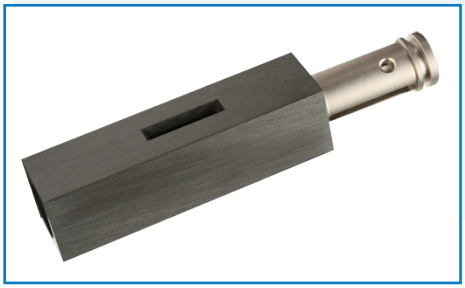
MAGNAPLATE
COATINGS ENGINEERED FOR YOUR SUCCESS

Tufram®

Surface Enhancement Coatings Protect Aluminum and Aluminum Alloys Against Wear, Corrosion, Sticking and Galling

BENEFITS

- Dramatically increase surface hardness
- Resist corrosion, chemicals and acids
- Prevent abrasive wear and galling
- Provide superior mold release
- Meet AMS 2469 and AMS 2482
- Offer high dielectric strength
- Meets the End of Life Vehicle (ELV) initiative for the automotive industry
- Self-lubricating for extended wear
- Many types meet FDA and USDA codes
- Speed cleanup and sanitation maintenance
- No outgassing in the vacuum of space
- Low COF eliminates sticking and product "hang up"
- Won't chip, peel or flake off like "paint-ons"
- Resistance to ultraviolet light



TUFRAM on this pneumatic shifter reduces friction as the accompanying piston runs against it. The shifter is used on aircraft towing vehicles, which operate under substantial loads.

Engineers worldwide recognize TUFRAM® as the solution to a host of problems encountered in commercial applications in all types of manufacturing, processing and packaging equipment.

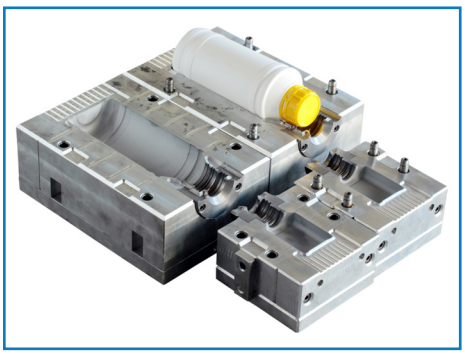
Created in a proprietary, multi-step process that makes aluminum surfaces harder than steel, TUFRAM coatings combine the hardness of aluminum oxide ceramic with the desirable properties of selected Magnaplate proprietary polymers to give aluminum parts previously unattainable levels of hardness, wear and corrosion resistance, as well as permanent lubricity.

ENGINEERING DATA & PERFORMANCE CHARACTERISTICS

Corrosion resistance. TUFRAM coatings exhibit much greater corrosion resistance than conventional hard anodizing. Some types show extremely high resistance to most common chemicals and salt spray. A TUFRAM-coated surface showed almost no corrosive activity after prolonged, continuous exposure to the atmosphere and salt water. In addition, TUFRAM enhancements on high-strength aluminum meet the AMS 2482 requirement of a minimum of 336 hours in salt spray.

When maximum corrosion resistance on aluminum is required, MAGNAPLATE HCR®, which provides up to 15,000 hours of required protection, is recommended.

Abrasion resistance. A smooth surface substrate produces the most abrasion-resistant TUFRAM finish. Taber abrasion measurements show that its wear resistance is far better than either case-hardened steel or hard chrome plate.



TUFRAM on bottle molds prevents erosion and galvanic corrosion causing poor release, high reject rates and shortened mold life.

TUFRAM provides superior protection in severe abrasive environments, such as on roller guides used to manufacture cardboard tubing.

USDA/FDA-compliant TUFRAM resists clean in place washdowns and sticking issues in tablet press machinery.

Friction. In some cases, the static friction decreases with an increase in load. TUFRAM eliminates “stick-slip” and undesirable vibration of higher break-away friction.

Hardness. Varies depending on the TUFRAM chosen and alloy used.

Adherence and impact resistance. TUFRAM coatings adhere firmly to most alloys, especially those containing magnesium. Impact resistance is limited only by the structural strength of the base metal to which they are applied.

FDA/USDA compliance. Compliance with FDA and USDA codes makes most TUFRAM coatings advantageous for food and pharmaceutical processing and packaging, and some medical industry applications.

Temperature. Exhibits high strength, toughness and self-lubricity down to -360°F (-218°C), and intermittent operating capability at temperatures as high as +950°F (+510°C), depending upon the process specified and the alloy used.

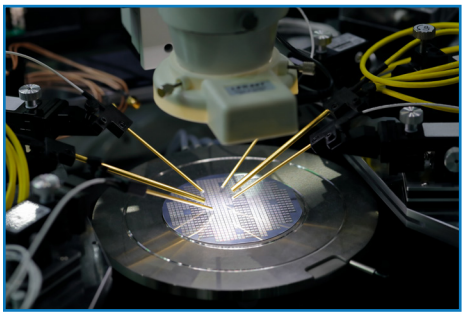
Non-stick release properties. Very few solid substances, even adhesives, adhesive-backed products or glues, will permanently adhere to the proprietary-polymer-impregnated surface of a TUFRAM-coated part. Most substances, such as plastics, rubber or slurries, release easily. Some extremely tacky materials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

Self-lubricating surface. Proprietary polymers impregnated into the aluminum during the TUFRAM process level off surface asperities to provide a permanent self-lubricating surface, and result in greatly reduced surface tension. TUFRAM-coated parts exhibit a longer wear-life, require less maintenance and provide greater operating efficiencies with less downtime. Mating parts that operate with a sliding or rotating motion experience a dramatic reduction in friction.

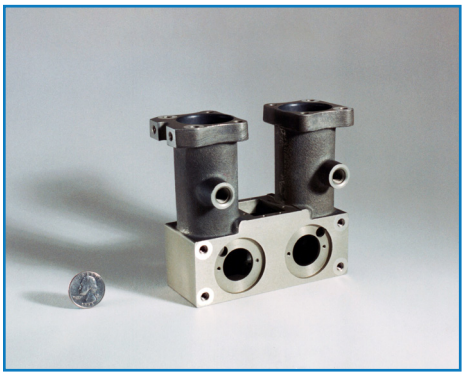
Thermal conductivity. Aluminum that has been coated with TUFRAM exhibits rapid heat and cold transfer. By converting the original single flat crystal into millions of surface facets, the TUFRAM process permits heat distribution within the encapsulated outer surface far better than that of untreated aluminum.

Resistance to acid and alkaline solutions. Some TUFRAM types provide superior resistance to attack from acid or alkaline solutions and atmosphere.

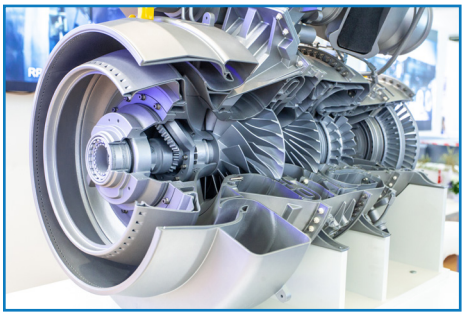
Non-wetting. The new, integral surfaces are oleophobic and hydrophobic, and resist wetting by most liquids. Cleanup is faster, easier and more thorough. Parts become self-cleaning. Maintenance time and labor are greatly reduced.



TUFRAM coatings are excellent in vacuum environments. The TUFRAM coating on this wafer chuck provides wear resistance and does not generate particulate under vacuum, enabling contamination-free wafers to be manufactured.



TUFRAM coatings protected aluminum fuel mixing control valves on the LEM Ascent Engine of Apollo 13 against vibration and "outgassing," operating in a vacuum and temperature variations.



Aluminum air compressor impeller blades exhibit longer wear life, reduced drag, and improved airflow after being coated with TUFRAM to protect them against corrosive and erosive chemical process industry gas streams.

Performance in vacuums. TUFRAM coatings have been applied to parts on many space vehicles. They are required to perform in very challenging environments, including vacuums, and under conditions of extreme vibration. TUFRAM is ideal for vacuum packaging and machinery that must operate under vacuum.

Application to aluminum alloys. Aluminum and its alloys that contain less than 5% copper and 7% silicon and that do not contain excessive zinc or lead are most suitable for the application of TUFRAM coatings. Most cast, forged, extruded or wrought alloys can be treated. The degree of hardness or penetration does vary with some alloys. Finish color may vary depending on base alloy, coating selection and thickness.

Coating tolerances and thickness. With few exceptions, a consistently uniform coating can be applied to parts of any configuration or weight, and virtually any size or thickness. Precise control of thickness permits use on threaded members and similar close-tolerance applications. By undersizing outside pitch diameter by roughly twice the coating thickness prior to coating, original thread sizes are maintained.

For machining allowances, note that overall final thickness of the coating is influenced by two factors:

A. Penetration

B. Surface Growth

The table below shows typical examples:

COATING THICKNESS	SURFACE GROWTH*
0.0008 inch	0.0004 inch
0.0010 inch	0.0005 inch
0.0020 inch	0.0010 inch

*Growth is approximately 50% of the thickness value

Thickness is customized for each application. Maximum thickness is limited by alloy composition. Minimum practical thickness is 0.0002 inch.

Dielectric properties. The TUFRAM process converts the aluminum surface to one with excellent dielectric characteristics, without affecting the high conductivity of the parent metal. The proprietary-polymer impregnation imparts outstanding properties as an insulator. The polymers do not absorb water. Non-conductive TUFRAM acts as an insulator.