

Empowering medical device applications with surface hardening

The nitrocarburizing process developed by Expanite enhances both the hardness and corrosion resistance of stainless steel materials - and not just for individual alloys. Therefore, the process is also recommended for medical device applications. It extends the lifespan of the respective application, thereby increasing patient safety and reduces cost.

Text & images by Expanite

Because of its unique properties and versatility, stainless steel is an essential material for medical devices and implants that frequently encounter liquids and tissue. Its corrosion resistance guarantees an extended lifespan and prevents the development of rust or other damage that could compromise the functionality and safety of medical products.

For decades, stainless steel has been extensively used in medical technology and is offered in a diverse array of alloy variations in the market. Numerous companies opt for these materials due to their corrosion resistance, with particular emphasis on the austenitic and duplex variants. Nevertheless, these options are challenged by their susceptibility to wear attributed to their relatively low hardness, often resulting in issues such as galling. Conventional techniques aimed to increase wear or galling resistance on stainless steel components come with a drawback – they often result in non-corroding steels becoming susceptible to corrosion post-treatment. Coating methods designed to prevent this issue involve the application of material, but in numerous cases, they exhibit inconsistencies in terms of layer thickness. This inconsistency leads to the accumulation of material on flat surfaces, while corners and edges experience a reduction in the protective



Stainless steel is an essential material for medical devices such as this knee implants.

layer. Additionally, coatings can develop cracks during significant expansions or contractions of the underlying material due to the different thermal expansion coefficients of the base material and coating. Small openings present further challenges, as the coating process may not be effectively applied depending on the process used. Bypassing these hurdles has become the core objective of Expanite, the Danish provider of surface hardening technologies.

Enhancing stainless performance

Addressing the problems with stainless steel involves applying surface layer

hardening, a process distinct from coating that relies on diffusion-based surface hardening. While traditional methods of surface layer hardening for stainless steels have been available to the industry for some time, they inherently possess two primary drawbacks. Firstly, all conventional methods result in a reduction in corrosion resistance. Secondly, the hardness values of stainless steels typically treated with nitrogen or carbon experience rapid degradation, resulting in a shallow hardening depth of only a few micrometers. Consequently, the underlying structure remains quite soft, potentially leading to a fragile shell-like effect.

Expanite has pioneered an FDA-compliant process that overcomes these limitations. In this process, the surface layer and the underlying material are profoundly hardened. This specially developed nitrocarburizing method is a thermochemical process for steel, facilitating the diffusion of nitrogen and carbon into the workpiece's surface. This achieves enhanced surface hardness, improved wear resistance, and heightened corrosion resistance. Nitrocarburizing combines the benefits of both nitriding and carburizing with a single process.

Protection from wear and corrosion

The stainless steel treatment typically involves a two-step process. During the initial phase (high-temperature procedure), nitrogen is introduced deeply into the boundary zone. This results in the material being hardened up to around 1 mm, with hardness levels ranging from approximately 300 HV for austenitic materials to 850 HV for martensitic materials.

In the subsequent stage, referred to as the low-temperature procedure, the workpiece is gradually heated to

a maximum of 470°C. This controlled heating enables the infusion of both carbon and nitrogen, effectively reinforcing the boundary layer to a depth ranging from 5 to 30 μ , achieving hardness levels between 1100 and 1300 HV. By combining both process steps, the fragile eggshell effect is avoided.

“Nitrocarburizing is a thermochemical process for steel facilitating the diffusion of nitrogen and carbon into the workpiece’s surface.”

To test wear resistance, Expanite conducted tests on several 316L samples that had undergone its proprietary hardening process, following ASTM standard G 98 guidelines. In this test, a ceramic test body is moved back and forth on a test specimen under a constant pressing force of 25 N. After a sliding distance of 100 m, the resulting

wear volume is qualified. Remarkably, the sample treated with Super-Expanite exhibited wear resistance levels 125 times superior to those of the untreated sample. While conventional surface hardening methods aim to enhance surface hardness, they frequently come at the cost of compromising corrosion resistance. This is precisely where our procedure steps in: Extensive testing has demonstrated that samples subjected to Expanite’s hardening process can endure up to 1000 hours in a salt spray fog chamber without exhibiting subsequent corrosion indications. In fact, surface hardening can occasionally elevate corrosion resistance to levels surpassing those of the untreated base material. ▲

About Expanite

Expanite is a Danish company specializing in heat treatment and surface hardening of stainless steel and titanium. The company has its head office in Hillerød near Copenhagen and service centers and licensees in the USA, Germany, Korea, and China. Expanite’s DNA is based on sustainable solutions to extend the life of components made of stainless steel, titanium, and other high-value alloys. www.expanite.com

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