

WEARTECH® SHS™ 9700U

Severe Abrasion, Flux-Cored (FCAW-S) Wire

Application Process

FCAW-S/GMAW-C

Weld Overlay for Hardfacing

Material Chemistry (wt%)

Chromium	< 18%
Boron	< 6%
Aluminum	< 5%
Niobium	< 10%
Carbon	< 3%
Manganese	< 2%
Silicon	< 2%
Iron	Balance

Rockwell C (HRC) Hardness

67 - 70 HRC typical

Wear Resistance

ASTM G65-04 Procedure A
typical 0.13g mass loss

Weld Deposit Properties

Density (g/cm³) 7.36

Impact Resistance

Drop Impact Testing:
Passed multiple impacts
at 165 ft-lbs

Overlay Description

SHS9700U is an iron based steel alloy with a near nanoscale (submicron) microstructure that features exceptional abrasive wear resistance with superior toughness and no high-cost nickel, tungsten and molybdenum in material chemistry.

Key Performance Characteristics

- 67 - 70 HRC single and double pass weld deposits
- Cost effective: contains no tungsten, molybdenum and nickel
- Provides exceptional wear resistance lasting significantly longer than most chrome carbide and complex carbide alloys
- High resistance to abrasion while maintaining high toughness
- Crystalline microstructure is engineered to submicron (400 nm) size
- Maintains high hardness after exposure to elevated temperatures

SHS9700U is a multicomponent steel alloy with a unique uniform glass-forming melt chemistry that allows high undercooling to be achieved during welding. This results in considerable refinement of the crystalline microstructure down to a near nanosize (submicron) range. Unlike conventional weld overlay materials which are macrocomposites containing hard particles and general carbides in a binder, the refined microstructure of SHS9700U is a uniformly hard matrix when welded and does not incorporate distinct hard particles in a binder. This allows SHS9700U to provide vastly improved hardness and wear resistance that lasts significantly longer than conventional macrocomposites. Additionally, SHS9700U is an iron-based alloy without tungsten carbide particulates.

High Hardness

The micrograph to the right shows how 69 HRC hardness develops within microns of the SHS9700U weld overlay interface. HRC hardness values in the micrograph were measured from a single pass SHS9700U weld overlay applied to A36 steel substrate.

High Wear Resistance

SHS9700U can be built up in as many weld passes as necessary with the second and subsequent layers providing maximum wear resistance of typical 0.13g mass loss in ASTM G65-04 Abrasion Tests.

Damage Tolerance

The superior toughness of SHS9700U occurs from the in-situ formation of high-volume fraction of refined complex borocarbide phases during welding which are surrounded by ductile phases. The borocarbide phases, which form during solidification, are completely wetted by the matrix and prevent premature pull-out, delamination and crack nucleation. The refined nature of the borocarbide phases allows the reduction of stress concentration sites and the ductile matrix supplies effective crack blunting and bridging.

Hardness as a Function of Heat Treatment

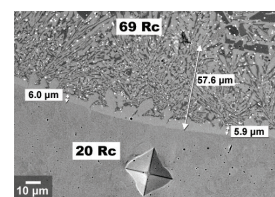
The effect of exposure to elevated temperature for SHS9192U and SHS9700U wires can be seen in the figure to the right. SHS9192U retains its hardness very well through temperatures of 1,000°F with only a small drop from the as welded hardness. SHS9700U shows a larger drop initial drop in hardness but it then stays above 61 HRC through 1,000°F.

Weld Parameters

Industrial Uses

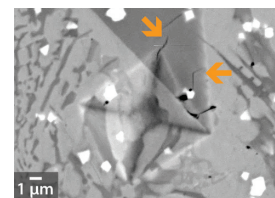
Mining

HRC Hardness



400mm length, near nanoscale micro structure

Superior Toughness



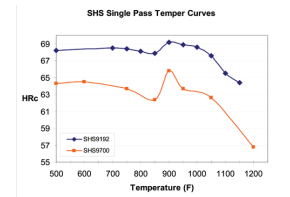
SEM image of Bickers indentation shows cracks are quickly blunted and stopped by the ductile matrix

WEARTECH® SHS™ 9700U

Severe Abrasion, Flux-Cored (FCAW-S) Wire

Weld parameters for SHS9700U wire variations listed in the following table produce very good weld overlays with a short arc-length resulting in smooth beads with good arc transfer in the short arc and small globular range. Stress relief cracking can be reduced by increasing preheat. All wire versions are designed to weld without porosity. When using recommended parameters, spatter can be kept to a minimum resulting in deposit efficiencies over 95%. High-weave speeds and wide-weave patterns are possible allowing for a wide range of overlay solutions. Additionally, SHS9700U exhibits exceptional multi-pass characteristics and can be welded to at least four passes allowing deposits up to 0.5 in thickness. The SHS9700U16 wire can be welded out of position on surfaces up to 90 degrees by stacking horizontal stringer beads. SHS9700U exhibits a density within the range of existing steels of 7.36 g/cm³. SHS 9700 weld overlays are ferromagnetic, extremely hard and tough and can be machined by high-speed grinding. Without using preheat, normal stress relief cracks will form and are generally spaced from 3/4 - 1 in.

Hardness After Heat Treatment



High hardness is retained after exposure to elevated temperatures

CUSTOMER ASSISTANCE POLICY

The Lincoln Electric Company is manufacturing and selling high quality welding equipment, consumables, and cutting equipment. Our challenge is to meet the needs of our customers and to exceed their expectations. On occasion, purchasers may ask Lincoln Electric for information or advice about their use of our products. Our employees respond to inquiries to the best of their ability based on information provided to them by the customers and the knowledge they may have concerning the application. Our employees, however, are not in a position to verify the information provided or to evaluate the engineering requirements for the particular weldment. Accordingly, Lincoln Electric does not warrant or guarantee or assume any liability with respect to such information or advice. Moreover, the provision of such information or advice does not create, expand, or alter any warranty on our products. Any express or implied warranty that might arise from the information or advice, including any implied warranty of merchantability or any warranty of fitness for any customers' particular purpose is specifically disclaimed.

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WEARTECH® SHS® 9700U

Severe Abrasion

KEY FEATURES

- Lower cost while maintaining near nanoscale (submicron) microstructure
- Provides exceptional wear resistance lasting significantly longer than most chrome carbide and complex carbide alloys
- Maintains high hardness after exposure to elevated temperature
- Limited to 2 layers max

TYPICAL APPLICATIONS

- Wearplate
- Ore Chutes
- Crusher Rolls
- Screw Augers

DIAMETERS / PACKAGING

Diameter in (mm)	33 lb (15 kg) Spool	33 lb (15 kg) Spool PLW	55 lb (25 kg) Coil	500 lb (227 kg) Speed Feed Drum
0.045 (1.1)	ED035659	ED035658		
1/16 (1.6)	ED035656	ED035657		
3/32 (2.4)			ED035655	
7/64 (2.8)			ED035654	ED035857

MECHANICAL PROPERTIES⁽¹⁾

Rockwell Hardness (R _c)	Wear Resistance
67-70	ASTM G65-04 Procedure A 0.13 g mass loss

DEPOSIT COMPOSITION⁽¹⁾

	%Fe	%C	%Cr	%B	%Nb	%Al	%Mn	%Si
Requirements	Balance	<3	<18	<6	<10	<5	<2	<2

TYPICAL OPERATING PROCEDURES

Diameter, Polarity ESO - in (mm)	Current (Amps)	Voltage (Volts)	Wire Feed Speed m/min (ipm)	Shielding Gas	Flow Rate (cfh)
0.045 in (1.1mm), DC+ ½ - ¾ (15) GMAW-C ¾ - 1 (20) FCAW-S	~135	24	7.0 (275)	75 Ar - 25 CO ₂	35 - 45
1/16 in (1.6mm), DC+ ½ - ¾ (15) GMAW-C ¾ - 1 (20) FCAW-S	~220	24	7.0 (275)	75 Ar - 25 CO ₂	45 - 60
3/32 in (2.4mm), DC+ ¾ - 1 (20) GMAW-C ¾ - 1.25 (25) FCAW-S	~375	25	7.0 (275)	75 Ar - 25 CO ₂	55 - 70
7/64 in (2.8mm), DC+ ¾ - 1 (20) GMAW-C 1 - 1¼ (40) FCAW-S	~450	26	5.7 (225)	75 Ar - 25 CO ₂	60 - 80

⁽¹⁾ Composition and properties depend upon dilution. Single layer deposit properties depend upon base metal and/or build-up material.

<p>IMPORTANT: SPECIAL VENTILATION AND/OR EXHAUST REQUIRED</p> <p>Fumes from the normal use of some welding products can contain significant quantities of components - such as chromium and manganese - which can lower the 5.0 mg/m³ maximum exposure guideline for general welding fume.</p> <p>BEFORE USE, READ AND UNDERSTAND THE MATERIAL SAFETY DATA SHEET (MSDS) FOR THIS PRODUCT AND SPECIFIC INFORMATION PRINTED ON THE PRODUCT CONTAINER.</p>
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Material Safety Data Sheets (MSDS) and Certificates of Conformance are available on our website at www.lincolnelectric.com

TEST RESULTS

Test results for mechanical properties, deposit or electrode composition and diffusible hydrogen levels were obtained from a weld produced and tested according to prescribed standards, and should not be assumed to be the expected results in a particular application or weldment. Actual results will vary depending on many factors, including, but not limited to, weld procedure, plate chemistry and temperature, weldment design and fabrication methods. Users are cautioned to confirm by qualification testing, or other appropriate means, the suitability of any welding consumable and procedure before use in the intended application.

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