

VeriClean

VERIFLO'S CUSTOM LOW SULFUR 316 VAR

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VeriClean, the standard material of construction for all Veriflo Corporation stainless products, with its tightly specified chemistry and mill processing, is a highly uniform, cost-effective material, tailored to the needs of the semiconductor industry.

Introduction

Standard steel industry 316L specifications are not stringent enough for the needs of Veriflo Corporation and its customers. Veriflo initiated a program to phase out all of its standard 316 L stainless steel and replace it with a custom low sulfur 316L "VeriClean" in the third quarter of 1990. The new material also includes Vacuum Arc Remelt (VAR), a process used to purify ingots of stainless steel to the levels required by the semiconductor industry.

Why VeriClean Is Better Than Competitive Material

VeriClean offers a cost effective optimization of properties specific to the needs of the semiconductor industry. Optimization is accomplished through alloy enhancement as well as tighter tolerances for melt chemistry and mill practice.

The result is improved pitting resistance to chlorides and related gases, consistently superior mechanical properties and good welding characteristics. VeriClean starts out with the maximum typical sulfur content of .005 or less percent. Low sulfur content is desirable in austenitic stainless steel because it reduces the amount of sulfur available to form manganese sulfide, a non-metallic inclusion responsible for the initiation of corrosion pitting. Corrosion pitting is the dominant corrosion mechanism in austenitic stainless steels, particularly in chloride and related environments.

Chemical Composition 316L Stainless Steel

Element	ASTM* Composition (AOD & VAR)	Typical VeriClean VAR Composition
C	.03 max	.015%
N	0.1 max	.03%
S	.03 max	<.005%
P	.045 max	.015%
Si	1.00 max	0.5%
Ni	10.0 to 14.0	13.2%
Cr	16.0 to 18.0	17.25%
Mo	2.0 to 3.0	2.75%
Mn	2.0 max	1.00%

Figure 1 Source: ASTM A276

Welding

Unfortunately, lowering the sulfur content in 316 stainless steel also has the side effect of lowering the weld puddle fluidity. This is very undesirable, as it results in a decreased weld penetration in relation to the weld width. VeriClean overcomes the poor welding characteristics of low sulfur stainless steels by specifying aluminum, calcium and titanium down to the limits of detection. When properly specified, good welding characteristics can be retained at low sulfur contents.

Corrosion

Nickel is an expensive alloying element. Most steel makers limit nickel additions to the minimum allowed — about 10 percent. The same is true for the element molybdenum. Both of these elements, however, offer enhanced pitting resistance, particularly molybdenum. In VeriClean both of these elements are tightly specified at higher than typical levels, nickel in the range 13.2 percent and molybdenum 2.75 percent. In fact, VeriClean has all alloying elements tightly specified, as shown in Figure 1. The tolerance for each element is set to narrow limits and in a rational manner to address specific materials issues that may concern the needs of the industry.

Delta Ferrite

Tolerances are set in an overall scheme to regulate the amount of delta ferrite. Delta ferrite is an important second phase sometimes present in austenitic stainless steels. Its presence is very detrimental to corrosion resistance. However, the total absence of delta ferrite can lead to hot cracking during welding. Laser welding is particularly susceptible to hot cracking because of the very rapid heating and cooling rates. The nominal 316L composition gives rise to a variation in delta ferrite from 0 percent to over 14 percent. VeriClean's tolerance scheme reduces this range by more than a factor of three. Thus, VeriClean achieves a cost-effective alloying for corrosion protection in balance with good welding characteristics.

Process Control

The steel making practice is also carefully specified. The ingots from the AOD process that are the starting material for the VAR process are specified to bottom poured and cropped low in order to eliminate porosity and minimize inclusions. The VAR process is tailored to the needs of VeriClean. The rolling / drawing and annealing schedules are carefully controlled to achieve our specified mechanical properties. The designed mechanical properties, in turn, give Veriflo Corporation's engineers an extra capability in their mechanical designs, and provide Veriflo customers with a more uniform and robust product.

Summary

VeriClean is a low sulfur 316L VAR processed stainless steel specifically designed for the needs of the Semiconductor Industry. It has been the standard material of construction for all of Veriflo's high purity stainless steel products since 1991. Veriflo continues to improve its products and build on its leadership position in materials technology.

For more information, visit Veriflo's Web Site (www.veriflo.com) or send an e-mail to: info@veriflo.com.

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