



ENGINEERING DATA AND APPLICATION GUIDE

General Magnaplate’s problem solving metallurgical specialists at our three Materials Technology Centers in North America help engineers increase reliability, wear, and performance of equipment by treating metal parts with one of our many “synergistic” surface enhancement coatings.

WHAT ARE “SYNERGISTIC” COATINGS?

Established in 1952, General Magnaplate’s coatings met NASA’s need for a new type of surface technology that would withstand the rigors of outer space. Magnaplate-applied coatings are created in multi-step processes that begin with a series of special cleaning treatments. Enhancement of the metals is then performed by conversion, deposition, thermal spray, or by a blend-matrix of all three – depending on the coating.

The process continues with a controlled infusion of selected engineering particles and/or metals. Unlike “paint-ons”, these particles are mechanically cross-linked and locked in through a proprietary process to become an integral part of the new surface.

Since the resulting surface is dramatically superior in performance to both the base metal and any of the individual components used in the enhancement technology, General Magnaplate coatings are considered “synergistic”.

GENERAL MAGNAPLATE CAN PROVIDE YOU WITH TURNKEY SOLUTIONS AND WILL ASSURE THE QUALITY OF THE FABRICATION.

Our finishing capabilities include grinding, superfinishing, machining, polishing and diamond polishing.

Federal, industrial and MIL-SPEC coatings and platings are available.

Worn parts such as injection molds, pump impellers, rolls and platens can be coated and/or restored.

In some cases, General Magnaplate can produce your parts complete from manufacturing to finishing.

PROBLEM-SOLVING BENEFITS OF MAGNAPLATE COATINGS

- Create a harder-than-steel surface
- Allow substitution of less expensive metal
- Resist environmental and chemical corrosion
- Permanent dry lubrication
- Resist abrasion and galling
- Self-lubricating for extended wear
- Exhibit a very low coefficient of friction
- Offer superior mold release
- Eliminate sticking and product “hang-up”
- Won’t chip, peel or flake off
- Creates a smooth surface on castings
- Speed cleanup and sanitation maintenance
- Many meet FDA and USDA codes
- ITAR and REACH compliant (International)
- Impart dielectric strength
- Radiation and UV resistant
- Reduce equipment downtime
- Can be customized for the application



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TUFRAM®
For Aluminum Alloys**NEDOX®**
For Most Base Metals**COATING DESCRIPTION**

These “synergistic” surface enhancement coatings create harder-than-steel, permanently dry-lubricated aluminum surfaces that resist corrosion, abrasion and galling. Treated components outwear and outperform case-hardened steel, stainless steel and hard chrome-plated parts.

Controlled infusion of various proprietary materials within a modified nickel alloy plating. Subsequent controlled treatment cycles assure thorough infusion of the proprietary material into the surface layer and concurrently increase hardness of the matrix. Meets and exceeds ASTM B656, ASTM B733, MIL-C-26074, Class 1, 2, 3 and 4, and its replacement specs AMS 2404 and 2405.

HARDNESS, WEAR AND ABRASION

Up to Rc 65. Equilibrium Wear Rate using Taber abrasion testing method #6192 of Fed. Std. #141 (CS-17 wheel): 0.5 to 1.5 mg per 1000 cycles. Exceeds AMS requirements by 3 times.

Up to Rc 68 per ASTM B-578-87. Equilibrium Wear Rate using Taber abrasion testing methods #6192 of Fed. Std. #141 (CS-10 wheel): 2.0 to 4.0 mg per 1000 cycles. Exceeds AMS requirements by 2 times.

**FRICITION PROPERTIES
ASTM D 1894-01**

(Friction values will vary based on mating surfaces.)

Coefficient of friction: as low as 0.05. Eliminates stick-slip and undesirable vibration.

Coefficient of friction: as low as 0.09. Eliminates stick-slip problems and undesirable vibration.

**CORROSION RESISTANCE
ASTM B 117**

Most TUFRAM types exceed the basic salt spray requirements of AMS 2482 and AMS 2469. Some TUFRAM coatings are resistant to alkaline and acid solutions.

Most types of NEDOX will survive 300 hours in salt spray. Selected types can withstand over 3000 hours. Coating thickness will affect corrosion resistance; special types can survive in H₂S, encountered in oil field applications.

TEMPERATURE

(Results depend upon the process specified and the alloy used.)

Operating range: -360°F (-218°C) to as high as +800°F (+427°C) for intermittent operating conditions.

Operating Range: -250°F (-157°C) to +550°F (+288°C). Some coatings will survive temperatures as high as +1400°F (+760°C).

THICKNESS

Range: 0.0004” to 0.003” per side, with tolerance as low as ±0.0002”. (Coating thickness is normally 50% growth per surface and 50% penetration per surface.)

Surface build-up from 0.0002” to 0.0015”.

**FDA/USDA
FDA 21 CFR 175.300**

Many comply with FDA and USDA codes.

Many comply with FDA and USDA codes.

APPLICATIONS

TUFRAM not only improves the performance and durability of aluminum components but often allows easily machinable aluminum to replace steel or stainless in many applications. Meets ELV requirements and is REACH compliant.

Steel, stainless, copper, brass, bronze, titanium, and aluminum are the basic metals that can be enhanced by the use of one of the many types of NEDOX. Abrasion resistance, lubricity, corrosion resistance and/or mold release can be obtained through the use of NEDOX.

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HI-T-LUBE®
For Steel, Stainless,
Copper Alloys**MAGNADIZE®**
For Magnesium Alloys**COATING
DESCRIPTION**

This multi-layer, metallic dry-film lubricant coating is recognized by the "Guinness Book of Records" as the solid with the lowest coefficient of friction. Deposited sequentially, then through a proprietary diffusion process, it produces an extremely dense, malleable lubricating surface, capable of surviving in a broad temperature range and under high loads.

A proprietary coating system that surpasses all other current methods of magnesium treatment for the prevention of oxidation and galling. Additional enhancement of this coating is achieved by an infusion of supplementary proprietary polymers or dry film lubricants.

**HARDNESS,
WEAR AND
ABRASION**

Wear rate is negligible after break-in period. Can withstand extremely high compression loads (in excess of 150,000 psi.)

Up to Rc 58 to 60. Additional dry films can be applied for special longer wear characteristics.

**FRICITION
PROPERTIES
ASTM D 1894-01**
(Friction values will vary
based on mating surfaces.)

Coefficient of friction: after break-in burnishing, as low as 0.03. Lowest coefficient of friction of any solid in the world.

Coefficient of friction: as coated, 0.12 to 0.15; with supplementary surface coatings of dry lubricants or proprietary polymers, it can be as low as 0.04.

**CORROSION
RESISTANCE
ASTM B 117**

Up to 200 hours in salt spray at 0.001" thickness.

Up to 75 hours, as coated; with supplementary proprietary treatment, 300 hours; with some grades of proprietary polymer, over 1000 hours salt spray resistance is obtainable.

TEMPERATURE
(Results depend upon the
process specified and the
alloy used.)

Operating Range: -360°F (-218°C) to +1000°F (+538°C). Coating can be modified to withstand higher temperatures depending on application.

Operating Range: -100°F (-73°C) to +550°F (+288°C).

THICKNESS

Range: 0.0007" to 0.0015". Control of coating is ± 0.0003 " for 0.001" thickness. Thickness may vary with application load.

Meets the requirements of MIL-M-45202 and AMS-2476. Thickness range 0.0002 to 0.003". Surface growth is up to 70% of total thickness, depending on type and class.

**FDA/USDA
FDA 21 CFR 175.300****APPLICATIONS**

A solid, multi-metal lubricant that can operate in a vacuum with no outgassing or in high radiation environments. Ideal for use on splines, gears, bearings, rails, aircraft impellers, etc.

Ideal for use on frames, housings, gear boxes, wheels and any light weight, low inertia-required components. Sealed MAGNADIZE coatings prevent outgassing in vacuum applications.

CANADIZE®
For Titanium Alloys

MAGNAPLATE HCR®
For Aluminum Alloys

MAGNAPLATE HMF®
For Most Base Metals

A hydrogen-free, super-hard, fracture-free coating process specifically developed to prevent hydrogen absorption, a major problem often encountered in the surface treatment of titanium and titanium alloys. Exceeds performance requirements of AMS 2488.

High-technology coatings that increase atmospheric corrosion protection beyond all known methods of aluminum treatment while also providing superior coefficient of friction.

The coating creates an ultra-hard, mirror-smooth, highly reflective surface that exhibits a uniquely low coefficient of friction, exceptional wear properties and high temperature resistance.

Up to Rc 45.

Up to Rc 48. Equilibrium Wear Rate using Taber abrasion testing method #6192 of Fed. Std. #141 (CS-17 wheel): 2.75 mg per 1000 cycles. Exceeds AMS requirements by 5 times.

Up to Rc 68. Equilibrium Wear Rate using Taber Abrasion testing methods (CS-10 wheel): 0.2 to 0.4 mg per 1000 cycles.

Coefficient of friction: as coated 0.15; with dry film lubricants, as low as 0.04. Available with a variety of dry lubricants or can be combined with proprietary polymers.

Coefficient of friction: as low as 0.09.

Coefficient of friction as low as 0.05 without the use of polymers. Eliminates “stick slip” and undesirable vibration.

Titanium’s natural resistance to corrosion is enhanced by the CANADIZE process.

Total maximum achieved on 6061-T6 has exceeded 15,000 hours.

Exceeds 336 hours when thickness is 0.001” or greater. Cosmetics of chrome, but with greater corrosion resistance, and without the environmental concerns normally associated with chrome plating.

Operating Range: -200°F (-129°C) to +1200°F (+649°C).

Operating Range: -110°F (-79°C) to as high as +600°F (+316°C) for intermittent operating conditions.

Operating Range: -250°F (-157°C) to +950°F (+510°C).

Range: 0.0001” to 0.0006”. Titanium 6AL4V produces the best oxide coating.

Range: 0.001” to 0.0025” per side (±10%). Growth is approximately 50% of the thickness value.

Range: 0.001” to 0.002” growth per surface.

Can be FDA and USDA compliant.

Complies with FDA and USDA codes.

CANADIZE enhances surface hardness, eliminates galling, binding and seizing, and does not absorb hydrogen during processing. Provides permanent dry lubricity. Used extensively on aerospace and aircraft components.

MAGNAPLATE HCR on aluminum offers optimum service life for most applications — particularly where corrosion is a problem.

Recommended for packaging machines, closure devices, chutes, hoppers, folders, rolls, lathe beds, ball valves, and areas where high wear is encountered, as well as for products where a microfinish and/or static reduction is vital.

MAGNAPLATE HTR[®] and MAGNAMAX-HT[™]

For Extreme Temperatures

MAGNAPLATE BTC[™]

For Most Base Metals

MAGNAPLATE TNS[®]/TNSF

For Most Base Metals

MAGNAPLATE HTR dramatically increases release efficiency and resistance to wear at high pressures and very high temperatures.

MAGNAMAX-HT is a solid dry film lubricant that can withstand high temperatures while providing a low coefficient of friction.

HTR and HT can be used as an additional enhancement for TUFAM, NEDOX, or PLASMADIZE coatings.

As low as 0.13 dynamic, 0.14 static for HTR.

MAGNAMAX-HT was tested in accordance with ASTM G 99 05 and ASTM D 1894-01. Pin on Disk test results showed an average COF of 0.266 at 800C.

Some HTR coatings will survive 1000 hours in ASTM B-117 salt spray.

MAGNAMAX-HT exhibits resistance to most acids and alkaline environments.

HTR: Operating Range: 330°F (-165°C) to +950°F (+510°C).
Intermittent: over +1100°F (+593°C). Vacuum: to +2400°F (+1316°C).

The maximum operating temperature for MAGNAMAX-HT is 1500°F (815°C)

Surface build-up for HTR and HT is from 0.0002" to 0.002".

HTR is recommended for use on injection molds, seal bars, roll dies, gears and bearings, and bag formers.

MAGNAMAX-HT is ideal for applications which require a low coefficient of friction at high temperatures.

Chrome replacement coating for extreme wear resistance. This functional coating is a composite structure that offers extreme wear resistance with ductility and corrosion resistance without the need to perform secondary operations such as grinding, which is usually required with hard chrome plating processes.

Hardness range Rc 60 to an equivalent of Rc 70. Taber Abrasion testing per ASTM D4060 on steel: 5.2mg weight loss per 10,000 cycles, compared to 24mg weight loss for hard chrome.

Average Coefficient of friction: 0.223 Static and 0.227 Kinetic, a vast improvement over chrome's averages of 0.324 Static and 0.397 Kinetic.

Tests showed no sign of corrosion after 120 hours.

Maximum operating temperature 900°F (450°C).

Thickness range from 0.0002-0.0015".

Air locks, hydraulic actuators, propeller hubs, pump shafts, turbines, oilfield, helicopter and generator components, and aircraft landing gears.

Non-stick release coatings prevent residue buildup on labeling equipment and metal parts in contact with tapes, adhesives or hot melt glue.

Typically Rc 35. Nominal abrasion resistance as measured by Taber Abrasion using CS-17 wheel; can be as low as 0.5 mg per 1000 cycles depending on surface roughness.

Generally 0.2 to 0.35 depending on surface roughness. Lower surface roughness will have lower COF at some reduction in release.

Resistance may vary depending on materials used.

Service temperature up to 300°F (149°C). TNSF can withstand 600°F without significant thermal degradation.

0.002" to 0.005".

MAGNAPLATE TNSF has been formulated to provide adhesive and glue release along with offering FDA compliance for direct food contact. Can be engineered to comply with USDA codes.

Most parts used in the manufacture or handling of adhesives or hot melt glue. Increases service life of machinery where sticking or buildup is a problem.

MAGNAPLATE 10K™ SERIES

The Next Generation of High Temperature Coatings – Beat the Heat – Get Release

MAGNAGOLD and GOLDENEDGE

For Most Base Metals

DYNALOY®

For Most Base Metals

Each of the three types of Magnaplate 10K can be applied to all coating families. 10K series offers many benefits including release at high temperatures, low surface energy, excellent hydrophobic properties and have no PFOA or fluoropolymers.

Enhanced PVD coatings. MAGNAGOLD is processed at lower temperatures, allowing the coating of a greater variety of materials without causing loss of hardness or distortion of the substrate. GOLDENEDGE provides an ultra-hard, micro-thin surface enhancement for blades or other sharp-edged devices. Lengthening service life by as much as 20 times.

Extremely thin, enhanced proprietary chrome process protects against wear, galling, friction and corrosion. Creates a micro-surface that aids in lubricant dispersion.

Excellent abrasion resistance through a wide range of operating temperatures.

Up to a hardness equivalent of Rc 85. Equilibrium Wear Rate using Taber abrasion testing methods #6192 of Fed. Std. #141 (CS-10 wheel): 0.5mg per 10,000 cycles. A thin, dense surface coating that wears better than most metals.

Hardness in excess of Rc 67.

The 10K Series of coatings have excellent coefficient of friction values. Samples were tested per ASTM D1894, and results show that 10K coatings function after being exposed to temperatures well beyond the capabilities of standard polymer coatings.

As low as 0.11 depending on original microfinish or mating surface.

Eliminates friction over a wide range of applications and environments. Extremely thin coating does not affect tolerances.

Salt spray tests are ongoing – results so far exceed 2000 hours.

Resistant to most acids, alkalis, fluxes, solders, and weld splatter.

Resists attack by most organic and inorganic compounds. Base metal porosity, surface hardness and other factors affect corrosion resistant properties.

10K1 operating temperatures to 1000F
10K2 operating temperatures to 1000F
10K3 operating temperatures to 850F

Operating range: -360°F (-218°C) to as high as +800°F (+427°C) for intermittent operating conditions, depending upon the process specified and the alloy used.

High temperature resistance. Operating range from 399°F (204°C) to 1699°F (926°C).

0.0002-0.002"

MAGNAGOLD – A thin uniform coating ranging in thickness from 0.00004" to 0.00030" or 1 to 7.5 microns. Meets performance requirements of AMS 2444. GOLDENEDGE – A thin uniform coating ranging in thickness from 0.00004" to 0.00006" or 1.0 to 1.5 microns.

Uniform in thickness and range from 0.0001" to 0.0003".

Complies with FDA and USDA codes.

Comply with FDA and USDA codes.

Seal jaws, griddles, autoclaves, turbines, mandrels, molds and dies.

Typical MAGNAGOLD applications include punches, hobs, dies, bearings, taps and more; also used on aerospace components. GOLDENEDGE enhances sanitation in cutting, dicing, grinding, slicing, and sawing operations, among others. Reduces blade changing by keeping edges sharper longer.

Typical applications include bearings, blades, clamps, conveyors, molds, pistons, rollers, pumps, tooling, valves, and wear plates.

PLASMADIZE® For All Base Metals

LECTROFLUOR® For All Base Metals or Combinations

Any of General Magnaplate's FDA-compliant coatings can benefit from the addition of MAGnanoSHIELD® for anti-microbial protection

This next generation of thermal spray coatings features high levels of wear and corrosion resistance, dry-lubricity and mold release not possible with conventional spray methods. Infused matrix of metals, ceramics, proprietary polymers and/or dry lubricants creates structural integrity and a non-porous, moisture-proof surface that passes the 180° bend test.

A series of proprietary polymer and copolymer based coatings that exhibit superior chemical and corrosion resistance in extremely hostile environments, at both high and low temperatures. Coatings have excellent mold release properties.

Provides unsurpassed wear resistance. Can exhibit 10 to 15% increase in wear resistance over thermal sprayed plasma tungsten carbide coatings, and up to 30% over thermal sprayed plasma ceramic coatings.

A series of surface coatings with basic hardness ranging from Shore D 75 – 85.

PLASMADIZE provides a highly lubricious, non-stick surface with a coefficient of friction as low as 0.06 compared to a COF of 0.22 for thermal sprayed tungsten carbide.

Coefficient of friction: as low as 0.10.

PLASMADIZE coatings can exceed 4000 hours salt spray, depending on the coating type used. Resists most acids, alkalis, and organic solvents.

Resistance to most acid and alkaline environments is excellent. For specific chemical environments, consult the resistance chart of the recommended LECTROFLUOR coatings.

Operating Range: -200°F (-129°C) to +1300°F (+704°C).

Operating Range: -400°F (-240°C) to +600°F (+315°C).

Normal coating thicknesses range from 0.002" to 0.010". Thicker coatings can be applied for salvage and repair of parts, depending on the application.

Range: 0.001" to 0.030".

Many comply with FDA and USDA codes.

Many comply with FDA and USDA codes.

PLASMADIZE is ideal for protecting or restoring all types of metal parts. Available as a release (non-stick) or gripping surface up to +1300°F (+704°C). Ideal for a wide range of food, packaging and oil and gas industries.

Recommended for use wherever lubrication, protection against corrosion, release, radiation- and UV-resistance are required. Also used in dielectric applications. 600-2000 V/mil ASTM D 149.

Antimicrobial materials based on metal complexes have become an effective weapon in the war against deadly microbes that cause food-borne illnesses, hospital infections and contaminated drugs. Yet these antimicrobial materials have shown a limited ability to deliver microbe resistance as part of a comprehensive surface enhancement treatment. MAGnanoSHIELD eliminates this limitation by offering microbe resistance in conjunction with other beneficial surface properties. It's now possible to specify a single coating that not only resists microbe growth and is FDA compliant, but also provides protection against friction, wear, moisture, chemical exposures and more.

Because MAGnanoSHIELD is incorporated into Magnaplate's existing wear-resistant coatings, it also offers durability and substrate compatibility that earlier antimicrobial materials could not achieve.

Keep it CLEAN with MAGnanoSHIELD By Improving Sanitation

- * Antimicrobial protection (99.9999% reduction in bacteria and fungus)
- * Interferes with DNA replication
- * Damages the cell wall of microbes altering cell membrane permeability and/or
- * Combines with bacteria proteins located in the cell wall and cytoplasm which interferes with normal cell functions
- * FDA compliant

Keep it LEAN with MAGnanoSHIELD By Improving Production Efficiency

- * Reduce chemical cleaning materials
- * Reduce maintenance man hours
- * Increase production run times
- * Reduce water usage

Magnaplate Worldwide™

General Magnaplate has created MAGNAPLATE WORLDWIDE, a global network of our facilities and our licensees. This network links our customers to facilities across the globe that can service their surface enhancement needs. All of our licensees have passed stringent quality tests, assuring that our coatings will be uniform no matter what country or continent they are processed in. The goal of every member of MAGNAPLATE WORLDWIDE is to provide surface enhancements which consistently meet the standards set by our customers, and do so with on-time deliveries in an environmentally friendly, safe and efficient workplace.



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