ExpaniteHard-Ti Questions and Answers

This article is a Q & A with Rune Strand regarding ExpaniteHard-Ti. Strand is project manager and material scientist at Expanite A/S, and he holds an MSc in material science and manufacturing. He has spent most of his career in the field of surface hardening and heat treatment of stainless steel.

Why is surface hardening of titanium relevant?

Surface hardening of titanium is relevant simply because titanium and titanium alloys by nature are soft and will exhibit poor wear resistance. This contradicts something we often hear: "Why would you need to harden titanium? Isn't that really tough?" The truth is that titanium and titanium alloys are actually very tough, but toughness, hardness and strength are often confused with each other. In general terms, hardness is the feature that will give a material wear resistance, and titanium by itself is not very hard.

Where do you see a hard titanium surface being beneficial?

Basically, the sky is the limit, both figuratively and literally. The aerospace industry uses an abundance of titanium, and any part that exhibits wear will benefit from our surface-hardening technique. Currently, we have seen the highest demand from the Swiss watch industry, where the goal is to make titanium watch parts more scratch-resistant. We also see the applicability in the emerging 3D/additive manufacturing (AM) market as well as medical devices.

What methods exist today to increase surface hardness and improve wear resistance?

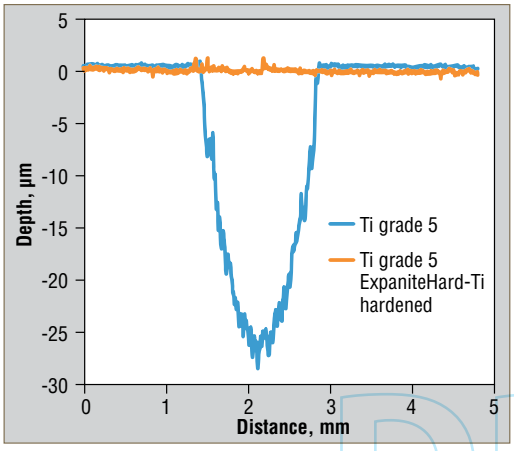
The most typical methods are anodizing and TiN coatings. Both of these are coating-type methods where the hardening effect is achieved by forming "something else" on the surface. This "something else" will have a good hardness and probably also decent wear properties. The drawback of these types of treatments is that there is a great risk of delamination of the coating, simply because it is "something else" than the underlying structure. Delamination can be initiated by temperature fluctuations, hard impacts, etc. and is often referred to as "the egg-shell effect."

Is ExpaniteHard-Ti a coating?

ExpaniteHard-Ti is far from a coating. The process relies on diffusion of interstitial atoms into the original microstructure of titanium/titanium alloys.

What are the typical achieved specifications for hardness and depth?

Typically, we achieve 30 µm and 1000 HV hardness. The graph shows the total elimination of wear in a standard ASTM G133 pin on a disk wear test.



What are the benefits of an interstitial diffusion hardening process such as ExpaniteHard-Ti?

The most pronounced benefit from a process like ExpaniteHard-Ti lies within the nature of the process – diffusion. Diffusion of interstitial atoms into an existing structure creates compressive stresses that result in a hardness increase. This completely eliminates any discussion about adhesion to substrate and delamination of the hardened zone because it is a part of the original structure and not "something else" on top.

Contrary to austenitic stainless steel, heat treatment of titanium is an important parameter to obtain certain mechanical properties. How do you accommodate this?

We can achieve basically all heat-treatment conditions simultaneously with the hardening process itself. If it is not possible to have the specific heat-treatment condition that is required within the parameters of our hardening process, then we do the specific heat treatment either before or after diffusion-hardening a part.

Are there any drawbacks of your process?

There are a couple, namely a slight discoloration and a little distortion. The discoloration can be omitted, and we are currently working on a modified version to commercialize the change in process details that is necessary. Concerning the distortion that can happen to parts when surface hardened, it is actually mostly due to a temperature in the treatment exceeding the alpha/beta transus temperature. This issue is also addressed in the new developments, however, where a temperature well below the alpha/beta transus temperature is used.

In what segments or fields are you seeing requests for such a process?

Mostly jewelry, but both the aerospace and medical industries are starting to show some real interest.

What is the matureness of said process?

We are ready to mass produce.

How do you provide the technology (on-site/service provider)?

Expanite offers two solutions: as with a normal service provider, where the customer sends us the goods, we harden and ship back; or as an onsite solution, where a customer can buy a furnace (preferably through a specific furnace manufacturer) and run the ExpaniteHard-Ti process on a license agreement.

What are typical lead times/cycle times?

Typically, it will not take more than 24 hours to do the actual hardening process. Expanite has a standard lead time of nine working days.

Do you see any upcoming applications for your technology?

Basically, any 3D-printed parts seem to be next big jump in the application of our ExpaniteHard-Ti process, where the benefits of the hardened zone can reach far beyond just the surface.

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