Replacing hard chrome with a suitable alternative remains a significant challenge for the aerospace industry (above).

The search for a suitable replacement to hard chrome on aerospace components has been a key supply chain priority for aircraft manufacturers. This is because of the documented health risks to workers and the impact on the environment from exposure to hexavalent chromium, a carcinogen that occurs during the chrome plating process and the most toxic form of chromium.

As a result, hard chrome is highly regulated in major markets worldwide. In the European Union, hexavalent chromium falls under the domain of the EU regulation, REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals), which establishes guidelines for the safe use of chemicals throughout the supply chain. Chromium is also closely regulated in the US by OSHA.

However, replacing hard chrome with a suitable alternative remains a significant challenge for the aerospace industry because of its widespread use as a surface coating on many components. Long prized for its hardness, ability to minimise sliding wear, corrosion protection and for extending the life of metal parts, it can be found on many applications such as aerostructures, landing gears, engine mounts and airframes. In many cases, it is used on components where there is metal-to-metal contact between moving parts due to its low coefficient of friction.

As a result, the process of replacing hard chrome requires aerospace companies to critically evaluate why they used hard chrome in the first place and to identify what problems it was addressing as they now seek to replace it with an alternative. This is a huge undertaking as each part that currently uses hard chrome needs to be reviewed for its functionality, its connectivity to other parts, wear...
With the increasing adoption of PVD coatings, the opportunity to eliminate hard chrome is becoming more certain (right).

Hard chrome can be found on applications such as aerostuctures, landing gear, engine mounts and airframes (below).

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Promoting the coatings

One alternative that is increasingly being utilised in the aerospace industry are PVD coatings, a strong non-hazardous, REACH-conforming replacement option to hard chrome.

Physical vapour deposition (PVD) coatings offer many of the same benefits and, in some ways, is superior to hard chrome.

Physical vapor deposition describes a variety of vacuum deposition methods that can be used to produce thin coatings. PVD is typically used to coat components at relatively low coating temperatures of 160-500°C. These temperatures are ideal because they are below the tempering temperature of steels so as to avoid altering the fundamental material properties.

Among the PVD options are several carbon-based coatings available that provide a unique combination of extreme surface hardness, low friction coefficient and anti-corrosion properties. One example, BALINIT C from coatings provider Oerlikon Balzers, has attracted the attention of some of the largest aerospace manufacturers in the world, including Airbus.

In November, Airbus announced it was expanding the use of BALINIT C to include copper alloys - a substrate commonly used for bearings and bushings in aircraft landing gear and its connectivity to an airframe. Previously, Airbus had approved the PVD coating for use on steel, titanium and inconel substrates.

The technical qualification of BALINIT C, as a non-hazardous and REACH-conforming option to hard chrome plating, completes the Airbus Industrial Qualification Process for production centres at Oerlikon Balzers UK and Oerlikon Balzers France.

"Airbus has confirmed that our BALINIT C coating meets their technical and industrial requirements," said Oerlikon Balzers global aerospace segment manager, Toby Middlemiss.

Oerlikon Balzers uses a mixture of metal and diamond-like carbon to create BALINIT C, a tungsten carbide/carbon (WC/C) coating. The coating applies to a thickness of 1 to 5µm enabling its use on roller bearings and landing gear parts. It creates a bright finish and with the uniformity of this coating, the need for post-finishing is eliminated saving time and money.

This is a distinct advantage over hard chrome, which needs to be ground back to tolerances and polished to achieve a uniform finish.

With the increasing adoption of PVD coatings by industry leaders such as Airbus, the opportunity to eventually eliminate hard chrome entirely from the aerospace industry is becoming more certain.

"It has been a big task for the aerospace industry to replace hard chrome because it isn’t as easy to find an exact replacement - every alternative will be a bit different," Middlemiss concludes. "Manufacturers have had to go back to the drawing board and evaluate why hard chrome was used in the first place, what the application is and what the suitable alternatives are that might work. It will continue to take a rigorous, evidence-based evaluation - surface-by-surface, component-by-component - to ensure that safety, performance, reliability and cost criteria are all addressed.”

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