

“Synergistic” Surface Enhancement Coatings Protect Most Metals — Including Aluminum — Against Wear, Corrosion, Sticking and Galling

- ▶ Dramatically increase surface hardness
- ▶ Resist corrosion, chemicals, and acids
- ▶ Prevent abrasive wear and galling
- ▶ Self-lubricating for extended wear
- ▶ Provide superior mold release
- ▶ Meets and exceeds requirements for ASTM B656 and ASTM B733
- ▶ Permanently dry-lubricated for very low COF
- ▶ Many meet FDA, USDA, and CFIA codes
- ▶ Speed cleanup and sanitation maintenance
- ▶ Eliminate sticking and product “hang-up”
- ▶ Ideal for cryogenic uses down to -250°F (-157°C)
- ▶ Prevent galvanic corrosion with incompatible metals
- ▶ Won't chip, peel or flake off like "paint-ons"
- ▶ NASA material #20386*
- ▶ ITAR and REACH compliant

All types of metal parts, including those made of aluminum, are treated with NEDOX to create a harder-than-steel, self-lubricating surface that resists corrosion, friction, sticking, galling, and static buildup, and exhibits superior mold release as well. The General Magnaplate-applied process improves parts made of less durable and/or less costly metals by adding physical properties that permit them to out-

perform and outwear even chrome and stainless steel. Because NEDOX-treated surfaces are superior in performance to the base metal itself or to any of the individual components used in the enhancement process, NEDOX coatings are considered “synergistic.”

* MSFC Handbook 527F (NEDOX SF-2), Johnson Space Flight Center #D9604F

Engineering Data and Performance Characteristics

Wear resistance

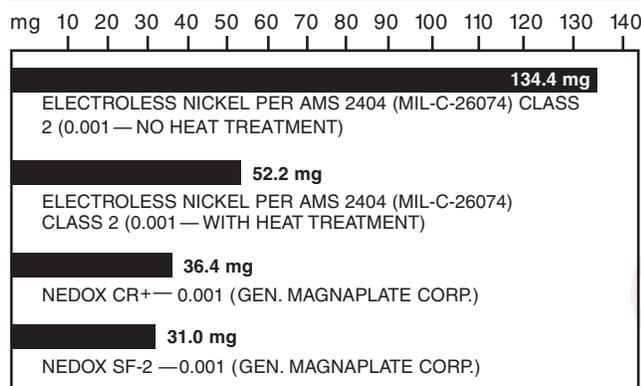
Hardness is up to Rc 68 (940 Vickers scale) — better than hard chrome plate. There is no degradation of fatigue strength. NEDOX coatings also eliminate the likelihood of galling or seizing.

Corrosion resistance

NEDOX “synergistic” coatings are superior in corrosion resistance to chromium or standard electrolytic-nickel plated coatings. A 0.001" coating

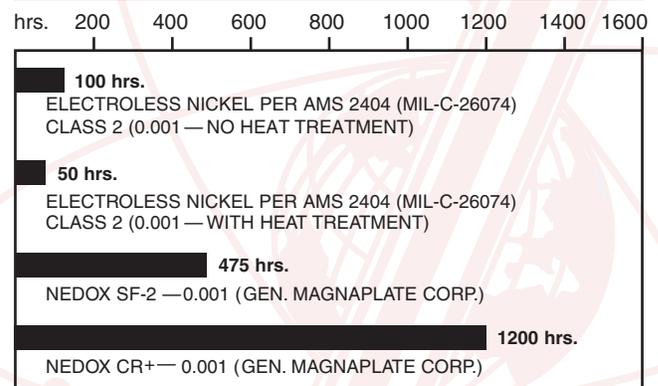
shows little or no corrosion after 14 months of continuous exposure to atmosphere and salt water. Good resistance to most common chemicals. Certain coatings show no effect after 90 days immersion in pH 3.0 – 9.5 solutions. Some NEDOX coatings are especially resistant to phosphate-free bleach used in washdown solutions in food processing and packaging operations. NEDOX coatings on aluminum also provide resistance to a wide range of chemicals.

EQUILIBRIUM WEAR RATES*



* Weight loss = mg per 10,000 cycles - CS10 wheel using Taber Abrasion per ASTM D 4060

SALT SPRAY TEST



Hours of exposure in 5% NaCl until first appearance of corrosion spots per ASTM B-117

Nuclear Applications

Nedox is well suited for use in reactors that are used for uranium enrichment. In the process that creates fissionable Uranium 235 from Uranium 238, uranium hexafluoride (UF6) is produced in a gaseous diffusion process. The UF6 was found to be one of the most active chemicals known, almost acting as a universal solvent. The components in Nedox are shown to have excellent chemical resistance to UF6.

Friction

Surface is smooth and slippery. In some cases, the static friction decreases with an increase in load. NEDOX eliminates "stick-slip" and undesirable vibration of higher break-away friction. For more information on friction, see General Magnaplate's Friction Data Guide on CD.

NEDOX FRICTION CHART				
Material	Vs.	Material	COF	
			Static	Kinetic
Steel		Aluminum	0.47	0.38
Steel		NEDOX SF-2	0.30	0.26
NEDOX SF-2		NEDOX SF-2	0.18	0.12
Teflon*		NEDOX SF-2	0.10	0.09

*Teflon is a registered trademark of DuPont

Temperature

Exhibits high strength, toughness and self-lubricity down to -250°F (-157°C). Exhibits flexibility down to -110°F (-79°C). 550°F (288°C) is the continuous operating temperature.

Thermal coefficients

Typical Coefficient of Thermal Expansion:

$$7.22 \times 10^{-6} \text{ in/in/1}^\circ\text{F. (13} \times 10^{-6} \text{ in/in/1}^\circ\text{C).}$$

Typical Coefficient of Thermal Conductivity:

$$.0105 - .0135 \text{ Cal-cm/sec/}^\circ\text{C.}$$

Versatility

With few exceptions, NEDOX coatings can be applied to parts of any configuration, any weight, virtually any size or thickness, and almost any metal (including aluminum). Precise control of coating thickness permits use on machine threads and similar close-tolerances.

FDA/USDA/CFIA compliance

Compliance with FDA, USDA, and CFIA codes makes many NEDOX coatings particularly advantageous for

food and pharmaceutical applications. These non-stick coatings eliminate the potential growth of mold and bacteria by creating a dense, non-porous surface. They are used extensively on processing, packaging and handling equipment to prevent product residue from clinging to machinery and add the benefits of quicker equipment cleanup and sanitation maintenance.

Non-stick release properties

Very few solid substances, even adhesives, adhesive-backed products or glues, will permanently adhere to the proprietary polymer-impregnated surface of a NEDOX coated part. Most substances, such as plastics, rubber or slurries, release easily. Some extremely tacky materials may exhibit mild temporary adhesion.

Thickness

Typical normal surface deposition is 0.0002" – 0.002" (±10%) and is based upon thickness requirement and coating formulation. (See section describing NEDOX FAMILY OF "SYNERGISTIC" COATINGS).

NEDOX vs. chromium plating

High-efficiency NEDOX coatings provide optimum uniformity and do not build up on high current density areas (see diagrams, below). Thus, costly and labor-intensive secondary machining and secondary finishing steps can be completely eliminated. An added feature is the ductility of NEDOX which allows a 180° Bend-Test without flaking or chipping.

The poor efficiency of chromium plating systems (10% – 14% under optimum conditions, even less with some configurations), when complicated by high and low current density areas, can lead to extremely uneven deposition rates and leave large variations in the coating thickness. Uneven deposition of chrome also results in a very brittle coating.

NEDOX



CHROMIUM PLATING

Low "CD" Effect

High "CD" Effect



Anti-static electrical properties

The proprietary polymeric impregnation usually imparts dielectric resistance, a low dissipation factor, and very high surface resistivity over a wide range of frequencies. However, special techniques developed by Magnaplate's R&D Group permit NEDOX to be made conductive enough to be used as an anti-static coating.

Non-wetting

Since our proprietary polymer-impregnated surfaces are both oleophobic and hydrophobic, they resist wetting by most liquids. Hence, clean-up is faster, easier and more thorough. In many cases, parts become self-cleaning. Maintenance time and labor are greatly reduced. Droplet exhibit excellent performance.

Value-added coatings permit substitution of carbon steel or aluminum for expensive metals

In order to reduce bottomline costs, innovative design engineers today are utilizing Magnaplate "synergistic" coatings such as NEDOX to permit substitution of aluminum and low-cost steels for more expensive metals such as stainless steel.

Stainless costs about five times more than carbon steel. Yet in many applications, a carbon steel part that has been protected by the proper type of NEDOX coating will have the corrosion resistance of stainless steel and can be used in place of the stainless part. Similarly, other lower cost ferrous alloys can be specified in a wide range of applications where higher cost substrate materials are currently used.

NEDOX-coated aluminum, too, has become a popular choice of design engineers, as well as of plant and materials engineers.

A few typical applications

Aircraft, aerospace, chemical processing equipment, electronic equipment, food processing, heat sinks, meters (gas & electric), molds (release agents), packaging equipment, pharmaceutical processing, pumps, sealing equipment, textile manufacturing, and valves.

Wide range of NEDOX surface enhancement coatings offers design flexibility

During the multiple steps of the NEDOX process, there are a number of variables that can be controlled to produce different surface enhancement characteristics.

Through experience and research, the exact control required to produce the desired results of a specific coating type has been refined. There are many different types of coatings within the NEDOX family of "synergistic" coatings. Each one has unique characteristics to meet application needs or can be modified to achieve special performance requirements.

NEDOX FAMILY OF "SYNERGISTIC" COATINGS

SF-2	Hardness (up to Rc 65) combined with lubricity. USDA/FDA compliant, CFIA approved. NASA material #20386*.
SF-2R	Same as SF-2, but with superior mold release. USDA/FDA compliant.
SF-2SB	Resists bleach washdown solutions and lactic acid from dairy equipment. USDA/FDA compliant.
604	Maximum chemical resistance, mold release, and abrasion resistance. High dielectric strength. FDA-compliant.
615	Maximum release properties. Operating temperatures up to 550°F (288°C). Sparkling black or white color. USDA/FDA compliant.
641	Excellent release for food and drug molding and manufacturing applications. Grey in color, USDA/FDA-compliant.
NH-2	Hardness of coating can be varied for excellent corrosion and chemical resistance.
CR+	Maximum wear resistance. Hardness up to an equivalent of Rc 68. Maximum salt spray resistance.
FM-5	Special combination of proprietary polymers and dry-lubricants. Low coefficient of friction after burnishing.
MR-3 (U-4)	Excellent mold release for plastics, urethane epoxies and rubber. Black color. Recommended for UV curing.
NH-1	Excellent for resistance to wear and corrosion. Hardness of coating can be varied based upon specific requirements.
NH-1SB	Same as NH-1, with superior corrosion resistance to chlorinated solvents.
HTR	Excellent release properties at high temperatures.
SLK	Combines release properties of 615 with the wear properties of SF-2. USDA/FDA-compliant.

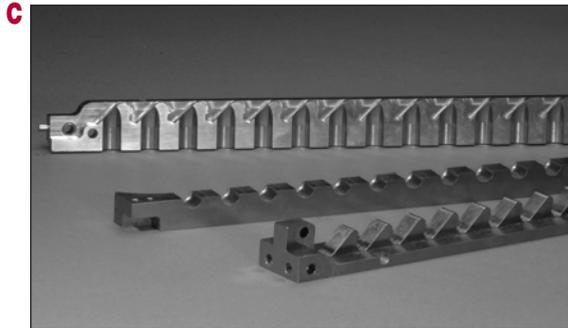
Examples of NEDOX Coatings in Use



A



B



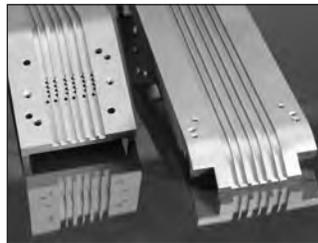
C



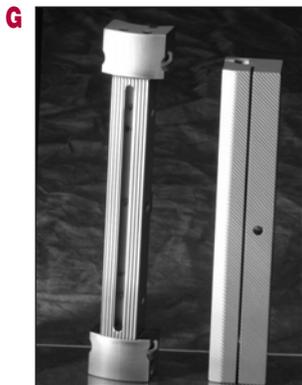
D



E



F



G



H

A. Feeder auger used in handling ultrafine powders for the non-woven industry. NEDOX provides the release necessary to keep the powders from sticking and caking.

B. A cookie manufacturer eliminates frequent production downtime to change batter-clogged cookie molds and also reduces mold replacement by treating brass molds with an FDA/USDA/CFIA-compliant NEDOX coating. Other food processors solve mold release, cleanup and sanitation problems by specifying NEDOX for molds, extrusion pistons and dies, filling nozzles, rollers, trays, kettles, and blades.

C. NEDOX was used on these lipstick mold parts to ease cleanup of residues left from the molding process. The smooth NEDOX surface increased product quality and appearance by minimizing pinholes and blemishes on the lipstick.

D. A NEDOX coating on the steel portions and a TUFGRAM® coating on the aluminum portions solved galvanic corrosion and erosion problems encountered on their combination steel/aluminum molds used to injection blow-mold PET bottles. The coatings also prevented corrosion created by condensation on both metals.

E. Actuators on the International Space Station (ISS) project are coated with NEDOX SF-2 to give them superior lubricity and a hardness of up to Rc 65. (NASA material #20386). The ISS is a partnership in space between the USA, Europe, Canada, Japan, and Russia.

F. Guide plates used in pharmaceutical form/fill seal machine. NEDOX prevents product hang-up, keeping flow rates steady.

G. A variety of seal bars are coated with NEDOX to increase wearlife and prevent packaging films from sticking during heat sealing operations.

H. These metering valves, which regulate the flow of oil in a jet engine, received the non-binding surface it needed with a NEDOX coating.



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