

# Stainless Steels

DATA SHEET

**B-51**

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## 309Mo STAINLESS STEELS

### Alloy type

23%Cr-13%Ni-2.5%Mo (309Mo) austenitic stainless steel.

### Materials to be welded

Mainly used under high dilution conditions, particularly dissimilar welds between stainless and CMn steels. There are no comparable base materials.

### Applications

There are 3 main areas of application:

**Buffer layers and clad steels:** Overlays on CMn, mild steel or low alloy steels and for joining 316L clad plate. Subsequent layers are deposited with an electrode chosen to match the cladding, eg 316L, 318. Also as a buffer layer prior to hardsurfacing with chromium carbide types.

**Dissimilar joints:** Tolerance to dilution is exploited in joining stainless types 410, 304L, 321 and 316L to mild and low alloy steels such as stiffeners, brackets and other attachments. Service temperatures above 300°C are normally avoided. For some of these applications a more economic alternative may be suitable, eg 309L, 307.

**Hardenable steels:** The high level of alloying and ferrite level tolerates dilution from a wide range of alloyed and hardenable steels to give crack-free welds.

### Microstructure

Austenite with ferrite normally in the range 10-30FN.

### Welding guidelines

Preheat and interpass temperatures depend on base material hardenability. For guidance, no preheat on mild steels, up to 250°C on hardenable steels.

### Additional information

There is a Technical Profile available on sub-arc welding with 309Mo. There is also additional information available covering the Supercore flux cored wires.

### Related Alloy Groups

The 309L consumables (B-50), 307 consumables (E-21) and 29.9 consumables (E-22) cover a similar range of applications.

### Products Available


Process	Product	Specification
MMA	<b>Supermet 309Mo</b>	AWS E309LMo-17
	<b>Ultramet B309Mo</b>	AWS E309LMo-15
	<b>Vertamet 309Mo</b>	AWS E309LMo-17
TIG/MIG/SAW	<b>ER309Mo</b>	BS EN 23 12 2 L
SAW flux	<b>SS300</b>	BS EN SA AF 2
	<b>SSB</b>	BS EN SA AF 2
FCW	<b>Supercore 309Mo</b>	AWS E309LMoT0-1/4
	<b>Supercore 309MoP</b>	AWS E309LMoT1-1/4

## General Data for all MMA Electrodes

<b>Storage</b>	<p><b>3 hermetically sealed ring-pull metal tins</b> per carton, with unlimited shelf life. Direct use from tin is satisfactory for longer than a working shift of 8h. Excessive exposure of electrodes to humid conditions will cause some moisture pick-up and increase the risk of porosity.</p> <p>For electrodes that have been exposed:</p> <p><b>Redry</b> 200 – 300°C/1-2h to restore to as-packed condition. Maximum 400° C, 3 cycles, 10h total.</p> <p><b>Storage</b> of redried electrodes at 50 – 200°C in holding oven or heated quiver: no limit, but maximum 6 weeks recommended. Recommended ambient storage conditions for opened tins (using plastic lid): &lt; 60% RH, &gt; 18°C.</p>														
<b>Fume data</b>	<p>Fume composition, wt % typical:</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Fe</th> <th>Mn</th> <th>Ni</th> <th>Cr</th> <th>Cu</th> <th>F *</th> <th>OES (mg/m<sup>3</sup>)</th> </tr> </thead> <tbody> <tr> <td>9</td> <td>6</td> <td>1</td> <td>7</td> <td>&lt; 0.5</td> <td>17</td> <td>0.7</td> </tr> </tbody> </table> <p>* F=28% for basic coated Ultramet B309Mo but this does not affect the OES.</p>	Fe	Mn	Ni	Cr	Cu	F *	OES (mg/m <sup>3</sup> )	9	6	1	7	< 0.5	17	0.7
Fe	Mn	Ni	Cr	Cu	F *	OES (mg/m <sup>3</sup> )									
9	6	1	7	< 0.5	17	0.7									

## SUPERMET 309Mo

General purpose rutile 309Mo MMA electrode

<b>Product description</b>	Acid rutile electrode made on nearly matching austenitic steel core wire. Moisture resistant coating gives sound porosity-free deposits. Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.											
<b>Specifications</b>	<b>AWS A5.4</b>	E309LMo-17										
	<b>BS EN 1600</b>	E 23 12 2 L R 32										
	<b>BS 2926</b>	23.12.2.AR										
	<b>DIN 8556</b>	E 23 12 2 R 23										
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 5, <b>QW442</b> A-No 8											
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN	
	min	--	0.5	--	--	--	22.0	12.0	2.0	--	10	
	max	0.04	2.5	0.9	0.025	0.030	25.0	14.0	3.0	0.5	30	
	typ	0.02	0.8	0.6	0.01	0.02	23.5	12.5	2.5	0.05	25	
<b>All-weld mechanical properties</b>	As welded					min	typical					
	Tensile strength					MPa	560	680				
	0.2% Proof stress					MPa	350	510				
	Elongation on 4d					%	30	37				
	Elongation on 5d					%	30	35				
	Reduction of area					%	--	40				
	Impact energy					+ 20°C	J	--	50			
	Hardness					HV	--	220				
<b>Operating parameters</b>	DC +ve or AC (OCV: 50V min)											
	ø mm	2.5			3.2	4.0		5.0				
	min A	60			75	100		130				
	max A	90			120	155		210				
<b>Packaging data</b>	ø mm	2.5			3.2	4.0		5.0				
	length mm	300			350	450		450				
	kg/carton	12.0			13.2	18.9		18.0				
	pieces/carton	609			336	261		162				

## ULTRAMET B309Mo

309Mo basic coated MMA pipe-welding electrode

<b>Product description</b>	Basic coated electrode on high purity 304L core wire manufactured to order. Designed to give moisture resistance and hence freedom from weld porosity. Recovery is about 120% with respect to core wire, 65% with respect to whole electrode.										
<b>Specifications</b>	<b>AWS A5.4</b>	E309LMo-15									
	<b>BS EN 1600</b>	E 23 12 2 L B 42									
	<b>BS 2926</b>	23.12.2.B									
	<b>DIN 8556</b>	E 23 12 2 B 20+									
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 5, <b>QW442</b> A-No 8										
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN
	min	--	0.5	--	--	--	22.0	12.0	2.0	--	12
	max	0.04	2.5	0.90	0.025	0.030	25.0	14.0	3.0	0.50	36
	typ	0.03	0.8	0.6	0.01	0.02	23.5	13	2.6	0.1	20
<b>All-weld mechanical properties</b>	As welded					min	typical				
	Tensile strength					MPa	560	680			
	0.2% Proof stress					MPa	350	510			
	Elongation on 4d					%	30	37			
	Elongation on 5d					%	30	35			
	Reduction of area					%	--	40			

## ULTRAMET B309Mo (continued)

<b>Operating parameters</b>	DC +ve			
	ø mm	3.2	4.0	
	min A	75	100	
	max A	120	155	
<b>Packaging data</b>	ø mm	3.2	4.0	Note: Product available to order only.
	length mm	350	350	
	kg/carton	15.0	14.1	
	pieces/carton	420	273	

## VERTAMET 309Mo

Rutile vertical-down electrode for dissimilar welds

<b>Product description</b>	<p>Rutile-aluminosilicate flux on high purity 309L core wire giving very low typical carbon levels. 'Low hydrogen' manufacturing technology ensures high resistance to weld metal porosity. The electrode is designed for all-positional use where the emphasis is on fast welding speeds achieved by the vertical-down welding technique (BS EN 287-1 PG position). For fillet and lap joints in thinner sheet material, an added advantage is reduced distortion resulting from the lower heat input of vertical-down welding. Although designed primarily for vertical-down it can be successfully used in all other positions.</p> <p>Recovery is about 110% with respect to core wire, 65% with respect to whole electrode.</p>										
<b>Specifications</b>	<b>AWS A5.4</b>		E309LMo-17								
	<b>BS EN 1600</b>		E 23 12 2 L R 11								
	<b>BS 2926</b>		23.12.2.AR								
	<b>DIN 8556</b>		E 23 12 2 R 13								
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 5, <b>QW442</b> A-No 8										
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN
	min	--	0.5	--	--	--	22.0	12.0	2.0	--	10
	max	0.04	2.5	0.90	0.025	0.030	25.0	14.0	3.0	0.5	30
	typ	0.02	0.8	0.8	0.01	0.02	23	12	2.4	0.1	15
<b>All-weld mechanical properties</b>	As welded					min		typical			
	Tensile strength					MPa		560		580	
	0.2% Proof stress					MPa		350		380	
	Elongation on 4d					%		30		42	
	Elongation on 5d					%		30		38	
	Reduction of area					%		--		50	
<b>Operating parameters</b>	DC +ve or AC (OCV: 45V min)										
		ø mm	2.5		3.2						
		min A	60		75						
		max A	90		120						
		Typical vertical-up	~65		~80						
		Typical vertical-down	~85		~110						
		ø mm	2.5		3.2						
length mm		300		300							
kg/carton	12.9		12.9								
pieces/carton	837		450								

# ER309Mo

Solid 309Mo wire for TIG, MIG and SAW

<b>Product description</b>	Solid wire for TIG, MIG and SAW.																																										
<b>Specifications</b>	<b>AWS A5.9</b> (nearest ER309LMo) <b>BS EN ISO 14343-A</b> 23 12 2 L <b>BS EN ISO 14343-B</b> (nearest SS309LMo) <b>BS 2901: Pt2</b> (nearest 309S95) <b>DIN 8556</b> SG X8 CrNiMo 23 13 (1.4459)																																										
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 6, <b>QW442</b> A-No 8																																										
<b>Composition (wire wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN																																
	min	--	1.0	0.30	--	--	21.0	12.0	2.0	--	5																																
	max	0.03	2.5	0.65	0.02	0.030	25.0	15.0	3.0	0.3	20																																
	typ	0.015	1.7	0.5	0.005	0.015	22	14.5	2.7	0.2	10																																
<b>All-weld mechanical properties</b>	Typical values as welded <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="2"></th> <th colspan="2">TIG</th> </tr> </thead> <tbody> <tr> <td>Tensile strength</td> <td>MPa</td> <td colspan="2">610</td> </tr> <tr> <td>0.2% Proof stress</td> <td>MPa</td> <td colspan="2">440</td> </tr> <tr> <td>Elongation on 4d</td> <td>%</td> <td colspan="2">35</td> </tr> <tr> <td>Elongation on 5d</td> <td>%</td> <td colspan="2">31</td> </tr> <tr> <td>Reduction of area</td> <td>%</td> <td colspan="2">54</td> </tr> <tr> <td>Impact energy</td> <td>+ 20°C J</td> <td colspan="2">&gt; 90</td> </tr> <tr> <td>Hardness cap/mid</td> <td>HV</td> <td colspan="2">205/220</td> </tr> </tbody> </table>													TIG		Tensile strength	MPa	610		0.2% Proof stress	MPa	440		Elongation on 4d	%	35		Elongation on 5d	%	31		Reduction of area	%	54		Impact energy	+ 20°C J	> 90		Hardness cap/mid	HV	205/220	
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<b>Typical operating parameters</b>		TIG		MIG		SAW																																					
	Shielding	Argon		Ar+2%O <sub>2</sub> *		SS300 **																																					
	Current	DC-		DC+		DC+																																					
	Diameter	2.4mm		1.2mm		2.4mm																																					
	Parameters	100A, 12V		260A, 26V		350A, 28V																																					
	* Proprietary Ar and Ar-He gas mixtures with <3%CO <sub>2</sub> , also suitable. ** <b>SSB, L2N</b> and <b>LA491</b> also suitable.																																										
<b>Packaging data</b>	ø mm	TIG		MIG		SAW																																					
	1.2	--		15kg spool		--																																					
	1.6	2.5kg tube		--		--																																					
	2.0	2.5kg tube		--		--																																					
	2.4	2.5kg tube		--		25kg coil																																					
	3.2	2.5kg tube		--		25kg coil																																					
<b>Fume data</b>	MIG fume composition (wt %) (TIG and SAW fume negligible)																																										
		Fe	Mn	Cr <sup>3</sup>	Ni	Mo	Cu	OES (mg/m <sup>3</sup> )																																			
		32	12	20	11	1.5	<0.5	2.5																																			

# SUPERCORE 309Mo, 309MoP

Rutile flux cored wires for dissimilar welding

<b>Product description</b>	<p>Flux cored wires made using an austenitic stainless steel sheath and rutile flux system. <b>Supercore 309Mo</b> combines easy operability, high deposit quality and exceptional weld bead appearance for downhand and HV welding. <b>Supercore 309MoP</b> is designed for all-positional welding.</p> <p>Metal recovery is about 90% with respect to wire.</p>																										
<b>Specifications</b>	<b>AWS A5.22</b> <b>BS EN ISO 17633-A</b> <b>BS EN ISO 17633-B</b>			<b>Supercore 309Mo</b> E309LMoT0-1/4 T 23 12 2 L R C/M 3 TS309LMo-FB0				<b>Supercore 309MoP</b> E309LMoT1-1/4 T 23 12 2 L P C/M 2 TS309LMo-FB1																			
<b>ASME IX Qualification</b>	<b>QW432</b> F-No 6, <b>QW442</b> A-No 8																										
<b>Composition (weld metal wt %)</b>		C	Mn	Si	S	P	Cr	Ni	Mo	Cu	FN																
	min	--	0.5	--	--	--	22.0	12.0	2.0	--	15																
	max	0.04	2.0	1.0	0.025	0.030	25.0	14.0	3.0	0.3	25																
	typ	0.03	1.3	0.7	0.01	0.02	23	12.8	2.3	0.1	20																
<b>All-weld mechanical properties</b>	As welded					min		typical																			
	Tensile strength					MPa	550	700																			
	0.2% Proof stress					MPa	350	550																			
	Elongation on 4d					%	25	32																			
	Elongation on 5d					%	25	30																			
	Reduction of area					%	--	40																			
	Impact energy					+20°C J	--	50																			
	Hardness					HV	--	245																			
<b>Operating parameters</b>	<p><b>Shielding gas:</b> 80%Ar-20%CO<sub>2</sub> or 100% CO<sub>2</sub> at 20-25l/min. Proprietary gases may be used but argon should not exceed 85%.</p> <p><b>Current:</b> DC+ve ranges as below for Ar-20%CO<sub>2</sub>. Welding with 100%CO<sub>2</sub> requires approx 3V higher:</p> <table border="1"> <thead> <tr> <th>ø mm</th> <th>amp-volt range</th> <th>typical</th> <th>stickout</th> </tr> </thead> <tbody> <tr> <td>1.2</td> <td>120A-22V to 280A-34V</td> <td>180A-29V</td> <td>15-20mm</td> </tr> <tr> <td>1.2P</td> <td>120A-22V to 250A-32V</td> <td>160A-26V</td> <td>15-20mm</td> </tr> </tbody> </table>											ø mm	amp-volt range	typical	stickout	1.2	120A-22V to 280A-34V	180A-29V	15-20mm	1.2P	120A-22V to 250A-32V	160A-26V	15-20mm				
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1.2	120A-22V to 280A-34V	180A-29V	15-20mm																								
1.2P	120A-22V to 250A-32V	160A-26V	15-20mm																								
<b>Packaging data</b>	<p>Spools vacuum-sealed in barrier foil with cardboard carton: 15kg</p> <p>The as-packed shelf life is virtually indefinite.</p> <p>Resistance to moisture absorption is high, but to maintain the high integrity of the wire surface and prevent any possibility of porosity, it is advised that part-used spools are returned to polythene wrappers.</p> <p>Where possible, preferred storage conditions are 60% RH max, 18°C min.</p>																										
<b>Fume data</b>	<p>Fume composition (wt %)</p> <table border="1"> <thead> <tr> <th>Fe</th> <th>Mn</th> <th>Ni</th> <th>Cr<sup>3</sup></th> <th>Cr<sup>6</sup></th> <th>Cu</th> <th>F</th> <th>OES (mg/m<sup>3</sup>)</th> </tr> </thead> <tbody> <tr> <td>16</td> <td>11</td> <td>3</td> <td>4</td> <td>6</td> <td>&lt;1</td> <td>6</td> <td>0.8</td> </tr> </tbody> </table>											Fe	Mn	Ni	Cr <sup>3</sup>	Cr <sup>6</sup>	Cu	F	OES (mg/m <sup>3</sup> )	16	11	3	4	6	<1	6	0.8
Fe	Mn	Ni	Cr <sup>3</sup>	Cr <sup>6</sup>	Cu	F	OES (mg/m <sup>3</sup> )																				
16	11	3	4	6	<1	6	0.8																				