

# WEARTECH® SHS™ 9290P

Severe Abrasion, (PAW) Weld Power

## Application Process

PAW Powder for  
Weld Overlay for Hardfacing

## Material Chemistry (wt%)

Chromium	< 20%
Tungsten	< 15%
Boron	< 10%
Molybdenum	< 10%
Niobium	< 10%
Carbon	< 5%
Manganese	< 5%
Vanadium	< 5%
Silicon	< 2%
Iron	< 18%

## Rockwell C (HRC) Hardness

71 - 74 HRC

## Wear Resistance

ASTM G65-04 Procedure A  
Typical mass loss 0.08g

## Weld Deposit Properties

Density (g/cm³)	7.72
Deposition	
Efficiency	80 - 85%

## Impact Resistance

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

## Overlay Description

SHS9290P is an iron based steel alloy with a near nanoscale (submicron) microstructure that features extreme wear and abrasion resistance with high toughness. SHS9290P is an alternative to 65% tungsten carbide PAW materials.

## Key Performance Characteristics

- 71 - 74 HRC hardness
- Extreme resistance to abrasion while maintaining significant toughness
- Alternative to 65% tungsten carbide PAW materials
- Provides exceptional uniformity of hardness and wear performance across a range of service environments

SHS9290P represents a technical leap in the development of advanced PAW hardfacing powders since it contains no added tungsten carbide, no nickel and no separate matrix. SHS9290P is designed to replace and be superior to existing PAW powders, including industry standard nickel/chromium/boron/silicon types laden with up to 65% tungsten carbide, traditionally used for extreme abrasion resistance. When applied as a PAW weld overlay, homogenous deposits are produced with extreme resistance to abrasion while maintaining significant toughness. The as-welded deposits contain a high proportion of submicron and near-nano borocarbide phases formed during solidification providing exceptional uniformity of hardness and wear performance across a range of wear environments.

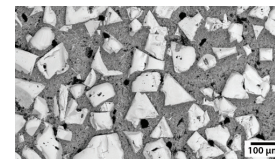
## Microstructural Refinement

SHS9290P allows high undercooling to be achieved prior to nucleation and growth. This results in significant refinement of the microstructure over conventional alloys solidifying via conventional liquid solidification growth modes. SEM backscattered electron micrographs (right) illustrate the differences in the microstructural scale of PAW hardfacing deposits. SHS9290P exhibits complex borocarbide phase scales which are much finer than 65% angular tungsten carbide or 60% spherical tungsten carbide deposits. This reduced microstructural scale promotes a highly uniform wear rate throughout the volume of the SHS9290P deposit. The highly refined (submicron) structure of SHS9290P makes the weld overlay deposit much more resistant to fine particle abrasion and erosion since the scale of the microstructure is finer than typical wear erodents (i.e., debris and particles). In contrast, the large scale of angular or spherical tungsten carbide particles in competing materials can lead to preferential wear of the matrix and cracking/pull-out of the hard tungsten carbide particulates.

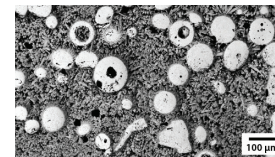
## Industrial Uses

Mining

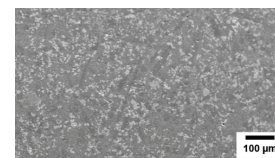
## SEM Micrographs



PAW deposit with 65% angular tungsten carbide particles



PAW deposit with 60% spherical tungsten carbide particles



SHS9290P deposit with highly refined microstructure

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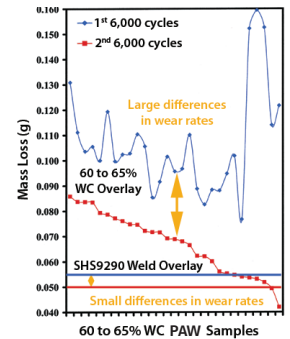
## Extreme Abrasion/Erosion Resistance

SHS9290P is designed to exhibit extreme abrasion/erosion resistance resulting from its unique structure consisting of high volume fractions (i.e. 60% - 70%) of highly refined complex borocarbide phases that result in extreme hardness of 71 - 74 HRC in hardfacing deposits. In the table to the right, ASTM G65-04 Procedure A wear testing shows a large number of wear results on 60 - 65% tungsten carbide PAW weld overlay samples as compared to SHS9290P weld overlay samples. Wear resistance can vary widely for tungsten carbide PAW materials due to tungsten carbide breakdown and dissolution during welding, and non-uniform distribution of tungsten carbide particles in the deposit as a result of size and density differences during welding. However, typical SHS9290P wear rates are low and exhibit little difference between the first and second 6,000 cycle tests based on the uniform and refined scale of the microstructure.

## Uniform Wear Performance

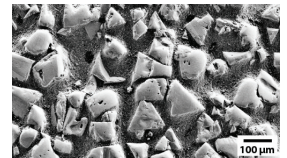
The SEM secondary electron images of 65% angular tungsten carbide PAW, 60% spherical tungsten carbide PAW and SHS9290P weld deposits were taken in the wear scar after 12,000 total cycles of ASTM G65-04 testing. When comparing the SHS9290P deposit surface to the surface of angular and spherical tungsten carbide deposits, the wear is uniform across the SHS9290P deposit while the matrix in the two tungsten carbide deposits is being preferentially worn out due to the non-homogenous nature of these deposits.

## ASTM G65-04 Wear Tests

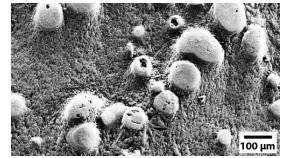


SHS9290P wear rates are low and consistent while 60 - 65% tungsten carbide rates are high and vary widely

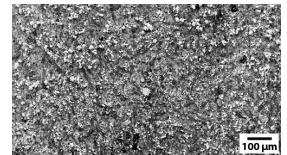
## SEM Micrographs



Wear scar with 65% angular tungsten carbide particles



Wear scar with 60% spherical tungsten carbide particles



Wear scar with SHS9290P highly refined microstructure

## SHS9290P PAW Hardness



Double pass overlays welded onto A36 steel with 73.1 HRC average

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