TiDA talk

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PVD Coating Now Available In New Zealand

New Zealanders are surrounded by PVD coated goods – everything from bathroom fittings, to cellphone covers, to golf club heads and razor blades are often PVD coated improving their appearance, strength and durability.

Up until now, local manufacturers have had to send their goods overseas to have this technology applied or import component parts which have already been PVD coated. But thanks to Tauranga project engineering firm Page Macrae Engineering Ltd, New Zealand companies can now add value and dramatically cut their costs by using the firm's Cathode Arc PVD Coating machine.

TiDA is working with Page Macrae to help local companies realise the potential that PVD coating has to offer.

Page Macrae development engineer, Bruce McLean, says the environmentally-friendly process has an enormous range of applications and can extend the life of an industrial part or product by up to five times compared to uncoated parts.

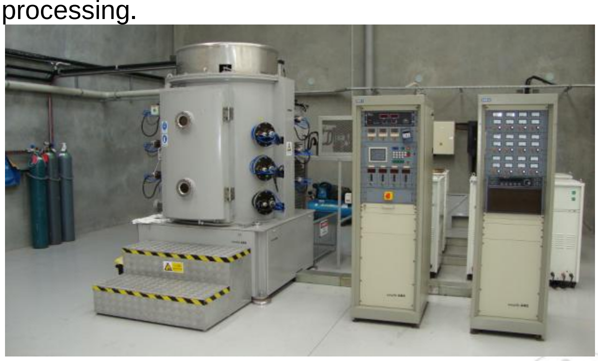
"One of the key benefits of these coatings is their superior corrosion resistance. Once coated with a metal nitride or carbide PVD coating, the part surface becomes inert and is impervious to attack in hostile chemical environments such as salt water, chlorine, geothermal steam and sulphuric acid which are found in many process applications and industries," McLean explains.

New Zealand manufacturers in the dairy, marine, energy, transportation and plastic sectors all stand to benefit from this technology being commercially available here at home.

"The base part can be made from lower cost materials and then PVD coated to achieve the desired level of corrosion protection, hardness, appearance or surface modification as opposed to using high cost materials and more traditional manufacturing processes to begin with."

Physical Vapour Deposition (PVD) is a process carried out under extremely low pressure conditions in high energy gas plasma.

Chamber vacuum levels in the order of 100^{th} of a Pascal when etching and a 10^{th} of a Pascal when coating are typical. The chamber can pump down to low 1000^{ths} of a Pascal to evacuate potential contaminants from the environment ahead of processing.



The only commercial-size PVD coating machine of this type in New Zealand.

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TiDA
Titanium Industry Development Association Inc

Before the product is coated it is "scrupulously cleaned" and placed into the 1.2m diameter by 1.3m high vacuum chamber which features rotating and revolving work piece holders. Arcs from a dozen titanium, zirconium or chromium targets are struck in the presence of argon gas initially to etch clean the work piece surface, then in the presence of a reactive gas to form the nitride or carbide – typically nitrogen or acetylene.

After just a few minutes the result is an even application of a very thin film coating, only a few microns thick. It's extremely hard (2000 - 2800 Vickers hardness) and is literally bonded to the substrate at the atomic level, McLean says.

"It's not like painting or other forms of traditional metal electro-plating where you dip a part into several baths of chemicals for several hours at each process step. "It's bombarding the surface with very high energy metal ions that are moving up to 15km per second. In addition to the primary surface reaction, you're literally blasting titanium ions several atom layers deep into the surface of the part being coated."

The coating is so thin you can make a part to final size, coat it and you're done.

McLean says the work surface is transformed into either a nitride, carbide or hybrid carbo-nitride depending on what gas is used and when. And by controlling the arc duration, reactive gas flow, chamber temperature and vacuum level, the characteristics of the PVD coating can be closely tailored to suit the end application.

PVD coating is used in three general areas – to produce decorative finishes (such as on tapware, automotive components and sporting goods); to produce functional coatings (such as more durable cutting edges for surgical instruments and machine tools); and to modify the surface of a product (to improve things like wear resistance, corrosion resistance or to reduce sliding friction).

A wide variety of coloured finishes can be produced by PVD coating technologies ranging from the gold/classic brass look (typical of a titanium nitride) through to pink, violet, green, blue and a very deep black.

Page Macrae are continuing to develop and refine process recipes to enable repeatable production of a range of different coloured coatings for different applications.

The $800,000 machine was originally made in China and is the only commercial-size PVD coating machine of this type in New Zealand.

"The process best suits batch production of smaller parts but the chamber can be configured to accept larger workpieces with appropriate fixturing," McLean says. "It's a case of working with interested parties to develop tailored solutions to product problems or requirements."

Page Macrae has also set up an industrial-scale ultrasonic cleaning line and drying oven alongside the PVD coating machine, and has a process QC lab with an optical microscope, micro hardness tester and a ball-crater thickness tester.

"The PVD coating process itself is very environmentally-friendly. It doesn't utilise or produce any hostile chemicals or toxic waste," McLean says.

"And the coating is so thin you can make a part to final size then coat it and you're done. You don't have to grind it undersize to begin with then again after traditional electro-plating so it can save a huge amount of machining time."

Those who are interested in applications for Page Macrae Engineering's PVD coating machine for their products can contact Bruce McLean by phone (07) 574 3202 or by emailing brucem@page-macrae.co.nz

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Extruding Titanium Now a Viable Option in NZ

Extruding light-weight yet incredibly strong titanium components for a vast range of industries is now possible in New Zealand thanks to Waikato University and South Auckland Forgings Engineering (S.A.F.E.) Ltd.

S.A.F.E General Manager Barry Robinson says the two organisations have been working alongside TiDA to test the consolidation processes and were now keen to work with New Zealand companies to produce titanium forgings.

"The potential for extruding titanium is significant, as the testing to date at Waikato University shows it is a very viable method of directly converting titanium powder to a dense, strong, solid forging with a huge range of uses," Robinson says.

"We aim to supply specialised products forged in a choice of titanium alloy variants, with the minimum order quantity being very low due to the ability to mix up a blend of powder in very small quantities."

Many industries could benefit from extruding titanium components including medical, aerospace, defence, marine, sports, automotive, and appliances, just to name a few.
Robinson says extrusion creates a great longitudinal 'grain' in the material, making it very strong. It is commonly used in the aluminium industry for making sections such as yacht masts, joinery, and electrical components, while extrusion is also used for brass, copper, steel, and plastics.

"The key benefit to direct titanium powder extrusion is that in the one process we both consolidate the powder as well as shape it into a useful section with good mechanical properties," he explains.

The process of extruding titanium involves compressing titanium powder (or an alloy mix of powder) into what is called a 'green powder compact'.

Robinson says the compact is then heated to approx 1000°C and quickly transferred to the preheated extrusion tool in the extrusion press. "In the extrusion tool a plunger compresses the hot powder compact, forcing it to extrude out a much smaller hole at the opposite end – very much like a household silicon gun but much harder!"

The hot powder bonds under the high temperature and pressures involved during the extruding operation, and the resultant solid extruded material is much longer and narrower than the original powder compact.

"The actual size and shape of the extruded product is that of the hole it was forced out of, with the length being governed by the volume of the powder compact."

The main difference when extruding titanium compared with other metals is that it must be heated and processed in a vacuum or in an Argon gas chamber.

"Titanium has a great affinity for oxygen while at high temperatures. The oxygen content affects the properties of the metal, so the hot titanium must be protected from the atmosphere," Robinson explains.

The extruded material can be used in two main ways – either directly (for example if a 10mm round bar was required then the extrusion die would be made accordingly and the extruded product simply cut to required length afterwards), or as a starting 'billet' for making virtually anything that can be forged.

"For example, a valve body would be made by extruding a suitably sized billet then cutting pieces off at just the right size to be reheated and directly forged to the final valve body shape in a press or drop-hammer."

S.A.F.E operates a heavy forging plant, a large heat treatment facility, machine shop, metallurgical laboratory and training facility on a three hectare site in Drury, South Auckland, to provide a "one stop shop" integrated manufacturing facility.

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Extruding Titanium Now a Viable Option in NZ Continued...

Over the last 40 years S.A.F.E have produced customised specialist forgings and heat treatment for most industries, and Robinson says the company is looking forward to embracing the immense opportunities which titanium has to offer.

“We have not yet made any titanium products – so far only test pieces to verify compaction processes. While there is still a lot of testing to go we are keen to find some applications that we can now make some titanium forgings for.”

For more information about how your company may be able to take advantage of the new extrusion process contact Warwick Downing on (07) 557 0342 email: info@tida.co.nz

Waikato University Partnership Boosts Titanium Industry

TiDA has now officially joined forces with Waikato University to unlock the billion dollar potential of New Zealand’s titanium industry.

The two parties recently signed a Memorandum of Understanding to work together to develop world-class research, teaching and resources to support the development of New Zealand’s emerging titanium industry.

TiDA chief executive Warwick Downing says titanium and powder metallurgy are revolutionising the way everyday products are manufactured all over the world.

The key to ensuring New Zealand companies are able to compete internationally and outclass their competitors is to invest in high quality research.

A national research and development (R&D) strategy will now be developed in conjunction with Waikato, and TiDA’s Applied Powder Metallurgy Centre in Tauranga will complement the university’s existing research facilities

University of Waikato Vice-Chancellor Professor Roy Crawford says the partnership is a joint commitment to meet industry needs. “This partnership will help to enhance New Zealand’s competitive advantage in the titanium industry by fostering research and teaching capabilities.”

The two organisations have already worked alongside each other for a number of years. TiDA was formed to help New Zealand companies develop new titanium products for the international market using powder metallurgy consolidation methods. It came about from the work of Titanox Development Ltd, which was established in 1997 to develop market-ready titanium alloy products based on the work led by Waikato University’s Professor Deliang Zhang.

Professor Zhang says the university’s partnership with TiDA reflects the nature of research and development in the 21st century.

“It encompasses the strategic importance of combining targeted medium to long-term fundamental research and industry based short-term research,” he says.

The Memorandum of Understanding was signed on September 27 at the TiDA Applied Powder Metallurgy Centre. The TiDA centre is on the shared University of Waikato and Bay of Plenty Polytechnic Windermere campus. The understanding between the university and TiDA also recognises the Bay of Plenty Polytechnic as a partner.

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