COATINGS

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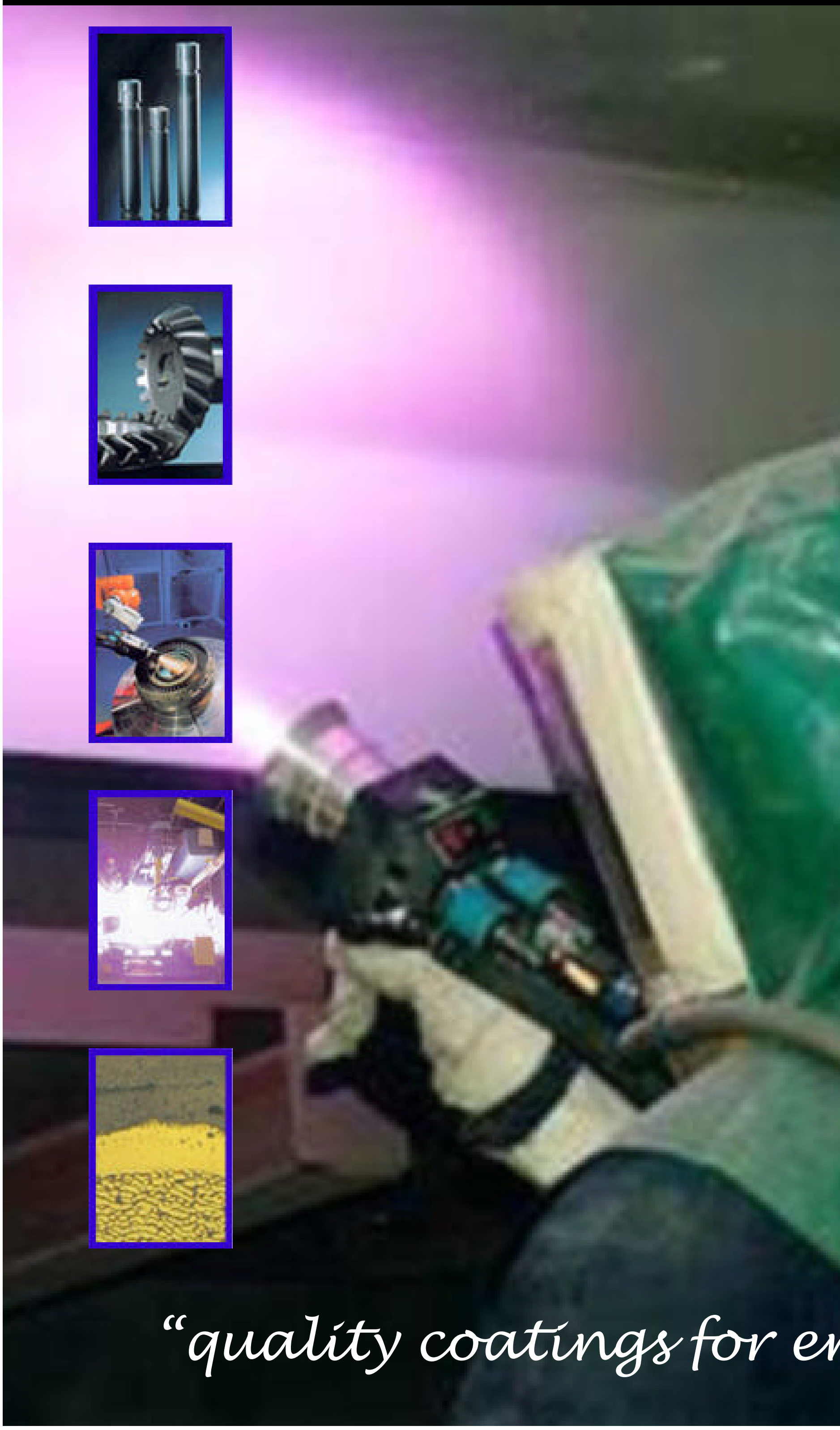
Official Publication of the Thermal Spraying and Surface Engineering Association

TSSEA
THERMAL SPRAYING & SURFACE ENGINEERING ASSOCOATION



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"quality coatings for engineers"

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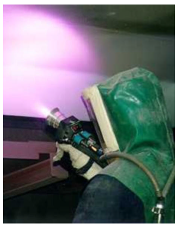
Cover Photograph

Courtesy of Metallisation Limited. Metallisation HSM700 Arcspray system in use for coating concrete structures.



TSSEA
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TSSEA News in Brief …..

"Coatings" now available via the web

- TSSEA's official publication "Coatings" is now available to its members quarterly as a PDF download document via the TSSEA web site. Simply click on the links for "Coatings" to download the document.
- Non-members may obtain copies of "Coatings" and the "Code of Practice" for the safe installation, operation and maintenance of thermal sprayed coatings plant from the secretary for £25.00 each
- In future back issues of "Coatings" will be available to members of the TSSEA via the web-site whilst non-members will be able to order issues through the secretary of the TSSEA.

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Broadened Horizons in the Automotive Sector

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The automotive industry is one of the largest and most dynamic global sectors. Over 70 million new vehicles are put on the road every year. The size and dynamics of this industry have created challenges equal to very few other sectors. These range from globalisation and industry consolidation to maintaining innovation and the effective use of new technologies.

In order to overcome this development, automotive OEMs and suppliers have embarked upon a range of business, operational, and technological measures. As an important supplier to the automotive industry, Sulzer Metco understands and meets these requirements in its own fields of activity.

Challenges in the Automotive Industry

Globalisation: The opening of borders and lowering of trade barriers have resulted in increased competition, brand erosion, and shrinking market shares. These challenges are met through standardization, lean production methods, and transparent communication.

Industry consolidation: Increasing competition and the need for stable vehicle prices have created a demand for higher efficiency and lower component costs. This has led to the outsourcing of entire projects to suppliers who are assuming higher responsibility and offering complete solutions and systems.

Technology and innovation: Demand for safety, comfort, performance, and lower noise levels, together with fuel economy and environmental trends, is encouraging manufacturers to develop additional features with lighter, smaller modules. This is fulfilled by improving design features, increasing the use of alternative materials, and enhancing components' tribological properties through surface technologies.

Sulzer Metco Approach.

Sulzer Metco has optimised its business models, offering competent and reliable partnership to customers. Its solutions and services are comprehensive as well as highly flexible, which guarantee efficient operation and delivery. The aim is to meet the above-mentioned challenges and to help its customers lower overall operating costs.

Focusing on business models an production processes, however, is not sufficient. Many of the above requirements can be met by engineering component surfaces used in vehicles. Employing its expertise and global reach, which was extended through a number of recent acquisitions, Sulzer Metco has established a broad range of surface solutions for automotive applications. Over forty such solutions have been applied in vehicles, some of which were developed for some of the most renowned automakers. As a result, automobile companies can have a large number of their surface-related requirements fulfilled by a single supplier.

Appropriate Surface Technologies

Innovative surface engineering equipment, application materials, and services can be valued resources for automotive firms, the most significant of which are thermal spraying, physical vapour deposition (PVD), and other surface treatment technologies.

Thermal Spraying

Thermal spraying of materials onto automotive parts consists of heating a material to molten or semi-molten state and propelling it onto a desired part to create a surface structure or coating. Major thermal-spray processes are vacuum and atmospheric plasma spraying, high-velocity oxy fuel spraying (HVOF), powder combustion, wire combustion, and electric arc.

The benefits of thermal spray include wear and corrosion protection, heat transfer control, electrical- properties enhancement, and dimensions and clearance control. The end results are cost reduction through better performance, longer component life, and reduced maintenance.

Figure 1 The cylinder bores in the Team Biland racing engines are plasma-coated to deliver higher efficiency. The Swiss Team Biland is a world-renowned go-kart engine manufacturer.

Thermal-spray solutions are applied to many parts along the drive-train and chassis, e.g. piston rings, piston crowns, transmission components, and brake discs. One significant example is the application of a plasma-sprayed metal coating on aluminium engine block cylinder bores. Apart from being applied in a number of Formula-one engines, this technology has also been adopted by the German Volkswagen (VW) group for the Touareg and Phaeton V10 engines, the Swiss Team Biland AG (one of the leading global go-kart engine manufacturers; Figure 1), and by many other motor-sport companies (see also STR 1/2003, p. 16). The benefits include smaller and lighter engine blocks due to the elimination of cast iron liners, reduced coefficient of friction, thermal-shock resistance, scuff resistance, lower wear rate, and reduced oil consumption (Figure 2).

Figure 2 Today, any automobile parts are coated or created, using Sulzer-Metco surface technologies. These provide protection against wear and corrosion or add decorative finishes – enjoy your ride!

PVD – a Thin-Film Technology

Physical vapour deposition, offered by Metaplas Ionon Oberflächenveredelungstechnik GmbH (a German subsidiary of Sulzer Metco) under the Maxit ® brand, is an environmentally friendly vacuum coating technology (see also STR 1/2003, p. 4). It involves evaporation, ionisation, and deposition of coating materials through magnetron sputtering or cathodic arc. The benefits include wear protection, low friction, and potential for fuel economy. Parts coated with this process include engine and gearbox components, hydraulic pistons, injection moulds, and tools.

PVD is also used on decorative parts such as grills, handles, fittings, and plates (Figure 3). Its advantages over chrome plating lie in the use of environment-friendly materials and in enhancing mechanical properties of the surface. The wide range of realized metallic colours (e.g. titanium or gold) guarantees wear-resistant decorative surface finishes, especially for interior applications.

Modifying of Surfaces

Surface treatment technologies, branded Ionit ® and Ionit OX, involve the re-engineering and modifying of surfaces rather than coating them. Included in the processes are plasma nitriding, nitro-carburising, gas nitriding, plasma activation, and oxidation. The benefits include extreme wear protection, corrosion resistance, low friction, and improvements in mechanical properties. Many parts along the drive-train and chassis are treated with these processes, e.g. crankshafts, ball joints, gear selector shafts, differential gear shafts, various bolts, rings, and fittings. Major automakers such as VW (Passat, Touareg, and Phaeton models) and leading Tier-1 suppliers rely on this enhancement process for cost effectiveness, flexibility, and environmental compatibility. To offer a one-stop-shop facility to its customers, these core capabilities are combined with additional processes such as heat treatment, grit blasting, surface preparation, polishing, and finishing. This provides infinite possibilities to fulfil any surface engineering requirement the automotive industry experiences – all from one partner.

A Core Contributor to Success

Automotive OEMs and suppliers are facing increased pressure to meet the demand for better products at lower cost. By enhancing surface characteristics of key auto-motive components cost-effectively, surface engineering can be a core contributor to success.

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Figure 3 PVD technique (Physical Vapour Deposition) used for decorative coatings (e.g. on handles) avoids the application of chromium and offers a wide range of metallic colours.

Euro/International Standards

The TSSEA continues to hold the secretariat for the BSI committee STI/40, which is responsible for input from the UK to the European committee CEN/TC240 in developing standards for all aspects of thermal spraying. Other countries in the committee have similar arrangements and the CEN meetings comprise of spokesman/delegates from each country represented. The secretariat of the euro committee is held by DIN in Berlin.

Proposals for standards are suggested by the delegates and then taken through the stages of discussion, public enquiry and voting. The International Standards Office (ISO) are advised when a new document is proposed and they are invited to comment and decide if they wish to participate. In which case they will receive copies of the documents and revisions as they occur. Such collaboration will result in parallel voting and if all is agreed a joint Euro/International standard is published. In the UK the identification number of such a standard is prefixed by the letters BS EN ISO followed by the number. Since this system was set up, 15 standards have been published and the current working programme includes 10 topics which are in different stages of discussion and public enquiry prior to final voting.

All these standards are subject to review after 5 years and over the past 2 years a number of euro/ISO standards have been revised. One such is the BS EN ISO 22063 which covers the application of sprayed zinc/aluminium coatings for the protection of iron or steel structures from atmospheric corrosion. This review is now completed and the revised document will very soon be published as BS EN ISO 2063.

It is expected that the work of these committees will continue for the foreseeable future because as the number of new topics will inevitably decrease, the 5 year updating will continue to grow, albeit more slowly.

Anyone who would like an up to-date list of the existing standards on thermal spraying an/or topics under discussion, please contact the secretary. Comments are regularly invited (by public enquiry—prEN) fro those concerned in the thermal spraying process and these may be sent to the secretary and collated so that they can be presented as from the committee. This is your opportunity to have your views expressed on the content of the standards.

Protection of Reinforced Concrete Structures by Thermal Spraying

Dr. Terry Lester
Metallisation Ltd.

Definition of the Problem

Due to the ingress of chloride ions through the matrix of reinforced concrete the reinforcing bars (rebars) within the concrete begin to corrode. Since the corrosion products take up more volume than the original metal the rebar effectively swells causing the matrix to crack. This allows more moisture and chloride ions to enter so that the problem escalates. Finally the result is large pieces of concrete separating from the structure weakening it and causing a danger to users of the structure and the immediate environment. (Figure 1)

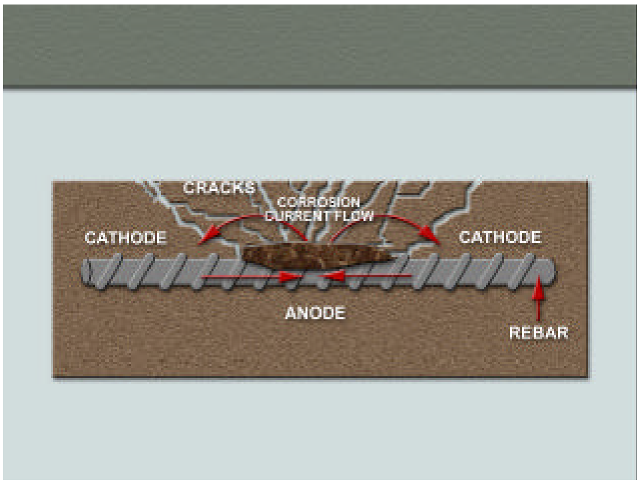


Figure 1 The problem of chloride ion ingress in reinforced concrete and the subsequent corrosion and damage processes.

To understand how to prevent this we need to understand the corrosion process a little better. Due to differences in the immediate environment of the rebar, the region near the cracks being attacked by the moist chlorides becomes anodic with respect to the rest of the rebar and a small electric cell is set up as shown in Figure 2 and current circulates. To stop the corrosion we must stop this circulation of current. This can be done by superimposing a more dominant current between the surface of the concrete and the rebar. There are two ways of achieving this, one is by attaching electrodes to the rebar and the surface and passing a current through using a generator. The other is to apply a coating of a material which is a much stronger anode to the rebar than the corroding section. Thermally sprayed zinc alloys are examples of such strongly anodic coatings.

Field Application of Zinc Alloys to Concrete.

There are many reports dealing with the effectiveness of sprayed zinc and zinc alloys and from here on I will deal with the method of applying the coating and variations on the alloys used. As an example the following are the techniques being used to treat the San Luis Pass bridge in Texas (Figure 3).

This is a long low bridge over a tidal estuary, which is therefore subject to very high chloride concentrations in a hot and humid environment on the Gulf of Mexico. The coating process is being carried out on site over a period of six months using high throughput arc spraying systems. The procedure is as follows:

- Remove all loose concrete.
- Grit blast the damaged area to remove rust and contaminants
- Repair the damaged area with a fast setting concrete
- Re-blast to provide a key for spraying
- Spray an alloy of Zinc, Aluminium and Indium.

Taking each aspect in turn, much of the unstable concrete could be removed using pry bars and then blasting was carried out from a portable

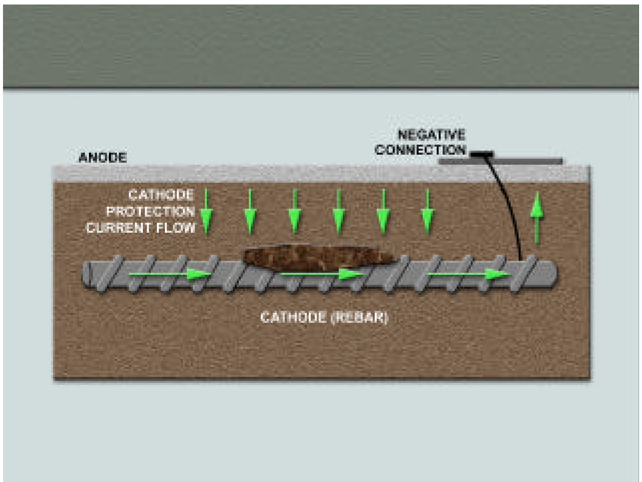


Figure 2 Methods of reducing the Rebar corrosion problem, offering cathodic protection by the application of zinc coatings

Figure 3 The San Luis Pass low-level bridge that is subject to tidal conditions, high in chloride ions.

blasting rig.

The rig remained on top of the bridge deck whilst the blast hoses were passed over the side to operating platforms beneath (Figure 4). Disposable silica based grit was used which was not recovered from the estuary.

Repairs to the concrete were then carried out and the surface re-blasted prior to spraying (Figure 5).

Spraying was carried out using Metallisation Arcspray 700 systems. Working with the contractor CRT they were modified to handle the new cored-wire material that was sprayed. Special dispensers were also made to protect the wire from the atmosphere and from dust etc. as shown just to the left rear of the man spraying from the cherry picker. The power supplies for all the system were mounted in a container on the bed of a trailer, which also carried a diesel generator and a compressor. Again long cables and hoses were slung over the side of the bridge.

Anode Material

Most commonly the sprayed zinc layer is not used alone but is coupled with a cathodic protection system to act as one of the electrodes. However in a sufficiently active environment and with the right choice of alloy it can be used alone. To achieve this in this case a recently developed cored-wire pseudo alloy was used. This comprised an aluminium sheath with a zinc/indium core to give a coating with greater protective properties. The properties of the alloy compared with conventional materials are shown in the table below.

	Zinc	Al-Zn-In	Comments
Theoretical energy capacity	370 A-hr/lb	760-1090 A-hr/lb	Al-Zn-In 2-3x energy capacity of zinc
Consumption rate at Bryant Patton Bridge, Florida	nil	12 microns/year (0.5 mils/year)	10-15 year life expectancy for –In in Florida
Current density at Bryant Patton Bridge after 5 years	0.54 mA/m^2 (0.05 mA/ft^2)	5.06 mA/m^2 (0.47 mA/ft^2)	Al-Zn-In 9x current density vs. zinc
Actual output at Queen Isabella Causeway Texas (5/10/00)	0.372 A (0.28 mA/ft^2)	1.308 A (0.98 mA/ft^2)	Al-Zn-In 3.5x current output vs. zinc
Current density in the FHWA temperature/ humidity chamber 21C 70%RH	0.43 mA/m^2 (0.04 mA/ft^2)	6.56 mA/m^2 (0.61 mA/ft^2)	Al-Zn-In 15x current density vs. zinc
Average anode open circuit potential in marine environment	-751 mV (CSE)	-1055 mV (CSE)	Al-Zn-In > 300mV increased driving voltage vs. zinc
Average adhesion test results	1.9-2.4 MPa (270-350 psi)	1.7-2.4 MPa (250-350 psi)	Similar adhesive strengths

Table 1 Comparison of properties of zinc vs. Al-Zn-In .

As is shown (Table 1) the alloy provides a significantly higher current density than pure zinc allowing it to provide greater protection to the rebars. The downside is that in circumstances of very high concrete conductivity the material is used up more rapidly than zinc so as always proper consideration of the actual circumstances must be given.

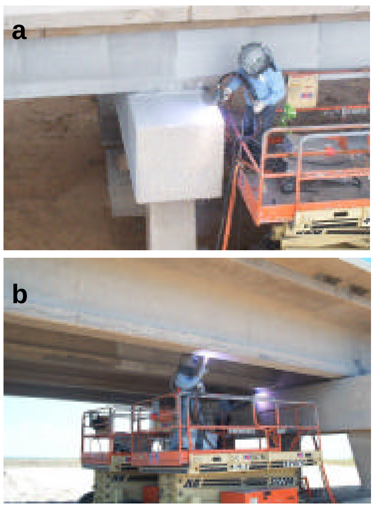
Conclusions

Overall the project has demonstrated the capacity of the spray systems, procedures and materials to effectively coat this bridge structure in a timely manner and without closing the bridge to traffic.

The Arcspray 700 systems were able to handle the environment and also the material whose diameter and shape was inconsistent a high throughput rates with excellent reliability.

The coating provided will be able to protect the structure with virtually no on-costs such as electrode or generator maintenance.

Figure 5 a and b Repairing the surface of the concrete using the Metallisation Arcspray 700 system



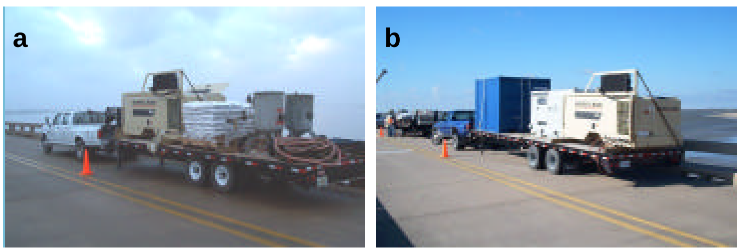


Figure 4 a and b The rig on the to-side of the bridge. .

TSSEA 2003 Programme

Annual Conference 2003

Ceramic Coatings for Industry

To be held on 16h July 2003
Beaumannor Hall,
Woodhouse,
Near Loughborough,
Leicestershire

Thermally sprayed Ceramic coatings were first introduced in the UK during the 1950's, before the introduction of Plasma Spraying. They were applied either by:

1. Spraying powder through a combustion flame gun, or
2. Spraying centreless ground rod through a combustion wire gun.

The resultant coatings were nothing like the quality achieved by today's technology using plasma or vapour deposition processes. However, some important applications were developed such as coatings for mechanical seals and other pumping components. Magnesium Zirconate Coatings for combustion chambers were successful in particular using gradated layers of cermets using different metal (Ni/Cr) blends.

Also a ready market was available for electrical insulation at elevated temperatures using alumina.

The main problems were:

1. Using powder with the Oxy/Acetylene flame gun, refractory materials were difficult to heat properly and the relatively low particle velocities resulted in coatings having either poor inter-particle cohesion or at the other extreme, cracking due to overheating of the coating in attempts to obtain more wear resistance. Adhesion was improved using Ni/Cr bond coats which also gave protection against substrate corrosion where aggressive fluids penetrated the porous coating.

2. Rod spraying was more successful particularly for wear resistant coatings. Also the coatings were denser than powder coatings and there was less tendency for corrosive fluids to penetrate to the substrate.

However, the practical problems of spraying brittle rods through guns designed to spray wires were eventually prohibitive. Also the rods were in short lengths (typically 1 metre) and the spraying operation was constantly being interrupted. Wastage was a problem due to the rods breaking.

Today's coatings using powder with the plasma process (or cored wires using electric arc guns) have greatly improved the coating quality and denser, better-bonded coatings of chrome oxide are commonly used on print rollers, compressor rods and pump parts where the high hardness and resistance to corrosive fluids are highly beneficial.

Vapour deposition coatings, now in common use, are providing thermal barrier zirconia coatings used in the gas-turbine industry, also wear resistant coatings for cutting tools.

The presentations will elaborate on these examples and we will also hear of the developments in HVOF spraying of ceramics.

Chrome Oxide sprayed Anilox roller being laser engraved. Photograph courtesy of Ceramet Limited, Stonehouse Gloucestershire
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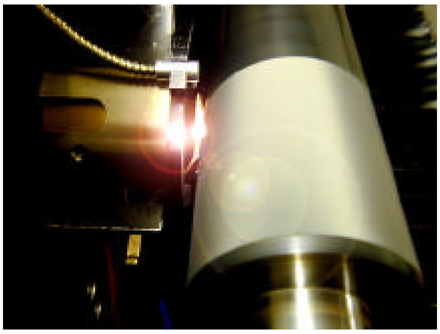

Programme

Morning Session	Chairman Mr.M.Cole BOC Gases
10.00-10.30	Mr.K. Harrison Sulzer Metco Ltd *A better understanding of thermal barrier coatings*
10.30-10.00	Mr.K.Lawson Cranfield University *The development of zirconia-based thermal barrier coatings using the EBPVD process.*
11.30-12.00	Tea/Coffee Break
12.00012.30	Mr.S.Bomford Plasma and Thermal Coatings Ltd *Industrial applications and process for thermally sprayed ceramic coatings*
12.30-13.00	Mr.M.Wilson Pamarco Ltd *Ceramic sprayed coatings on Anilox rolls which are subsequently laser-engraved*
13.00-14.15	(AGM) Lunch
Afternoon Session	Chairman Mr.K.Lawson Cranfield University
14.15-14.45	Mr.M.Cole BOC Gasses Europe
14.45-15.15	Dr.R.Morgan Liverpool University *The application of cold spraying for ceramc coatings*
15.15-15.45	Dr.M.Riley TWI Limited *Ceramic coatings HVOF spraying*
15.45	Close

Any changes of details or timings and presentation titles will be issued on the day.

TSSEA 2003 Programme

Conference Dates for 2003

Annual Conference

The Annual Conference will be held on the 16th July 2003 at Beaumanor Hall Woodhouse Leicestershire.

For details see the Annual conference page in this issue (page 8) or go to our web site at :

http:/www.tssea.co.uk

Autumn Conference

The autumn Conference will be held on Thursday 11 November 2003. More information will be available shortly and will be posted in "Coatings" and on the TSSEA web site.