Got it covered?

With advances in coating technology, the potential to improve component performance and reduce maintenance costs is far too good to be ignored. Steed Webzell reports

Above: Hardide Coatings' furnace Centre: Ziroctec's plasma-sprayed ceramic process Inset: Guyson blast cabinet robot loading Below: Hardide coated ball valves

The scale of demand for innovative surface coatings, from sectors of manufacturing where component performance and longevity are key, demonstrates the potency of new technologies – and the sheer potential value for plant engineers throughout the rest of industry.

For years, engineers have been using coatings to extend the service life of materials by improving their resistance to erosion, corrosion, and thermal and chemical damage. However, today the choices are much wider and more powerful – ranging from metallurgical and ceramic, to chemical, such as plastics and paints – with recently developed deposition techniques driving developments.

Few sectors have been more persistent in the drive for new coating technologies than aerospace. Here, the need to deploy lighter materials (to improve speed, fuel efficiency and load-carrying capacity), able to withstand extreme operating temperatures, has spurred R&D efforts, resulting in very promising coatings with application potential way beyond flight.

A case in point comes from the Nanotechnology Centre for Physical Vapour Deposition (NTCPVD), part of the Materials and Engineering Research Institute (MERI) at Sheffield Hallam University. Here, a family of new materials, known as titanium aluminides (TiAl), and in particular gamma TiAl, has been proven to be as strong as nickel-based alloys when operating at temperatures up to 760°C – and yet only half the weight. Its only drawback to date: wear and erosion resistance are compromised when operating temperatures exceed 650°C.

However, the EU Innovational project, supported by the European Commission through the Sixth Framework Programme for Research and Development, involves 24 high-profile European partners focused on developing better processes and materials to allow nano-structured coatings to be applied to gamma TiAl, using PVD techniques.

Vapour deposition

Coating families developed by the centre in Sheffield include TiAlYCrN, CrAlYN/CrN, CrN/NbN, TiAlN/VN, TiAlCN/VCN and Me/C, all offering combinations of reduced friction, increased wear and corrosion resistance, and good protection against high temperature oxidation. Key to these new coatings is vapour deposition technology, using techniques including magnetron sputtering, cathodic arc evaporation and hybrids, such as low-pressure plasma nitriding combined with PVD.

Such is the scale of success that, again in the aerospace sector, there is now a growing number of replacement programmes designed to retrofit new, higher performance, coated components to replace parts coming to the end of their useful lives.

Hardide Coatings, for example, has developed a tungsten-carbide based coating for chrome replacement programmes that has now seen the company enter into a three-year approval test programme with Airbus – with confidence tests also being performed at a further seven aerospace facilities. Its coating provides high wear resistance against abrasion, erosion and corrosion on components made from ferrous and nickel-based alloys. Independent ASTM G65 testing has shown that it wears 40 times slower than abrasion-resistant

AR-500, 12 times slower than hard chrome and four times slower than thermal spray tungsten carbide.

Reducing wear on flying parts is key to driving down maintenance costs in any industry, but it's increasingly critical for beleaguered airlines facing record fuel bills. Hence the interest in advanced coatings at the Farnborough Airshow earlier this year, where a number of innovations attracted significant attention, such as Tecvac's Nitron Flight.

Nitron coatings, with hardness values of 1,800HV, can be applied to titanium, steel and advanced alloy surfaces, such as aero-engine blades running at temperatures up to 700°C. They're applied in a duplex process, using PVD, and can range from 0.003 to 0.03mm thickness, depending on application. Tecvac claims that its tests show the coatings can reduce both wear and friction. For engine and airframe designers, that means: reduced total life costs; extended maintenance intervals; increased aircraft availability; reduced fuel consumption; reduced use of expensive and costly alloys; and, by substituting lighter metals, higher payloads.

All well and good, but engineers know that preparing and cleaning surfaces remains key to obtaining any high-integrity coating. And while it's easy to assume traditional surface preparation processes, such as blasting, remain largely unchanged, in fact several refinements are introducing new benefits to this traditionally cumbersome aspect.

Indeed, even the humble blast nozzle has been the subject of a recent step-change in design and functionality. The new Fan Blast tungsten carbide-lined nozzle, for example, from Airblast, flattens the concentration of blast in the centre of Venturi nozzles – giving wider, more uniform blast patterns, using the same media, flow rates and air pressures to process up to twice the area in a single pass.

Also, that most common of blasting problems – health and safety, given the amount of particulate dust caused by the process – has been addressed with, for example, a new blast cabinet from Guyson, which includes a cyclone separator or cyclonic media reclaim unit, positioned between the blast chamber and the dust collector.

Equipped with a blower, or harnessing the air flow created by the dust collector blower, the cyclone draws air from the blast cabinet, carrying media, fractured particles and dust out of the chamber through a duct, hose or pipe. Inside the body of the cyclone, media and dust are separated by mass. Heavier particles move to the outside, travelling in a spiralling motion down the cone of the cyclone to a media hopper, while lighter dust is suspended in the extraction zone at the centre, from which it is ducted to a dust collector.

Guyson makes the point that another way to address the dust and particulates problem is to eliminate the need for human operators. Its spokesperson says that, with the extensive use of robotics in painting, thermal spray coating and other finishing operations, "we can expect to see a growing number of robot-tended blasting machines in the near future". PE

Pointers

- New technologies have hugely extended coatings available to cut corrosion, erosion, and thermal and chemical damage
- Aerospace engineering has spurred vapour deposition and nanotechnology
- Sheffield Hallam's NTCPVD coatings are the result of new deposition techniques
- Hardide tungsten carbide and Nitron coatings offer massive improvements
- Zircotec zirconia-based plasma-sprayed ceramics could change the game in thermal radiation losses

Non-metallic surface solutions

Ceramic and plastic-based coatings are offering plenty of choice for plant engineers, particularly in the automotive sector. Typically, ceramics offer better thermal protection properties, while plastics score in applications where their non-conductive characteristics can make a difference.

Ceramic coatings, such as Zircotec's new zirconia-based high temperature plasma-sprayed ceramics (offering a thermal efficiency of less than 1.7W/mK, compared with 4W/mK for alumina), are effective at inhibiting thermal radiation from surfaces – and are already being used to lower under-bonnet temperatures and to protect hest-sensitive components.

Elsewhere, the development of an eco-sustainable coating for plastics has won Australia's national science agency CSIRO (Commonwealth Scientific and Industrial Research Organisation) and project partner Dulux Powder Coatings, one of that country's leading environmental awards. The Banksia Eco-Innovation Award recognised their new dry coating's ability to save energy and almost eliminate harmful emissions and solid wastes, produced as a result of the automotive industry's historical reliance on wet spray-painting technologies.

The Australian automotive industry currently uses 9.86 million litres of paints per year. All solvents in the process become airborne, while 2.5 million litres of solids go to landfill. "The problem the team had to solve was that most powder-coating particles only stick to surfaces that conduct electricity, and some of the plastics used to make certain automotive components are not conductive," explains Dr Voytek Gutowski of CSIRO. "We overcame this by coating the plastic components with a nanometre-thin layer of specially developed multifunctional molecules."

For its part, Dulux Powder Coatings developed new powder coatings that can be cured at much lower temperatures and for much shorter times than required by traditional powders. The new technology has been successfully commercialised over the last 18 months and is estimated to have the potential to save the industry $100 million every year.