WEARTECH® SHS™9192U

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

Application Process

FCAW-S/GMAW-C

Weld Overlay for Hardfacing

Material Chemistry (wt%)

Chromium	< 20%
Molybdenum	< 10%
Niobium	< 10%
Tungsten	< 10%
Aluminum	< 5%
Boron	< 5%
Carbon	< 5%
Manganese	< 5%
Silicon	< 2%
Iron	Balance

Rockwell C (HRC) Hardness

69 - 72 HRC Typical

Wear Resistance

ASTM G65-04 Procedure A

Typical mass lost of 0.10g

Weld Deposit Properties

Density (g/cm³) 7.68

Impact Resistance

Drop Impact Testing:

Passed multiple impacts at 165 ft-lbs

Overlay Description

SHS9192U is an iron based steel alloy with a near nanoscale (submicron) microstructure that features extreme abrasion resistance with high toughness, high volume of hard phases and superior high temperature hardness. SHS9192U is an alternative to chrome and tungsten carbides.

Key Performance Characteristics

- 69 - 72 HRC single and double pass weld deposits
- Extreme resistance to abrasion while maintaining high toughness
- Alternative weld material to:
  - Tungsten carbides
  - Chrome carbides
  - Complex carbides
  - Stick weld material loaded with carbides
  - Tungsten carbide laden Teflon® sheet overlays
- Maintains high hardness after exposure to high temperatures

SHS9192U represents a breakthrough in the development of hardfacing wires due to its ability to survive in extreme environments. SHS9192U is a patented multicomponent, glass-forming iron-based steel alloy designed to replace and be superior to existing cored wire products including chrome carbide, complex carbides and tungsten carbides; stick weld material loaded with carbides; and tungsten carbide laden Teflon® sheet overlays traditionally used for high abrasion environments. When applied as a weld overlay, SHS9192U deposits provide extreme resistance to abrasion while maintaining high toughness. While conventional weld overlay materials are macrocomposites containing hard particles and general carbides in a binder, SHS9192U is unique since it starts with a uniform glass-forming melt chemistry which allows high undercooling to be achieved during welding. This results in considerable refinement of the microstructure down to the micron and submicron range.

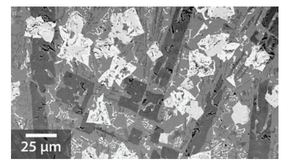
Extreme Abrasion Resistance

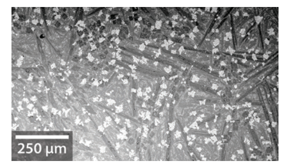
SHS9192U exhibits extreme abrasion resistance through the in situ formation of high volume fractions (i.e. 60% - 70%) of complex borocarbide phases. Conventional approaches to wire design incorporate hard particles in the core of the wire and are limited volumetrically to much lower fractions of hard particles which limit their wear performance. In wear resistance testing, typical mass loss of 0.10g in ASTM G65-04 abrasion tests for SHS9192U is revolutionary in a weld wire product. This unmatched wear performance allows SHS9192U to be used as an alterative for some severe wear applications currently dominated by 60% tungsten carbide PAW materials, the previous benchmark weld material for wear performance.

Industrial Uses

Mining

Structure





400mm length, near nanoscale microstructure

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Single Pass Hardness/Wear Resistance

SHS9192U has been engineered so that while the same levels of dilution can be expected (~ 30%) based on the application method, the dilution layer itself retains maximum hardness and wear resistance after a short distance from the weld overlay interface (i.e. within 100 µm). This allows maximum hardness/wear resistance to develop in the first weld overlay pass while conventional weld materials need two or more passes to generate their best wear characteristics. Elevated temperature hardness measurements have shown 680 Vickers hardness (60 HRC) is maintained at 1100°F showing that SHS9192U exhibits superior elevated temperature hardness. SHS 9192U overlays should be limited to two layers for typical applications

High Deposition Rate

SHS9192U does not rely on the incorporation of hard particles in the interior of the sheath, but instead high volume fractions of borocarbide phases form in situ during welding. This allows high amperage and wire feed rates to be used during the weld overlay process. Competing tungsten carbide wire materials often specify much lower feed rates due to carbide breakdown and dissolution which limits deposition rate and increases costs.

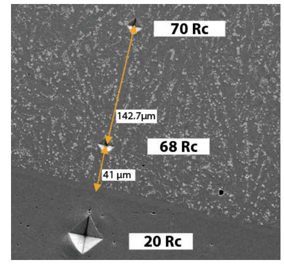
Superior Combinations of Wear Resistance and Toughness

Superior wear resistance of SHS9192U occurs from the in situ formation of high volume fraction of refined complex borocarbide 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, which consists of α-Fe and α-Fe phases, supplies effective crack blunting and bridging.

Hardness as a Function of Heat Treatment

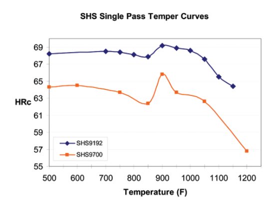
The effect of exposure to elevated temperature for SHS9192U and SHS9700U wires can be seen in the figure to the right. SHS9192U retains its hardness very well through temperatures of 1,000°F with only a small drop from the as welded hardness. SHS9700U shows a larger drop initial drop in hardness but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

HRC Hardness



Properties such as hardness are developed within microns of the weld interface

Hardness After Heat Treatment



High hardness is retained after exposure to elevated temperatures

The Lincoln Electric Company

22081 St. Clair Avenue ▪ Cleveland, OH ▪ 44117 ▪ U.S.A.

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