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New Processes in the World of Coatings

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Abstract

Volcanic ash and other abrasive substances- especially sand, salt and ice- do regularly cause problems, their effect which is similar to rough sandpaper, causes rapid engine wear with blades of the high pressure compressor affected particularly badly. Material is eroded from the pressure side, cracks appear and the trailing edge is sharpened like a knife, the abrasive effect also alters the geometry of the blades, leading of efficiency losses, increased fuel consumption and higher CO_2 emissions, several different types of coatings and materials core developed to help these situations for the future of the aero world.

Keywords

Coatings, Materials Engineering, Volcanic Ash

I. Introduction

Computational Materials Engineering (CME) allows materials to be developed much faster and in a more targeted way than before "This computer-aided simulation technique will half development times, bringing about a major reduction in time to market and that is just one of the advantages of CME [1].

Engine manufacturing, with its exacting quality requirements especially as regards safety – critically aspects , is an area where it can take the better part of decade to develop materials from coming up with the idea for a new alloy to maturing it for production use [2]. Among the most time consuming parts of this process are the optimization cycles required to produce and characterize the materials and process variants under consideration until a material is found that meets all the cost and quality criteria [3]. Unfortunately we can never be entirely sure whether the desired results are brought about by adding this or that percentage of tantalum, molybdenum or cobalt to material or by slightly modifying the heat treatment of the material, until several weeks later once all the relevant testing has been completed, the whole exercise must be repeated and refined again and again, but this is set to change, as now – with the aid of computers – it is possible to tailor materials production processes and components to precisely meets requirements [4].

For a long – time these methods could not be applied to materials research because of the extreme completely of the [5]. Improved by simulation, after an analysis of various temperatures points the parameter range can be restricted and the optimum material composition can be found [6] process that must be simulated, but now computers are much more powerful computational methods have been refined and there is a better understanding of the phenomena at atomic level, with CME we can tell in advance what effects new chemical constituents or a particular set of production parameters will have on an alloy's microstructure and hence on it's mechanical strength [7]. Considering the exact requirement emerging engines will have to satisfy, Each engine stage will in future be manufactured using the material that is best suited for the job. CME is a great help, as it permits a computer – based reselection of the most promising material variants which are then produced in the conventional manner.[8]

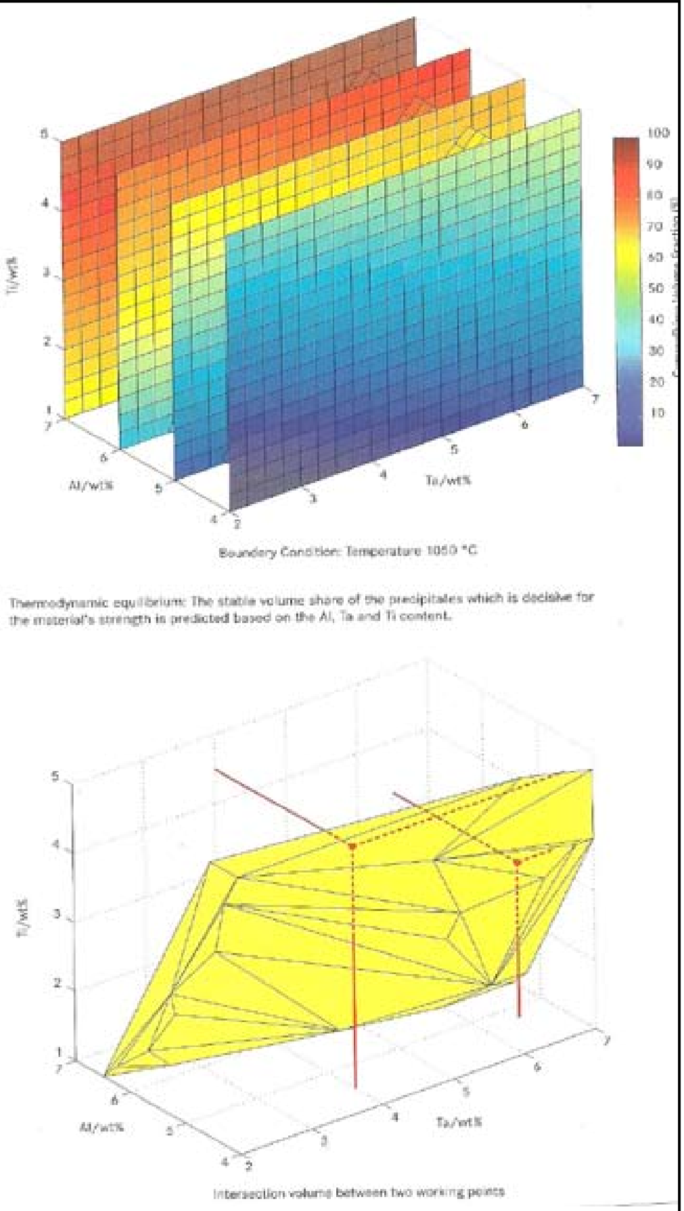

Fig. 1:

II. Coatings

A cloud of volcanic ash and the sharp edged ash particles has played havoc leading to efficiency losses, increased fuel consumption and higher CO_2 emissions, a new special protective coating which makes the blades and vanes of the high pressure compressor mare resistant to wear. The coatings is applied by Physical Vapor Deposition (PVD). A high power are evaporates and ionizes the coating material, and the metal vapor condenses on the blades as a microscopic thin film, the process can be controlled by adding reactive gasses to "tailor the film's properties nano layer by nano layer as PVD technology process" [9].

The process involves vapor deposition of more than just one material, where at least one ceramic and one – metallic layer, the ceramic layer supplies the hardness the impact of grains of sand traveling at 1000 kilometers per hour the is why impact absorbing metallic layer is added. Depending on the component, coating may be vapor deposited one after the other on an alternating basis; different materials are used depending on the component base material[10]

- Titanium and titanium oxide
- Chromium and chromium nitride

It's important to choose the right material for each application. The short flights operating in sandstorm prone desert area with numerous take off and landings make high performance engine material a must [11].

K-3 Coating Technique

Kinetic cold gas spraying- The basic working principle of the K3 process can be described in simple terms, firstly , a gas- typically helium or nitrogen-is compressed and heated to a temperature of around 800 degrees Celsius and then expelled at supersonic speed through a convergent divergent nozzle [12].

Fig. 2:

K 3 coating technique

The powdered coating material is introduced into this high- speed working gas jet with the aid of a carrier gas, when the microscopic particles in the flow of hot working gas collide with the surface of the component – at a temperature well below their normal melting point but at a very high velocity – they bond firmly with the substrate to from a very dense layer that adheres exceptionally well on the component surface since the comparatively low thermal energy of the particles is here compensated for by a much higher kinetic energy, the coating particles in the gas jet need not be molten as with conventional thermal spraying [13].

Advantages of this Thermal Spraying

it prevents oxidization and vaporization process that otherwise occur within the flow of gas and have led to problems in the past [14]. The high particle velocity results in a particularly dense coating. "layers applied using this process are of such low porosity that is used to produce the first coatings that actually increase the components structural durability, the applied coating adheres so well to the substrate and is so strong that it is virtually impossible to discern the coating/substrate interface, at least in the case of low- melting materials , another advantage of the new process is that it is suitable for a wide variety of coating materials, the low temperature of the particles permits the K3 process to be used not only Nickel and Titanium alloys, but also magnesium". "In all other thermal spray methods this highly reactive material is completely oxidized before it even impinges on the surface of the component". [15]

III. Results and Discussion

1. A better understanding of materials allows completely new alloys to be developed more quickly and also offers precision in calculating the safe service life of components, the CME approach helps improve the high- temperature resistance and mechanical strength of components while at the same time reducing their weight at lower development cost, CME to optimize the heat input generated by the linear friction welding and to assers pores in cast parts ," it allows us to evaluate more quickly where pares are tolerable where they are not and to determine how and where exactly occurs."[16]
2. CME would be an ideally suited tool for the additive manufacturing technologies that are now emerging with the help of new simulation techniques, it will be possible to judge the potential of this additive processes more accurately. [17]
3. It gives engines that are optimized down to the last detail, burn less fuel and meet higher profermance and demand.[18]
4. If we compare coating - three blades uncoated and conventionally coated and last one is applied by Physical Vapor Deposition (PVD) the blade coated with (PVD) can be repareable, this shows that blade multilayer coatings perform much better.[19]
5. Blades coated by (PVD) techniques suffer minimal wear in service, So the high pressure compressor will keep performing in it optimum range for longer. That increases engine efficiency, cut fuel consumption and reduces CO2 emissions.
6. K3 – Counts among the thermal spray process that include plasma spraying ,flame spraying, high velocity flame spraying , and wire are spraying that promise to open up numerous interesting applications for the new process in the world of industrial coatings. [20]

The traditional way to protect turbine blades or engine causing components against the corrosion or wear, and to repair them when they are damage, is to deposit a functional coating on a component using a thermal spray process, but the turbulent flow generated when the powder material come into contact with the ambient air often result in a process coating structure that is not sufficiently durable for certain applications.

The Kinetic cold gas spraying process a solution to this problem [7].

Fig. 3:

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This process also scores high when it comes to coating thickness. There is virtually no limit and even several centimeters are achievable. Another advantage of the new process relates to the diameter of the spray jet which can be focused down to about five millimeters enabling it to precisely followed surface counters and selectively applying coatings. Sometimes even without the need for masking. In the flame spraying the diameter of the spraying cone is much larger, the coating efficiency of the new process is much higher can reach 90 percentage where's the best results with flame spraying is 40 percentage [8]. The coating material must be ductile which rules out it's use as a means of depositing ceramic coating.

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