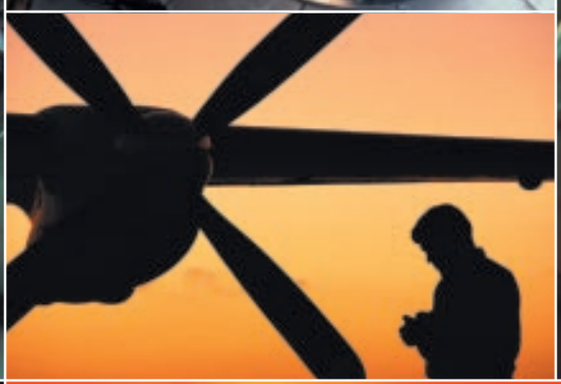
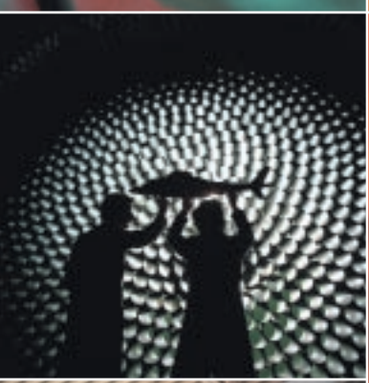
PRAXAIR
SURFACE TECHNOLOGIES

# The Power of Praxair









# Delivering Powerful Performance

**You want performance you can count on. Praxair Surface Technologies has the power to deliver. You want high quality, cost effective, surface enhancement solutions. We respond from 35 state-of-the-art global facilities. No other company has the same range of capabilities and resources to compete in today's demanding environment.**

**That's why original equipment manufacturers (OEM), airlines and maintenance and repair facilities (MRO) partner with us when they want the best result to tough problems. We reduce the harmful effects of abrasion, oxidation, corrosion, erosion, wear and extreme heat on aircraft engine and airframe parts and accessories. Our coatings and repairs extend product life, increase productivity and reduce operating costs by using innovative processes like our detonation gun, plasma spray and HVOF.**

**Our complete line of repair procedures rounds out the requirements needed to complete the full job scope. Then, our performance-driven workforce delivers the required results where they're needed and when. Since the early 1950's, we've brought powerful solutions to the gas turbine industry. That's the power of Praxair.**

# Applications

## Meeting the challenges of advanced aviation

From the beginning of commercial gas turbine flight, we helped major engine manufacturers find ways to make jet engines fly longer between overhauls. Our super-hard tungsten carbide and chromium carbide coatings became core elements in gas turbine designs.

Now there are hundreds of parts for which Praxair coatings are “bill of material” on OEM specifications from General Electric, Pratt & Whitney, Rolls Royce, Honeywell, Boeing and Sikorsky, among others. Advanced work continues on the next generation of thermal barriers to further reduce component temperatures and clearance control systems. Customers worldwide depend on our materials, coating processes and component repair services to help reduce downtime, provide cost-effective overhaul of costly components, and increase the use of lighter, stronger materials.

### Gas turbine engine applications

Commercial aeronautical design engineers know Praxair coatings deliver powerful performance over a wide range of operating temperatures. These reliable and consistently applied coatings enhance the life of critical parts, giving customers cost-effective results for longer component service life.

Praxair’s expert repair services restore critical, expensive turbine engine components for both civil and military aircraft engines. Our state-of-the-art brazing techniques, welding, machining, fabrication, heat-treating, shot peening and restoration coatings help ensure peak engine performance at the lowest total operating cost.

As requirements change, so do our capabilities. We continually develop new surface design alternatives to increase the life of advanced engine components and reduce scrap rates, which lowers operational costs and increases value at overhaul.

### Critical component maintenance

We provide high-quality aircraft component overhaul and repair for both commercial and military applications. Our applications provide repair and coating applications for naval, air, and land-based military components. Services include parts repair based on OEM engine or airframe manuals, government work specifications, FAA Designated Engineering Representative (DER) repairs, parts exchange and part inventory management programs. Our existing partnerships provide additional support for new production and aftermarket products.

# Improving critical airframe component performance

Praxair coatings are used in a growing number of airframe structural components and systems, often where coatings have not been used in the past or in place of other surface treatments.

Praxair has been named a preferred supplier for all Boeing titanium slat and flap track repairs, and we are able to perform all repairs required by manuals and service bulletins. Our facilities are D1-4426 approved for special processes and are fully equipped with on-site machine shops capable of providing a full range of repair, coating, and plating options. With procedures continually optimized and managed by qualified personnel, we can significantly reduce turnaround time. AOG repair service is available on select flight control components.

## Coating and repairs for helicopters

High vibrations create unique forms of stress in helicopter components. The low-fatigue properties of Praxair coatings make them particularly well suited to helicopter applications. In addition, their compatibility with higher strength, lighter materials (such as aluminum and titanium) enable designers to improve performance and reduce weight without compromising structural integrity.

# Quality

## Committed to excellence

### Global quality standards

Throughout every operation, we continue to challenge our own high standards in pursuit of tighter tolerances and greater product performance. Our centralized quality department sets strict requirements for repeatability and consistency. At every production location, metallurgical labs monitor all processes to ensure these standards are met.

### Programs that raise the bar

Not satisfied with these extremely high quality levels; our trained specialists are dedicated to building value through management techniques such as world class manufacturing and “Lean Initiative” programs.

Praxair is strongly committed to “Six Sigma” to achieve new levels of productivity and continual quality improvement. The reduced errors and rework resulting from this step-by-step, problem-solving methodology helps provide higher quality and more effective customer service.

*The bottom line:* Praxair makes the most of its resources to deliver superior products at competitive prices.

### Certifications

Our external certifications and approvals reflect our emphasis on quality. Praxair is certified by the FAA, JAA, CAAC, Euro-FAA, NADCAP, and other major authorities; and many of our facilities are ISO 9001-2000 and AS 9100 certified to meet customer requirements.

### Customer service

Our people are committed to exceeding customer expectations. Every employee, using quality management programs and systems, works to ensure total customer satisfaction. The skilled representatives in our customer service network strive to make sure all work matches customer expectations and requirements.

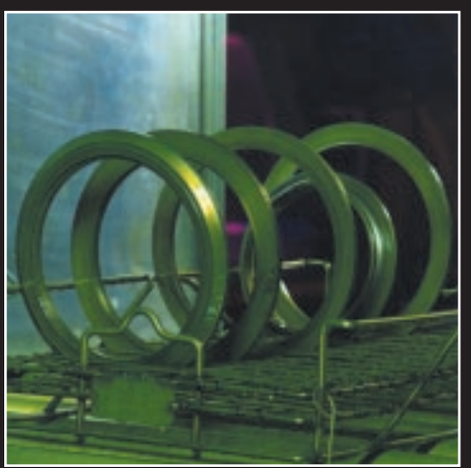
Praxair Surface Technologies

# Services

**Surface Treatments**
Anodizing
Chemfilm/Alodine
Chemical Vapor Deposition
Chromic-Sulfuric or Hard Coat Anodizing
Copper Plating
D-Gun™ Coatings
Dry Film Lube
Electroless Nickel
Electrodeposition – Tribomet™
Engineered Hard Chrome Plating
FELTMETAL®
Honeycomb
HVOF Thermal Spray Coatings
Industrial Painting
Inorganic Spray Coatings
LHE Cadmium and Ti-Cad Plating
Manganese Phosphate
Passivation
Physical Vapor Deposition – EBPVD
Physical Vapor Deposition – Cathodic Arc
Plasma Spray Coatings
Platinum Aluminide
Silver Plate
Solid Film Lubricants
Sulfamate Nickel
Super D-Gun™ Coatings
Surface Preparation and Paint
Tribomet™
Wire Arc, Flame Spray
Zircoat™
Zinc Phosphate

**Finishing and machining**
Abrasive waterjet
Automated turning
Balancing
Blending
Brushing
CNC machining, milling and drilling
Electrical Discharge Machining – EDM
Grinding
Honing
Lapping
Large diameter machining
Large milling capabilities
Mechanical sizing
Polishing
Sanding
Spark erosion grinding
Surface grinding
Vertical milling
Vibratory
VTL

**Certified welding**
Dabber T.I.G.
Electric Arc
Electron Beam
Gas Tungsten Arc
Metal Inert Gas
Micro Plasma
Pulse T.I.G.
Resistance Spot
Tungsten Inert Gas



**Inspecting and testing**
CMM Digital Laser Scanning
Eddy Current
ETC-2000 Automated Eddy Current
Fluorescent Penetrant
Gaging and Dimensioning
Laser Holography
Magnetic Particle
Moment Weigh
Nital Etch
Profilometer
Radiography
Ultrasonic
Ultrasonic C-Scan
X-Ray

**Heat treatment and brazing**
Atmospheric Brazing
Atmospheric Heat Treat
BrazeAway
High Temperature Vacuum Brazing
Honeycomb Brazing
Inert Gas Brazing
Inert Heat Treat
Vacuum Heat Treating

**Material forming**
Cold Metal Forming
Hot Metal Forming
Mechanical Sizing

**Other service operations**
Abradable materials
Abrasive blasting
Acid stripping
Aluminum Oxide blasting
Ceramic peening
Chemical stripping
CMM
Creep forming
De-brazing (disjoining)
Electrolytic stripping
Gaging and dimensioning
Glass bead peening
Graphite varnishing
Grit blasting
Mechanical stripping
Moment weigh
Sealing
Shot peening
Silicon carbide blasting
Steel shot peening
Stress relief
Ultrasonic cleaning
Vibratory tumbling
Water Jet cutting
Water Jet stripping

**Manufacturing**
Large diameter machining
Large milling capabilities

# A broad range of coating alternatives

Because no single coating process is the best solution to every surface problem, Praxair offers a wide range of alternatives for your application. We developed and patented many of the methods and materials used today, so we know more about them than any other company. Our innovations go beyond traditional line-of-sight systems like the detonation gun and include surface technologies such as EBPVD (vapor deposition), Platinum Aluminide (diffusion), and Tribomet™ (electrodeposition) coatings.

### Thermal spray coatings

Thermal barrier, tungsten carbide, chromium carbide and copper-nickel-indium are just a few of the coatings we can apply using one of several thermal spray technologies. Multi-axis robots and automated systems assure reproducibility and precise control of coating thickness.

### Super D-Gun™

The Super D-Gun™ ejects particles at extremely high velocities typically exceeding 3,000 ft./sec. This process results in significant improvements in coating properties, such as fatigue, over those of other thermal spray coatings.

### D-Gun™

Like the Super D-Gun™, the original D-Gun (detonation gun) process produces coatings that exhibit extraordinary wear and mechanical properties. By combining volatile gases and controlled amounts of powder, the D-Gun blasts the coating material into the surface of the component generating outstanding bond strength and density. The D-Gun remains the benchmark in thermal spray coating technologies.

### High-Velocity-Oxygen-Fuel (HVOF)

The HVOF coating process introduces powders of metals or cermets into a high-temperature, high-velocity gas stream. The stream heats and propels them against a prepared surface. HVOF coatings have excellent density and low oxide levels providing enhanced wear and corrosion resistance.

### Plasma spray

In plasma-sprayed coatings, powdered material is heated and accelerated in a high-temperature plasma stream and projected against the surface. Standard production coatings include pure metals and metallic alloys such as nickel or ni-chrome; and ceramics such as alumina, chromium oxide or alumina-titania, and cermets.

### Electron Beam Physical Vapor Deposition (EBPVD)

High-performance thermal barrier coatings are applied to turbine and combustor components in state-of-the-art EBPVD coaters. Praxair's thermal barrier coatings created using EBPVD technology provide fine columnar microstructures that are highly tolerant to lateral strain. Aero-engine and industrial gas turbine-sized components can be coated with this process. We are continually working to improve existing applications as well as develop next-generation-engineered surfaces.


### Cathodic Arc Physical Vapor Deposition (CAPVD)

Praxair uses Cathodic Arc PVD for ultra-hard wear, corrosion and erosion-resistant thin-film coatings on precision parts. This extremely versatile process allows the deposition of pure metals, metal nitrides, carbides and carbo-nitrides as a monolayer, multilayer, graded or alloy film. Praxair offers TiN, ZrN and CrN as monolayer and multilayer coating with a controlled stoichiometry up to over 20-micrometer coating thickness.

### Platinum Aluminide Diffusion

In addition to simple aluminides, Praxair offers platinum aluminide coatings – the coating choice for many aviation gas turbine hot section airfoils. These coatings provide exceptional oxidation protection compared to the simple aluminides and are used for many HP and LP turbine airfoils where additional environmental protection is needed. Platinum aluminide coatings also provide exceptional Type I and Type II hot corrosion protection and are used in marine and industrial gas turbines to minimize corrosion.

Platinum aluminide coatings are produced in several steps. A precisely controlled platinum layer is first deposited by electroplating. The Pt layer is then diffused into the superalloy through vacuum heat treatment and is subsequently aluminized via a vapor phase aluminizing process capable of simultaneously coating external airfoil surfaces and the internal airfoil cooling passages when desired.

### Tribomet™ Electrodeposition

Praxair applies Tribomet™ abrasive coatings, Tribomet™ wear-resistant coatings or Tribomet™ MCrAlY coatings using highly automated plating tanks that are computer controlled for time and operation sequence. This non-line-of-sight coating technology permits better thickness control than thermal spray coatings, in addition to excellent metallurgical bonding and low porosity. Recent developments include abrasive tip coatings as well as new McrAlY and carbide chemistries.

### Tank Platings

Praxair's modern, environmentally sound tank plating facility enhances our coatings and repair capabilities. Responding to the growing demands for exacting specifications, consistency, quality, dependable turnaround time, and competitive pricing; we provide a very high degree of control in electro-deposition of chrome, nickel and silver, as well as the capability for electroless nickel plating, with ancillary services for turnkey results that meet our customers' needs.

Our plating baths are computer controlled with multiple rectifiers to allow simultaneous plating of various parts and configurations. Chemistries are monitored and maintained by an on-site laboratory. Combined with specialized tooling and conforming anodes, our plating process delivers levels of consistency, repeatability, quality, and cost-efficiency that are uncommon in conventional plating systems.

Innovation

# R&D: Keeping the innovations coming

Reflecting our tradition of innovation, Praxair's R&D capabilities are world class. On-going research is fundamental to our industry leadership, and we continue to develop more technologically advanced answers for tomorrow's coating needs.

## Top research scientists

Praxair offers customers access to some of the world's most renowned scientists in the coatings industry. These highly qualified professionals have published extensively, literally "writing the book" when it comes to many application techniques. They work with a staff of experienced lab technicians, specialists and research engineers to continually develop new coating processes and products.

## Unmatched testing facilities

Praxair's testing and analytical facilities provide an extremely broad range of testing procedures – from performance analysis to materials selection and from micro-structural characterization to surface topography. As a result, we can often replicate a customer's operating environment.

## Experience the power

Whether it's the desire to achieve the ultimate design for a new component or a need to improve a current design, we invite you to partner with Praxair Surface Technologies. Experience the excitement that comes from working with the best minds in the business to find the best solutions for surface enhancement. Experience the power of Praxair.

PRAXAIR®
SURFACE TECHNOLOGIES



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