



The Tantaline[®] Surface Alloy Process as an Alternative to Solid Corrosion Resistant Alloys

Industry experts estimate that in the United States alone, the cost of losses caused by corrosion in industrial and manufacturing processes is \$17 billion annually ^[1]. For the chemical, refining, oil and gas-related processing industries, corrosion of valves and equipment is a common problem, causing large negative impacts on these processes.

The Tantaline® Surface Alloy Process as an Alternative to Solid Corrosion Resistant Alloys

By Brian Hood

Introduction

Industry experts estimate that in the United States alone, the cost of losses caused by corrosion in industrial and manufacturing processes is \$17 billion annually [1]. For the chemical, refining, oil and gas-related processing industries, corrosion of valves and equipment is a common problem, causing large negative impacts on these processes. These impacts include:

- Reduced equipment life and equipment failure, leading to unplanned downtime.
- Increased equipment maintenance costs.
- Potential environmental impact due to fugitive emissions.

Various corrosion resistant alloys (CRAs) have been developed for harsh environments. These alloys include Hastelloys®, Inconels® and the reactive metals titanium and zirconium. While effective in many corrosive environments, there are alternatives to these materials.

Flowserve offers the corrosion resistant and cost-effective Tantaline® brand tantalum surface alloy for the Flowserve brands Durco, McCANNA, Worcester Controls and Noble Alloy, for highly corrosive applications. In this paper, we will explore the Tantaline® technology, a tantalum surface alloy produced by Tantaline Inc., which is partnering with Flowserve to expand this technology. We will also review the advantages and limitations of tantalum surface alloying in industrial valve applications. This paper will explain the application of this useful material and the tantalum surface alloying process.

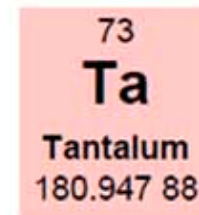
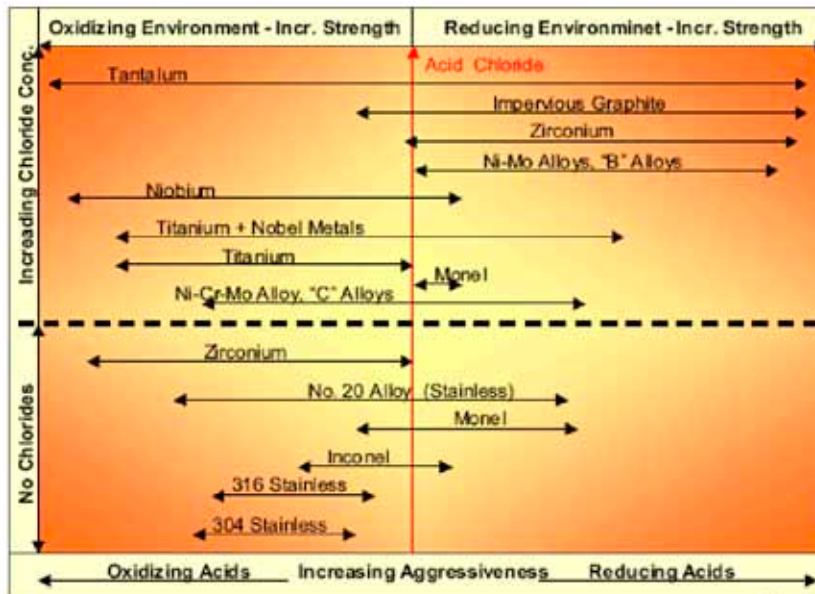


Fig 1. Oxidizing and reducing acid materials comparison Chart

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Tantalum Metal and its Properties

Tantalum is a chemical element produced from the mineral tantalite. Compared to other CRAs, it is highly resistant to many forms of corrosion in applications where metals are required in chemical processes. This unique property leads to extended life cycles in equipment used in these processes. In some applications, tantalum has a zero corrosion rate. Additionally, multiple corrosives may be alternated for various processes in the same equipment.

Tantalum is considered an exotic metal. It is very heavy (50% heavier than lead) and expensive due to its rarity and the lengthy and costly processes used to produce it. Due to its expense, it is typically used for only the most demanding applications. Oxygen readily forms with tantalum to create a thin oxide layer which provides it with its corrosion resistant properties. Compared to other CRAs, Tantalum has one of the widest ranges of corrosion resistance. (Fig 1)

Tantalum does have some drawbacks. It oxidizes readily in air, and will decompose rapidly at elevated temperatures over 350°. It is also susceptible to nitrogen and hydrogen embrittlement over 250 °C. Fluoride ions, fluoride compounds (such as hydrofluoric acid), sulfur trioxide and potassium hydroxide will readily attack tantalum as well. [1]

The Tantaline® Process

Tantaline has developed a methodology for applying tantalum through a chemical vapor deposition (CVD) process to produce a .002"-.008" (50um-200um) layer of pure tantalum on the stainless steel valve components of ball and plug valves. The Tantaline surface alloy is different from traditional coatings in that it forms a metallurgical bond to the 316 stainless substrate, which makes it extremely rugged and durable, whereas traditional coatings rely on a mechanical bond that could be susceptible to chipping and spalling.

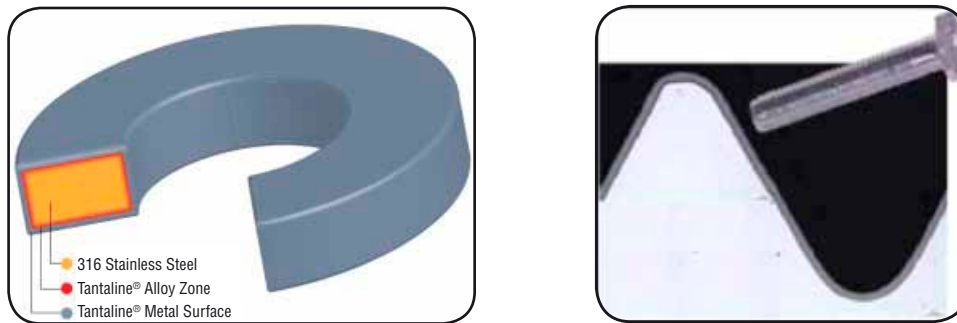


Fig 2. The Tantaline® surface alloy with substrate, alloy zone and pure tantalum layer (© Tantaline Inc)

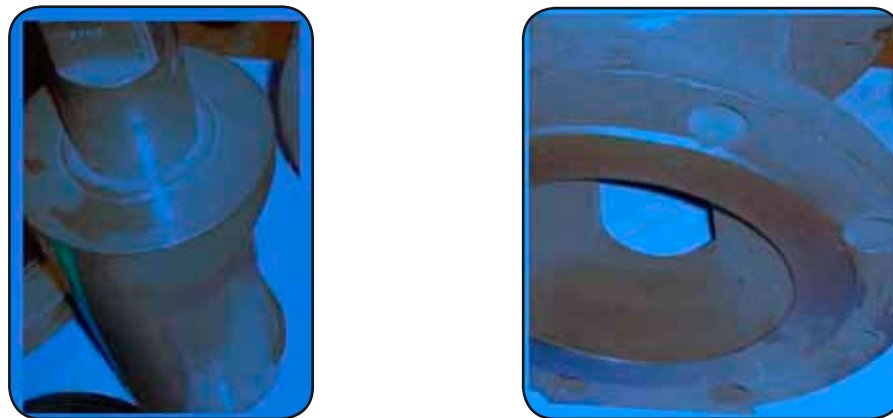


Fig 3. Tantaline® tantalum treated Durco Plug valve plug and valve body (© Flowserve Corporation)

The use of the high-temperature gaseous process allows for surface alloying of complex shapes like valve bodies, an advantage over more traditional coating methods. This process provides 100% treatment of the part and internal passage ways (Fig 2, Fig 3). It is also a more efficient way to use this expensive material, providing a finished lower cost part similar to the cost of a Hastelloy® C component and a performance that could be many times longer. As a final quality control step, all parts are submerged in boiling 28% HCl for 48 hours to test the surface alloy integrity. The valve components are returned to Flowserve for inspection, assembly and test, and receive a full factory warranty along with a two-year Tantaline warranty on the surface treatment.

Performance

Potential users may have concerns about how tantalum surface alloying performs in the field, with the treated surfaces cycling against the various seals in a valve. Extensive laboratory testing has been conducted on various quarter turn valve designs, including a sleeve-lined plug valve, top-entry ball valve and a three-piece ball valve.

Testing included cycling the valves under pressure, then disassembling them and inspecting the parts for wear. This was followed by corrosion testing the cycled components to assess surface alloy integrity. The photos below show components after 10,000 cycles. The parts maintained excellent integrity with only polishing of the surface (Fig. 4 and Fig. 5). Subsequent corrosion testing showed the surface alloy was unaffected and had 100% corrosion integrity.



Fig 4. Cycle tested Worcester Controls Ball valve ball (© Flowserve Corporation)



Fig 5. Cycle tested Durco Plug valve plug (© Flowserve Corporation)

Applications

Applications for tantalum surface alloy on valves are the same as those for most CRA materials, including nickel alloys, titanium, zirconium and solid tantalum:

- Acids including hydrochloric, sulfuric, acetic, nitric, phosphoric and formic
- Wet chlorine
- Bromine
- Applications that exceed the capability of polymer lined products

Markets include:

- Chemical processing
- Oil and gas
- Pharmaceutical
- Food
- Mining
- Electroplating

The tantalum surface alloy does have the same chemical limits as pure tantalum metal, and it is not recommended for abrasive slurries. However, it is resistant to aqueous erosion.

Conclusion

The surface alloying of valves with tantalum can offer some economic and performance advantages over valves manufactured from solid CRAs or solid tantalum, providing equal or superior corrosion resistance at costs similar to nickel CRAs. This can offer end users increased service life and higher system performance under challenging operating conditions, leading to higher process efficiency and a lower total cost of ownership.

Brian Hood is the Product Manager for ball valves at the Flowserve Cookeville facility.

For information and pricing contact the factory at:

Flowserve Corporation
1978 Foreman Drive
Cookeville, TN 38502
Phone: 931-432-4021
Fax: 931 432-3105
www.flowserve.com

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Flowserve World Headquarters
5215 N. O'Connor Blvd., Suite 2300
Irving, TX 75039

Phone: 972 443-6500
Fax: 972 443-6800

Flowserve Corporation
1978 Foreman Drive
Cookeville, TN 38502

Phone: 931-432-4021
Fax: 931 432-3105

www.flowserve.com

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