Workshop on thermal spray and laser clad coatings

COATINGS FOR HIGH TEMPERATURE APPLICATIONS

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Abstracts

Thermal Coatings for Glass Industry

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Most of technologies used for manufacturing products from glass work either with glass melts or softened glass. Depending on their composition the melting points of glasses vary from below 1000^{o}C to over 1700^{o} C for pure quartz, the forming temperatures are lower but it is still several hundred degrees C. That means that the used tools are exposed to high temperature loading resulting in shortening their service life. Thermal coatings deposited on tools can help to lessen this problem. Coatings can as well help with the wetting problem when molten glass sticks on the tools or prevent the corrosion of tools. The paper reviews these and other applications where thermal coatings were applied. In general, thermal coatings in glass industry are not used up to their potential.

Properties of Novel Hybrid Water/Gas DC Arc Plasma Torch

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A new type of plasma torch with combined stabilization of electric arc by water vortex and gas flow is presented. This hybrid water/gas stabilization offers the possibility of adjusting plasma jet parameters within a wide range from high-enthalpy low-density plasmas typical for liquid stabilized torches to lower enthalpy higher density plasmas generated in gas stabilized torches. Moreover, gas flow in the cathode part protects a cathode tip and thus a consumable graphite cathode used in water-only stabilized plasma torches could be replaced by a fixed tungsten cathode. Examples of hybrid WSP torch utilization for high temperature application are given.

Behavior of hardmetal compositions during spraying and high temperature coating service

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Thermal spray can be considered as a technology which allows to realise the functionality of hardmetals on the surface of large parts, which cannot be produced by powder metallurgy for technical and economical reasons. The properties of the most important hard phases WC and Cr_3C_2 as well as TiC as an alternative are discussed. The commercially available hardmetal compositions are reviewed and their high temperature properties are discussed. The contribution reviews the behavior

in the different spray processes, with focus on currently most important HVOF and HVAF processes, in a historical content. The spray process influences both the chemical and phase compositions. The influence of heat treatments on coating microstructure and the oxidation in service are discussed.

Tribology of metallic and hardmetal thermal spray coatings at high temperature

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Thermal spray coatings find numerous industrial applications for wear protection of mechanical components, both at room and at elevated temperatures. Specifically, coatings obtained by processing metal alloys and hardmetals of suitable composition using high-kinetic-energy thermal spray processes (such as HVOF, HVAF, D-gun, etc.) are of particular interest in such applications because of their combination of density, hardness, toughness and oxidation resistance. Their tribological behaviour, however, can differ significantly from that of the corresponding bulk materials, because of the numerous microstructural peculiarities of thermal spray coatings. This presentation therefore aims to provide an overview of the current understanding on the tribological behaviour of thermal spray metal alloy and hardmetal coatings, particularly at high temperatures. After a brief introduction on the fundamental concepts of tribology, the presentation will combine existing literature reports and original research data to highlight the specificities of these materials under a variety of wear processes (e.g. sliding wear, abrasive wear, etc.), coupling the results obtained at the laboratory scale to actual observations on serviced components whenever possible.

Microstructure and Mechanical Properties of Axial-Injection Suspension Plasma Sprayed ZrO2-8Y_2O_3 coatings

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Nanostructured materials are of particular scientific interest because of their physical and mechanical properties, which are superior to those of conventional materials. They are more widely used in various industrial applications mainly due to decreasing production costs. The work is concerned with a study of microstructure and mechanical properties of (ZrO2-Y2O3 coatings. The coatings were sprayed by means of a SPS (Axial III) and APS (Plancer 120, Metco 204 NS). The microstructure and composition powders and coatings were analyzed by SEM FEI Novaä NanoSEM 200 and TEM Philips CM20 with EDAX EDX. Their phase composition was studied using a Bruker D8 Advance diffractometer. In opposite to conventional lamellar APS microstructure, SPS coatings showed two-zone microstructure which consisted of nano-particles surrounded by fully molten areas. Mechanical properties were determined using nanoindentation technique(MCT-CSM) with a Vickers intender (the Olivier and Pharr methodology). Nanoindentation tests showed a distribution of the mechanical properties (hardness and Young's modulus) which is related to the different areas (molten and partially molten) present in the coatings.

Improving Plasma Spray Efficiency Through the Application of Advanced Cascade Gun Technology

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Cascaded plasma guns where neutrode segments are used to extend the length of the plasma arc in a plasma gun. It was observed that fluctuations in arc stability are substantially limited by utilizing the cascaded plasma gun technology compared to traditional plasma gun designs. This results in improved coating quality, better deposition efficiency, higher deposition rates and also in lower operational costs. A single electrode gun, SinplexPro™, using the cascaded gun technology was developed. Its design was based on the TriplexPro™ platform which has been for many years the leading technology development in high efficiency plasma spraying. Results of a study conducted to compare the performance of the newly developed SinplexPro™ to traditional plasma guns are presented.

HVOF coatings for power industry

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The presentation is focused on the HVOF sprayed coatings, suitable for high temperature applications. The properties of selected HVOF sprayed coating are described with focus on their mechanical resistance, stability under high temperature, tribological properties and corrosion resistance. The examples of coatings applications on the particular components for power industry will be shown.

Laser treatment of films and coatings

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The presentation describes the different applications of lasers in coating deposition processes. After a short introduction concerning the types and principal characteristics of the laser and the emitted light beams, a description of the mechanism of interaction between the laser beams with typical coating materials is presented. The laser treatment processes in solid, liquid and gaseous phase are depicted and their characteristics are shown. The numerical simulation of thermal fields at laser treatment is also presented. Subsequently, the recent papers on films coatings produced in one - and two - steps laser deposition are reviewed and the principal results are shown. Finally, the well-known industrial applications of laser processes in thermal spraying coatings such as e.g. anilox rolls are briefly described and some new ones are discussed.

Thermal spraying and hybrid processes: the use of laser technology

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Laser technology is well known for materials transformation. Applied for just surface treatments or deeper for a melting process, multiple applications have already been developed. Then, combined with thermal spray technology, a large potential of development and applications can be imagined. Apply in a complement to the spraying step; lasers can operate as auxiliary processes before, during or after the main process, leading to a wide range of coating improvements (microstructure, adhesion, etc.). Moreover, according to the large diversity of laser technology as well as thermal spray domain, diverse materials can then be treated from organic to metallic and finally ceramic material. By a selection of representative research cases, the aim of this paper is to introduce the most significant laser treatments for thermal spray applications. Laser pre-treatments (ablation and texturing) promoting coating/substrate adhesion are suitable to prepare the surface of sensitive substrates such as aluminum, titanium, magnesium alloys or composites. Laser treatments applied simultaneously during the spraying process deeply modify the coatings microstructure. These hybrid technologies allow in situ laser melting of coatings, resulting in improved mechanical properties and enhanced wear and corrosion behaviors. Finally, laser post-treatments can improve coatings density and adhesion, and also induce phase transformations and structure refinement. As a summary, laser treatments seem particularly promising for improving the thermal spray coating behaviors and then to promote new applications in several domains.

Comparison of properties of coatings for high temperatures by advanced laser cladding and thermal spray technologies

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The presentation will focus on the review of state-of-the-art laser cladding and high-kinetic spray technologies and the coating properties and performances. The application examples will be also presented.

Laserprocessing using high power diode lasers in heave industry

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The application of high power diode lasers in heavy industry, particularly in the areas of thermal processing and laser cladding, is a complex process, whose efficiency has a substantial impact even on the manufacturing procedures preceding laser processing. This article deals with industrial applications of laser cladding in the sectors of heavy industry. The article describes the applications of cobalt and aluminium bronze coatings on heavy-duty machine parts(i.e. parts working under extreme conditions, such as high temperature, high pressure or a corrosive environment) through the use of laser cladding. In addition, using a method of laser cladding, aluminium bronze coatings

were applied to the surfaces of ball joints. This resulted in the formation of functional layers with a low coefficient of friction, a weld density of over 99.99 % and a weld thickness of over 4 mm. During the process, a deposition rate of 3.8 kg/hr and efficiency of about 90 % were achieved. Using the same method of laser cladding, cobalt base alloys (Stellite 12) were applied on the rolls of rolling mills. Again, this resulted in the formation of functional layers with a thickness of 6.5 mm (the substrate thickness was 12 mm), a weld density of over 99.99 % and a hardness of over 600 HV. High power diode laser techniques can be effectively applied in many sectors of heavy industry in order to make the manufacturing of machine parts more efficient and to improve its overall quality and productivity.

Lasers in New Technologies Research Centre

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The presentation will introduce the R&D competencies of New Technology Research Centre in the branch of laser technologies. The usability of high power lasers for surface treatment, cutting or welding of technical materials, as well as low power lasers for various industrial applications will be presented.

Measurement of optical properties of coatings and surfaces

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A measurement system was developed at University of West Bohemia to measure optical properties of coatings and material surfaces at room and high temperatures. Measured can be emissivity, reflectivity, transmissivity and absorptivity in dependence on wavelength and temperature. The obtained values can be used for example for radiation heat transfer, laser absorption, noncontact temperature measurement and temperature induced coatings degradation investigation. The measurement system is divided into two parts, room and high temperature part, which both use an FTIR spectrometer for spectral resolution. The room temperature part of the system is based on a gold coated integration sphere and variable angle reflectivity accessories. The high temperature part of the system is based on laser heated sample and high temperature black body as radiation sources. The sample surface temperature is measured by infrared camera and a reference coating placed on a half of the sample surface. All the system is automated for emissivity measurement at different temperatures. The temperature range of high temperature part is from 300°C to 950°C. The spectral range covered is 2 to 20 µm for the room temperature part and 1.4 to 26 µm for the high temperature part. From the measured spectral normal/angular values a total and hemispherical values can be calculated. Details of the system are presented along with measurement uncertainty and examples of measured samples.