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Low Friction Chromium— Good Medicine for Ailing Surgical Instruments

This is the first of three articles that deal with a coating known as low friction chromium, an extremely hard and wear-resistant coating that can be deposited on precision metal components via a unique and proprietary process. This article gives a brief history of how rising medical costs have dictated a need for a coating process that would extend the usable life of expensive medical devices used in biomedical surgery. Some of the salient features of this coating are also discussed which make it a logical choice for the thousands of surgical instruments currently in use in hospitals across the USA.

The last twenty-year period has been prime time for bio-medical research and development, which has revolutionized the science of implanting prosthetic devices and led to vastly improved lifestyles for thousands of people.

The down side of this exciting season of change is soaring medical costs due to an aging population. This, in turn, has prompted salary cuts for medical personnel as well as drastic reductions in staff, and subjected all aspects of the industry to close scrutiny in an attempt to lower the costs to the public.

One area for potentially significant cost savings focuses on the thousands of tools used by orthopedic surgeons: bone screw taps, cannulas, arthroscopic blades, bone saws, broaches, chisels, electro surgical cauterizing blades, etc., and many others developed due to improved sophistication of design of human prostheses. Although most of these instruments (see Figure 1.) have historically seen multiple use where autoclaves are employed for sterilization, the repeated usage of these items, and the fact that many of these consist of soft, ductile stainless steel, takes its toll on both their functional use and appearance. Not only do tools become terribly discolored from the effects of superheated steam and harsh chemicals from the sterilization process, but also, surface gouges and scratches from handling further harm their appearance, and tools requiring sharp cutting edges lose their fine edge along with their luster.

While many sophisticated coating processes have evolved to improve the oxidation and wear resistance of various tools, one such coating that has received the most universal

Figure 1. The diversity of medical instruments currently being coated with low friction chromium include biopsy needles to bone screw taps. The coating has a lustrous, platinum-satin finish, is non-reflective and highly wear-resistant. (Photo courtesy of Norman Noble, Inc.)

acceptance by the medical industry, thus far, has proven to be low friction chromium, whose attributes related to the coating of medical tools are listed as follows:

BENEFITS OF THE LOW FRICTION CHROMIUM APPLICATION PROCESS

(1) Work piece will not undergo distortion or metallurgical changes because the operating temperature of the process bath is under 212°F.
(2) Coatings can be applied to intricate tools as a final process.
(3) Coating thickness can be varied according to end use of the tool.
(4) Coating is applied uniformly to all surfaces, including recesses and holes.
(5) Areas not requiring deposition can be masked.

(6) The process is very cost-effective relative to many other coating processes.
(7) The final product contains a "platinum-satin" finish that has low reflectivity and is very pleasing to the eye.

Some of the technical merits of low friction chromium have also been well documented through laboratory-accredited test procedures as follows:

TECHNICAL MERITS OF LOW FRICTION CHROMIUM HARD COATING

1) Increased Surface Hardness

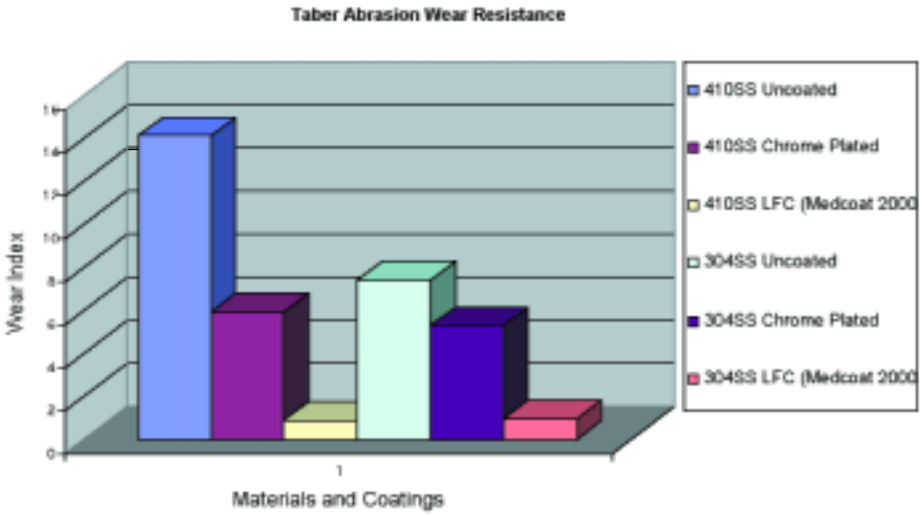
A test specimen of soft (Rb 83) AISI 410 martensitic stainless steel was coated with 25µm (.001") of low friction chromium in preparation for micro hardness testing in accordance with ASTM E-384, utilizing a Knoop indentor and 100 gram load. Hardness of the coating averaged 1074HK (approximately Rc 73). This hardness is significantly higher than that published for conventional electroplated chromium coatings which range from 850-1050 HK.

2) Improved Wear Resistance

The Taber Abrasive Test was employed to measure the resistance to dry abrasion of coated and uncoated test panels of type 304L austenitic stainless and type 410 martensitic stainless steels. One set of each was electroplated with conventional hard chromium and the other set coated with low friction chromium. The test was run for 5,000 cycles in compliance with specification FED-STD-141, Method 6192.1 utilizing a CS-10 Calibrase wheel and 1,000 gram load.

Results in Figure 2 (below) show dramatic improvement in wear resistance for the low friction chromium coating over the uncoated specimens and those coated with conventional hard chromium.

Figure 2. Bar chart results of the Taber Abrasion wear test performed on AISI 410 and AISI 304 stainless steel samples coated with MEDCOAT™ 2000 low friction chromium and conventional electroplated chromium.



3) Improved Corrosion Resistance

Because uncoated austenitic stainless steels are known to be vulnerable to pitting and crevice corrosion attack in many types of environments, test ASTM G48 was chosen because of the aggressiveness of ferric chloride solutions on stainless. Test panels of bare 304 stainless steel and one coated with low friction chromium were subjected to 72 hours of continuous testing at 50°C. Visual inspection of the coated sample showed no evidence of crevice corrosion after this time period, whereas the uncoated sample contained moderate to severe pitting at the points of contact.

4) Excellent Adhesion of Stainless Steel Base Metal

One sample of type 304L austenitic stainless steel was coated with 13 µm (.0005") thickness of low friction chromium and was bent 180° around a 1/4" diameter mandrel, per ASTM B-571. Examination of the coating under 10X magnification showed no evidence of cracking, peeling, flaking or crazing of the coating. (See Figure 3.) As per the second part of this test, the sample was repeatedly bent back and forth until rupture occurred, and no separation or peeling of the coating occurred.

Figure 3.
Photograph of the outer area of the 180° bend of the AISI 304L stainless sample coated with low friction chromium. There is no evidence of crazing, peeling, or cracking of the coating from the base metal. 4X Magnification.

Conclusion

Low friction chromium is a coating that can offer the medical industry an opportunity to extend the life of expensive, precision surgical instruments and thereby help stem the tide of skyrocketing medical costs to the consumer. One brand of low friction chromium, MEDCOAT 2000™ has been certified to USP Class VI and is available from Norman Noble, Inc. of Cleveland, Ohio.

JFP Technical Services is an independent metallurgical testing laboratory that has provided consulting and testing services since 1991. John Paciorek, President, has over 25 years experience in materials testing and failure analysis.

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