free flowing Silver-flo™ filler metals are selected. Silver-flo™ 56, Silver-flo™ 55 or Silver-flo™ 452 are recommended.

#### Technical Considerations

##### Silver-flo™ Filler Metals Containing Tin

May be prone to cracking if quenched from high temperatures (in excess of 300°C).

##### Recommendations

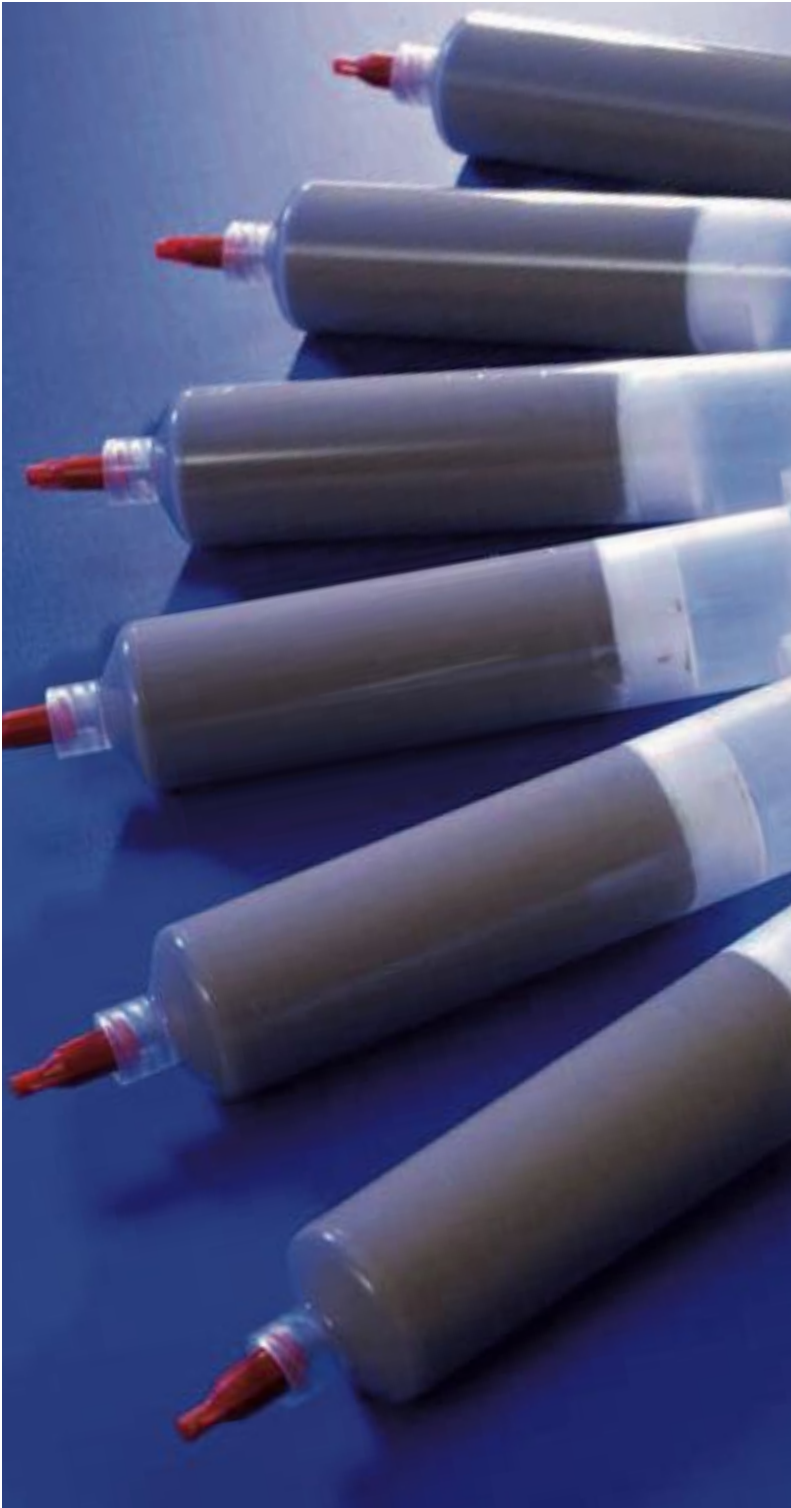
This applies particularly to the low silver, high melting tin containing filler metals. They should not be quenched when brazing components with widely differing coefficients of thermal expansion.

##### When not to use Silver-flo™ Filler Metals.

Silver-flo™ products are not suitable for brazing aluminium, cast iron, titanium or magnesium alloys.

Alu-flo™ products are recommended for aluminium. Argo-braze™ 49H can be used for cast iron alloys.

# SILVER-FLO™





## KEY









### Elements

Ag	Silver
Cu	Copper
Si	Silicon
Sn	Tin
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
	Cadmium-free	

### Properties

	Free flowing filler metal when molten
	Medium flowing filler metal when molten
	Sluggish flowing filler metal when molten
	Optimum joint gap
	Suitable/unsuitable for marine applications
	Aerospace approval
	Tensile/shear strength Mpa*
	Service temperature
	Cadmium-free product contains < 0.010% cadmium

\* Please note that the tensile/shear strength data provided refers to the alloy strength in the cast condition. It does not directly relate to the strength of a brazed joint. Joint strength is more directly a function of factors such as the joint design and brazing process.

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