A sure thing

Thermal coatings for highly stressed components

It ain´t easy for components in industrial key applications. Growing pressure on costs, performance and time constantly push them to the limits of their capacity. The greatest breakdown risks are abrasion, erosion and corrosion. Today, one established standard for prolonging service life and increasing stress resistance is the thermal spray coating of critical components. Virtually unlimited combination options of coating material and substrate offer enormous scope for surface replacement, regeneration, repair, upgrading and enhancement. As a reputable expert in the field of sophisticated surface technology, the company Pallas GmbH & Co. KG sets standards with the wide range and virtuoso combinations of thermal spray processes it employs. When it comes to new coatings or seals, their long years of experience and know-how make the specialists at Pallas highly sought-after development partners for industry and research.

Hardly any other coating process is as versatile and as adaptable to specific applications as thermal spraying. Whether it is in the machine and plant engineering sector or in the automotive, printing, aerospace, paper, offshore or steel industry – highly stressed components and materials are regularly expected to achieve the impossible. Requirements like wear and corrosion resistance combined with outstanding mechanical strength are demands that a particular material in itself can often not fulfil. A similar conflict of objectives is often encountered in the clash between the necessity for lightweight construction and friction reduction, on the one hand, and increasing performance demands by customers, on the other.

But there are durable solutions to such problems, in the form of new finishing technologies and optimally customised thermal spray coatings. With these, the various demands on component surfaces and cores can be separated functionally and thus disengaged from each other. Through the exclusively topical treatment of the areas affected by wear or the consequences of manufacturing faults, the – often extremely expensive – basic component can continue to be used. This means significant savings of time and money.

Comprehensive range

With six different thermal spray processes to choose from, Pallas offers an unusually wide range of treatment options for individual components and small to medium batches – all from a single source. In addition to powder and wire flame spraying (FSW, FSP) the Pallas process portfolio also includes electric arc (ARC), plasma (APS) and high velocity oxy-fuel spraying (HVOF) as well as laser cladding (LC). And the choice of coating materials, coating structures and thicknesses available from Pallas is equally outstanding. The company is also renowned as an expert in multifunctional coating systems that combine several properties. Its decades of collaboration with a wide range of sectors explain not only the huge spectrum of readily available working materials but also the company's innovative capacity when it comes to the development of unconventional solutions. Its cross-process competence also makes Pallas a desirable partner for the development of coatings in large-scale production runs.

Different levels of energy

Depending on the type of component and its deployment scenario, thermal coatings for resistance to wear and corrosion are applied using flame, electric arc, plasma, HVOF or laser processes. The main differentiating factor for the individual methods is the different levels of thermal and kinetic energy with which the spray particles are deposited onto the base material. **Powder flame spraying** creates coatings with thicknesses up to several millimetres and is particularly suitable for repair coatings using metals. In **wire flame spraying** practically any coating material that is available in wire form can be deposited. In this way, high-performance wear and corrosion resistant coatings as well as overlay coatings made of aluminium, bronze or molybdenum can be created. This process can also be used to create self-lubricating surfaces. **Electric arc spraying** is a cost-effective way of using electrical energy to create firmly bonded, wear-proof surfaces that are resistant to high temperatures and oxidation, depending on the working material deployed in the process. In the up to 20,000°C-hot plasma flame, **atmospheric plasma spraying** even processes refractory ceramics and their compounds into extremely hard, wear resistant coatings. In the case of **high velocity oxy-fuel spraying (HVOF)**, the particles hit the substrate at speeds of up to 750 m/s. The combination of such a high level of kinetic energy with a relatively low level of thermal energy is optimal for creating very firmly bonded, homogeneous and dense hard metal coatings. **Laser processes** are appropriate for improving the surface properties of expensive, highly stressed components. Because the energy applied is limited to an area of just one or two millimetres in diameter, the thermal strain on the component and coating material is kept to a minimum. The metallurgically fused, high-density coating with minimal dilution created in this way is durably bonded to the component surface even under extreme strain.

In contrast to galvanic surface treatments, in which coatings are applied en masse to rack and barrel goods, the thermal spraying processes described above – even when they are automated – are applied to individual components, which means correspondingly lower material loss through waste. Another argument for these processes is their fast implementation – in the case of permanently installed components even on the customer's premises. This significantly shorter treatment time is often the reason cited for the superiority of thermal spraying in comparison to galvanic treatment. If a bearing seat with a diameter of 120 millimetres and a length of 200 millimetres needs to be coated with 2/10 hard chrome, it may have to spend over twelve hours in the galvanic bath, depending in the specific parameters selected. The same thermally sprayed coating can be deposited in less than two hours. Because of their construction, rotation-symmetric components like rollers, shafts and cylinders are particularly suitable for thermal coating. Thanks to the fact that the treatment is limited to a small area and the thermal strain on the component can be precisely controlled, even substrates like wood or composites of carbon fibre or fibre glass can be coated. When several of these thermal spraying processes are combined, the efficiency of enhancement, regeneration or repair of affected components can often be even further improved. Annual growth rates of eight to ten percent are convincing confirmation demand for this versatile surface treatment technology is on the rise.

Coats for all purposes

Coating thicknesses from 20 microns up to several millimetres, as good as no restrictions in terms of coatable base materials and a virtually unlimited choice of coating materials characterise the flexibility of the thermal spraying process. The coatings applied in this way adhere primarily through mechanical grouting. In addition to corrosion and wear resistance, they also provide electrical or thermal insulation and allow the creation of anti-friction, non-stick, overlay and self-lubricating coatings. For **anti-corrosion**

coatings for sealing seats, rollers and moulded parts, stainless steel, aluminium or zinc are the coating materials primarily used. Sealing seats and rollers are given coatings with inexpensive low-melting metals up to several millimetres thick, as required. For **anti-wear protection**, hard metals like tungsten carbide and chromium carbide – or ceramics – are used depending on what suits the specific application scenario best. For example, these particular materials are increasingly being used in landing gear construction in the aviation industry instead of hard chrome for the coating of the hydraulic rods. However, there is now an emerging trend in this sector towards titanium carbides. These lighter coating materials, although not so hard, are significantly more temperature resistant and thus meet demands for weight reduction and temperature resistance. Extremely hard and wear-proof ceramic coatings offer reliable protection against corrosion and wear in abrasive and thermally or chemically aggressive atmospheres.

Overlay coatings are mainly used in the aviation industry and in energy production. To comply with the extreme conditions that prevail in compressors and turbines, they are mechanically resilient and high-temperature resistant even though their hardness has been intentionally reduced in order to provide the necessary porosity. The tips of the rotor blades rub themselves into the overlay coating applied to the turbine guide casing, thus minimising the space between movable and stationary turbine parts without causing any damage. In this way, a distinct increase in the performance and the efficiency of the turbine is achieved. In the textile or paper industry, the nickel-plated surface of the guide and feed rollers – which are exposed to aggressive chemical, thermal and mechanical strain – is given an additional ceramic protection coating on its critical zones. This coating also ensures the requisite high quality of the surface. Coatings with a defined porosity protect piston rings and bearings against seizing up under dry-running conditions.

For the enhancement of the **fibre composites** deployed in numerous sectors because of their light weight, more and more applications are relying on ceramic coatings. Whether for rollers in the printing or paper industry, air baffles for the brake discs of Formula One racing cars or heat-shield shingles in the aerospace industry – high-performance ceramic coatings, customised to the specific application, protect such highly stressed components against premature wear and thermal or corrosive strain.

Thermal or **electrical insulation coatings** are created by means of powder coating or plasma spraying. Here, too, ceramic coating materials perform convincingly thanks to their efficient thermal insulation and high-temperature resistance properties. Often, the fact that they are corrosion and wear resistant is an additional bonus. Depending on the thickness of the coatings, specific post-processing can provide dielectric strengths of over 10 kV, making them a reliable protection for equipment against damage through leakage current or short circuits. Depending on operating conditions like application temperature, corrosion and diffusion resistance, special coatings with plastic or PEEK may also be used. Heat-conductive metal coatings for evaporators, for example, can considerably increase the efficiency of air con systems in cars, thus making significantly smaller and also more lightweight constructions possible. Currently, promising findings in terms of cost-efficiency and eco-friendliness are emerging from ongoing experiments into replacing electrical cables in wiring harnesses with thermally sprayed copper coatings on fibre composites. For the steel industry, Pallas has developed a high-temperature resistant, thermally insulating roller coating. In order to protect the copper base body – which is plated with a thick coat of nickel – of the up to 18-ton rollers against the regular strain of thermal shock, Pallas combined several coating materials and coating processes. The resulting coating has a slight insulating effect with a 4 to 5-times delayed thermal flux. This increases the service life of the internally cooled rollers at operating temperatures of up to 1,500 °C by a factor of 4. A coating structure with these properties would be impossible to achieve with galvanic treatment or other coating processes. And, because thermal coatings are precisely reproducible in terms of their properties, the option of regeneration of the roller coating after wear is secured.

Extensive know-how

Elaborately manufactured components, working materials that are difficult to obtain and time-critical key functions often make repairs, regeneration or upgrading of wear-affected components by any other means than thermal coating quite simply unfeasible. However, the huge range of potential applications for thermal coating and the possibility of custom-configured properties remain merely theoretical possible without the addition of years of experience with these processes and extensive knowledge of the coating materials. Only through a detailed cost-benefit analysis and through determination of a multitude of parameters that must be taken into account can a clear picture be drawn as to which process is the most suitable option in any specific case. In addition to types of stress and strain, factors like chemical and thermal conditions, interactions with surrounding media, costs per piece and functions of the component as well as duration and general feasibility of a replacement purchase all flow into this evaluation. On the other hand, thermal spraying is technically and economically unrivalled with regard to the potential it offers in terms of made-to-measure service life extension. Thanks to the company's profound expertise and the versatility of the processes it applies, Pallas is in a perfect position to exploit this potential to the maximum – and is therefore the perfect partner for sophisticated challenges in the field of surface treatment.

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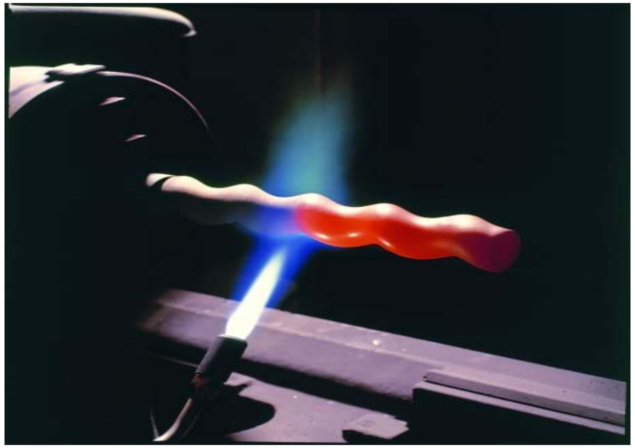
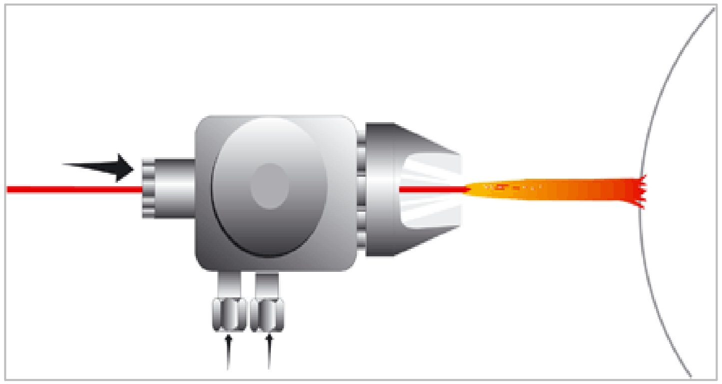
Picture 1: A sure thing: With six different thermal spray processes to choose from, Pallas offers an unusually wide range of treatment options.



Picture 2: Powder flame spraying creates coatings with thicknesses up to several millimetres.



Picture 3-4: In wire flame spraying pracitcally any coating material that is available in wire form can be deposited, while electric arc spraying is a cost-effective way of using electrical energy to create firmly bonded, wear-proof surfaces that are resistant to high temperatures and oxidisation.

We would be pleased to send you these or other images in printable resolution via e-mail.

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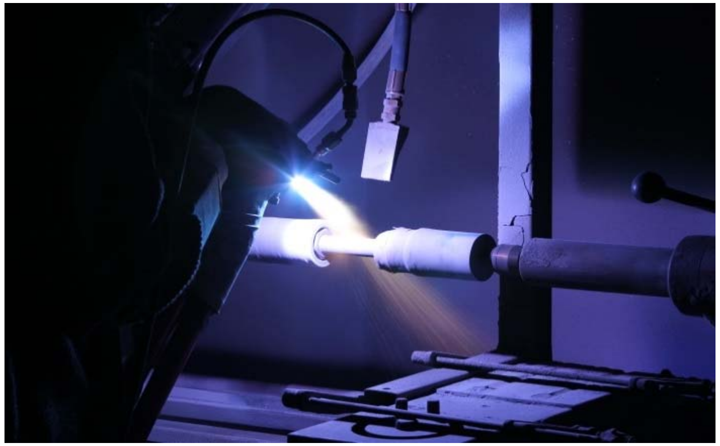
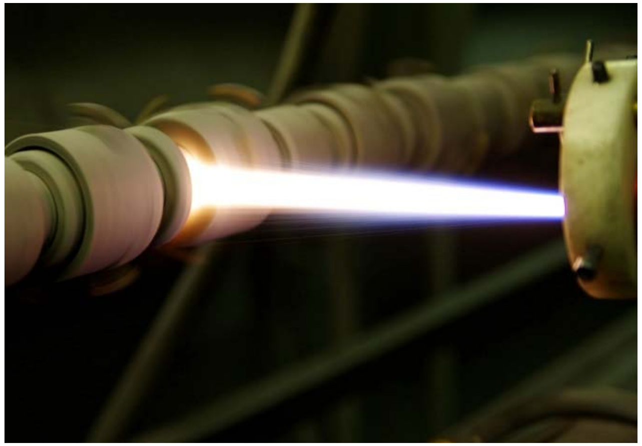
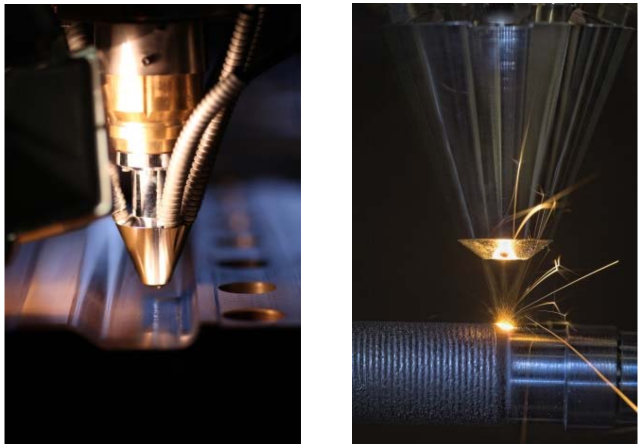


Picture 5: In the up to 20,000 °C-hot plasma flame, atmospheric plasma spraying even processes refractory ceramics and their compounds into extremly hard, wear resistant coatings.



Picture 6: In the case of high velocity oxy-fuel spraying (HVOF), the particles hit the substrate at speeds of up to 750 m/s.

Picture 7: The combination of such a high level of kinetic energy with a relatively low level of thermal energy is optimal for creating very firmly bonded, homogeneous and dense hard metal coatings.



Picture 8-9: Laser processes are appropriate for improving the surface properties of expensive, highly stressed components.

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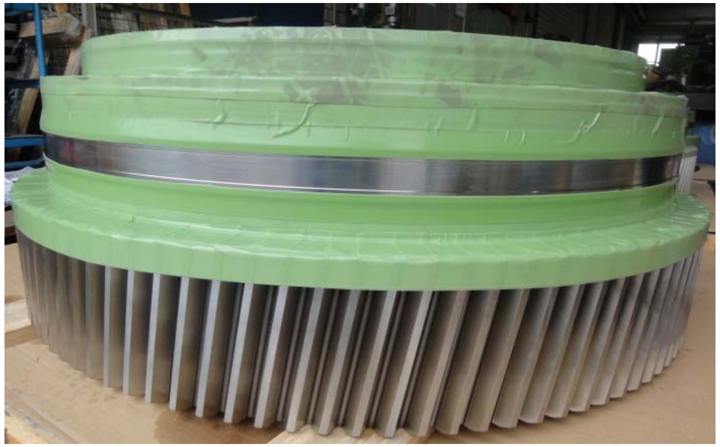
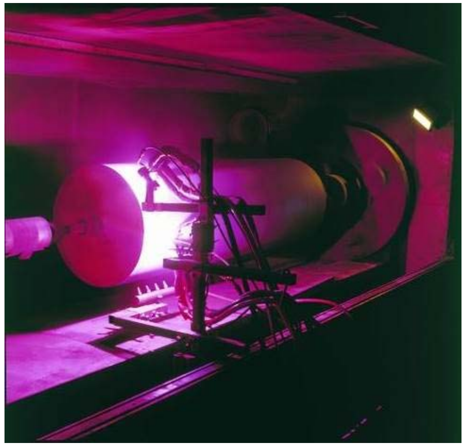

Picture 10: The uncovered spots inside and outside of this pinion gear drive will be thermal coated, sanded and burnished.


Picture 11: In its own sandblast cabin Pallas prepares castors for brake dynamometers for the coating process.


Picture 12: The castors are processed with a mobile sandblast device.


Picture 13: After the sandblast, the castors are cleaned and coated.

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