TECVAC

Accredited Nadcap™ Coatings

High Performance Nitron™ Flight Coatings for Aerospace Components

Nitron™ Flight takes off at Tecvac – high performance Nitron™ Flight coatings for aerospace components

Tecvac Limited are the only company who can offer NADCAP approved, Nitron™ Flight, high performance physical vapour deposition (PVD) coatings. Our advanced range of Nitron™ Flight coatings can help manufacturers and operators (both civil and military) to:

- reduce life cost of ownership
- increase aircraft and mission availability
- become more environmentally friendly in an era of ever increasing costs of aviation fuel and scarce material resources.

Our Nitron™ Flight anti-erosion coatings can:

- assist you to maintain your engine's optimised SFC for longer – saving fuel, reducing emissions.
- enable your rotatables to remain 'on-wing/in operational service' for longer.
- resolve your material interface issues, enabling weight-saving combinations of material to be utilised in aerospace and defence applications.

Find out more today and let Tecvac's coatings help you to maximise your time between overhauls (TBOs), reduce your inventory costs, develop weight-saving world-class design solutions and minimise operational costs, whilst thinking about our planet in the 21st Century.

Tecvac Limited are approved for coating and testing services with ISO 9001:2000, BSEN 9100:2003 and PRI NADCAP Approvals. We are already approved by Rolls-Royce who have our coatings in service, to offer a level of anti-erosion protection on various compressor stages of one of their commercial aero engine programmes. Our coatings are now on the Airbus A380 programme, where we provide PVD coatings for Ti/Ti surfaces on undercarriage bearings.

Tecvac Limited's coatings are also used in a number of other aerospace/defence/space related applications. Other components coated with Nitron™ Flight include actuation components, aileron control arms, bearings – engine/undercarriage, control systems, fuel systems and valve components.

We are now working with major bearing manufacturers, global aerospace OEMs and UK Ministry of Defence who all understand the benefits that they can achieve from our range of Nitron™ Flight, high performance, PVD coatings. Engine components are good candidates for the applications of our coatings – the following is an indication of a typical application:

Component:	Titanium and nickel alloy compressor rotor blades and stator vanes
Coatings:	Nitron™ Flight A/Nitron™ Flight B to reduce blade erosion from hard particles
Thickness:	6µm to 8µm multi layers
Notes:	The Nitron™ Flight coating has advantages in this application because the coating is very smooth and relatively free from defects. The low stress, thin film coatings counter any potential delamination

The cost of aviation fuel is still rising and focusing everyone's minds as can be seen from the following IATA Jet Fuel Price Monitor, current as of 27 June 2008 (based on the latest price data from the leading energy information provider *Platts*). The weekly index and price data shows the global average price paid at the refinery for aviation jet fuel.

Understandably, aerospace designers and manufacturers have seen a change in design objectives over the last twenty years in terms of overall efficiency improvement requirements such as reduced fuel consumption and lower emissions. Over the past fifteen years the weight of medium range civil aircraft has fallen from 35% of gross

Current price of aviation jet fuel and impact on year's fuel bill of the global airline industry (as at 27.07.08)

	Index*	$/barrel	cts/gal	$/mt	% change 1 week ago	% change 1 month	% change 1 year
Jet Fuel Price	**469.8**	**171.9**	**409.2**	**1354.4**	**+3.9%**	**+2.3%**	**+96.2%**

New fuel price average for 2008 **$136.9/barrel** Impact on 2008 fuel bill **+$83 billion**

takeoff weight to 29% – with a concomitant increase in payload weight from 17%–23% – an increase of 30% in usable payload. The use of coatings to provide a support and wear resistant barrier for the substrate has had a significant input into this improvement in overall efficiency. Coatings allow engineers to look at less dense materials and more optimised, lower weight designs in their quest for minimising non-payload weight.

The Advisory Council for Aeronautics Research in Europe (ACARE) *Clean Sky* initiative has set challenging targets for the aeronautics and air transport Industry to be reached by 2020, which include:

- 50% reduction of CO_2 emissions through drastic reduction of fuel consumption per passenger kilometer
- 80% reduction of NO_X (nitrogen oxide) emissions.

Coatings have played a major part in aero engine design improvements and will continue to play a significant role in future design decisions by providing economic and safety benefits to aero-engine components and aerospace components and structures. In the future, typically over 50% of long haul operating costs will be engine related (fuel burn/engine ownership/engine maintenance). Tecvac Limited's Nitron™ Flight, High Performance, PVD coatings will help to keep these costs down and will contribute to the achievement of the environmental targets for the reduction of both CO_2 and NO_X emissions by 2020.

In general, the effect of multilayer coating super-finished compression blades is to improve the specific fuel consumption by 0.75–1.5%. Specific fuel consumption (SFC) is the measure of the amount of fuel to produce one unit of power.

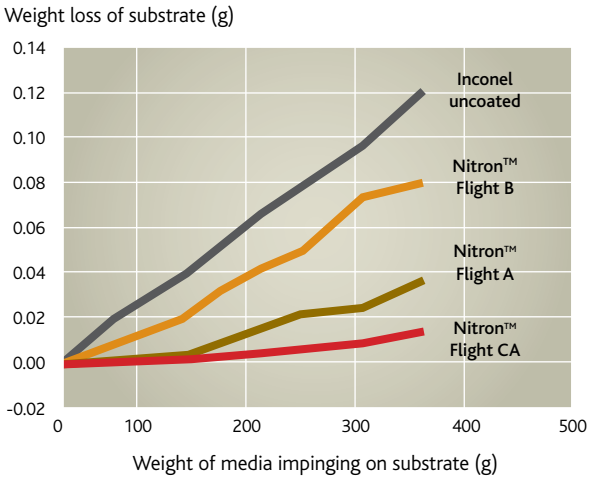
Performance and advanced repairs will play a greater role now and in the future as fuel and material costs continue to escalate. Therefore the ability to obtain more life from existing components is vital to sustain efficiencies. The use of re-usable, sacrificial PVD coatings – to maintain the enhanced surface finish of compressor blades and vanes for a longer period of operational life between overhauls – can demonstrate significant fuel savings over the lifetime of an engine.

Nitron™ Flight B

Nitron™ Flight A

Nitron™ Flight CA

Erosion Performance of Nitron™ Flight Coatings



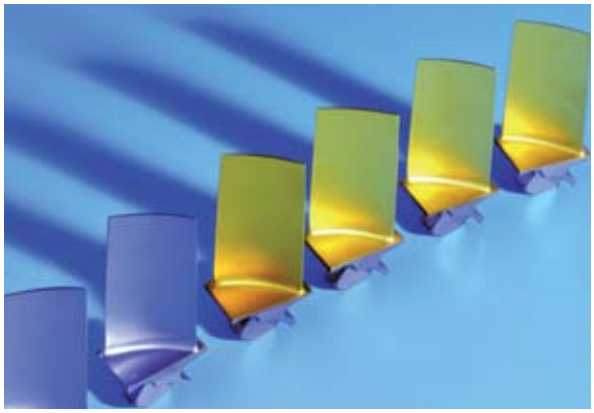
NITRON™ FLIGHT B
Gives between 1.4 and 2.7 times erosion protection over the life of the test – compared to uncoated Inconel.

NITRON™ FLIGHT A
Gives between 2.7 and 8.7 times erosion protection over the life of the test – compared to uncoated Inconel.

NITRON™ FLIGHT CA
Gives between 14 and 33 times erosion protection over the life of the test – compared to uncoated Inconel.

Nitron™ Flight Coatings on compressor blades subject to particle erosion, provides protection against critical shape changes and distortions at the airfoil leading edges, and against degradation of the surface that, without protection, can otherwise have a large effect on the aerodynamic efficiency of the compressor.

Tecvac Limited's Nitron™ Flight Coating in conjunction with a super finished substrate helps ensure mission readiness, maintained performance, operator safety, and optimal life cycle costs.



A full coating portfolio to meet the varying application demands

In addition to the coating of propulsion components. Tecvac offer a range of coatings which can enhance the performance of other aerospace parts such as bearings, seals, valves, actuation components and fasteners.

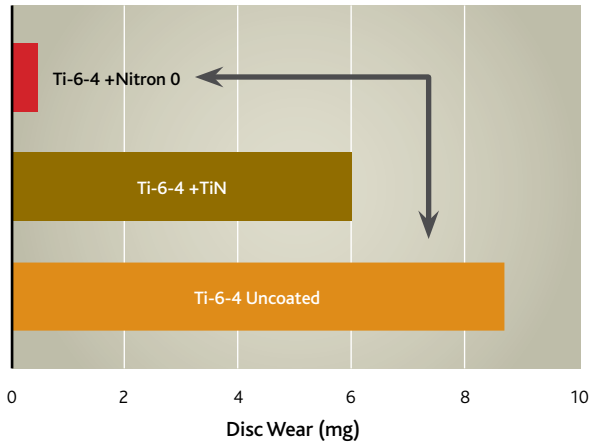
Titanium alloys have exceptional strength-to-weight ratios, good fatigue strength and outstanding corrosion resistance. However these alloys have poor tribological properties resulting in premature failure in service due to abrasive and adhesive wear.

In lightly loaded applications the performance can be greatly improved by coating with standard PVD Titanium Nitride (TiN), however, at higher loadings the inherent softness of the substrate can result in early failure – therefore a duplex process, which can enhance the surface hardness of the Ti alloy, is required.

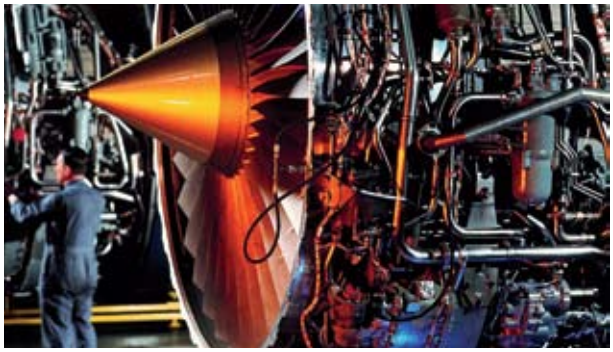
Tecvac have developed the Nitron 0 process to solve this problem. The components are treated using a twin heat treatment-deposition process in which a diffusion zone-rich in metal nitrides is formed beneath the PVD hard coating.

This patented technology results in coatings which are highly adhered and fully supported by a hardened sub-surface layer. The resultant effect is a vastly improved wear resistance with a concomitant improvement in service performance. Evidence of this effect can be seen in the two graphs shown below.

Sliding wear comparison of uncoated Ti-6-4 vs TiN coated and Nitron 0 coated

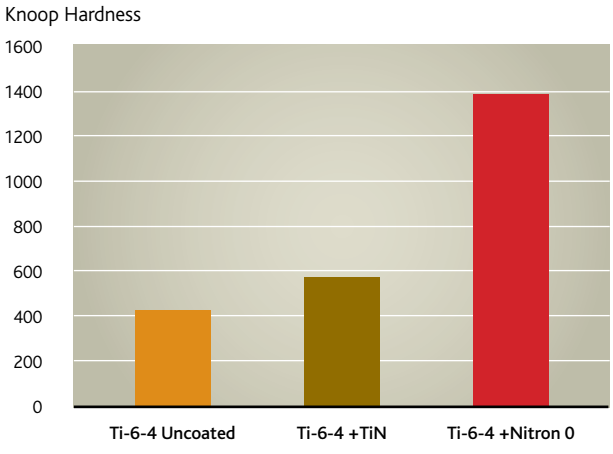


Nitron™ Flight CA offers real performance benefits for compressor blades and vanes. However, its capabilities in high load bearing and elevated temperature applications makes it also beneficial for valve components, fasteners and high temperature seals as well as landing gear and engine bearings.



Nitron™ Flight MC-a WC/C based amorphous carbon coating (Me-C:H) is a derivative of pure Diamond-Like-Carbon (DLC) coatings. MC is a relatively low hardness but extremely lubricious coating suited to provide exceptional performance in medium to high loading conditions for instance bearings operating up to 2000N/mm^2. The low coefficient of dry friction <0.1 means that the uncoated mating part is also protected against wear under sliding stress. Coating both contact surfaces improves the CoF still further by a factor of 2. Nitron™ Flight MC is applied at temperatures of 2500˚C so it can be used to coat sensitive heat treated components. Its inherently low friction coefficient renders it an excellent coating choice for fasteners, gear wheels and actuator roller bearings.

Knoop hardness values for 100g load (Titanium alloy uncoated/TiN coated/Nitron 0 coated)



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