International Advanced Research Centre for Powder Metallurgy & New Materials (ARCI)

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Electron Beam Physical Vapour Deposition System (EBPVD)

Overview

EBPVD technology is known to deposit the coatings with columnar microstructure which results in enhanced strain tolerance and erosion resistant at high temperatures. Owing to this specific technological feature, EBPVD coatings are popularly employed for depositing the ceramic coatings with extremely lower thermal conductivity. One of the best known configurations of such thermal barrier coating (TBC) is the top coat of yttria stabilized zirconia (YSZ) with a suitable bond coat on aero engine gas turbine blades and vanes. Further, EBPVD technology is also suitable for depositing a wide variety of metallic, alloy and composite materials which is also suitable for the bond coat applications such as MCrAlY (M = Ni or Co) on the super alloy substrates for enhanced functional performance. Such an EBPVD technological unit with specific features and special capabilities has been established at ARCI in collaboration with M/s International centre for Electron beam technologies, Kiev, Ukraine for readily serving the Indian industry. The EBPVD consisting of multiple EB guns which will melt and evaporate the ingot materials under specific vacuum conditions in a controlled chamber wherein the vaporised materials get subsequently deposited on the substrate materials. Specialized jigs and fixtures were designed and processing parameters were optimized to provide the TBC's on a variety of components needing protection against the high temperatures. In addition, an innovative methodology has been created to benefit the Indian strategic sector and industry for refurbishing and repairing a variety of blades and vanes indigenously during engine's periodic overhauls thus saving notable amount of foreign currency.

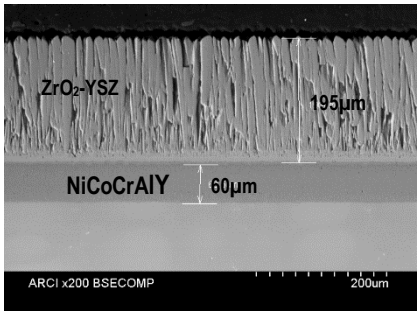
Key Features

- Coatings obtained are dense, uniform and smooth
- Possible to obtain gradient compositions, structure and properties as required
- 50-100 µm/hr deposition rate with a productivity of 10-15 kg/hr
- Large window of coating thickness (10µm-2 mm)
- Ability to coat thin foils, strips, sheets & heavy blanks

Electron beam physical vapour deposition (EBPVD) System

Potential Applications

- By changing the processing conditions such as ingot composition, part manipulation and EB energy, EB-PVD technology is capable of depositing various coatings such as: functional gradient coatings, multilayered thick ceramic coatings, textured multilayer coatings, biological coatings
- Hot Corrosion & Oxidation Resistant Coatings
- Uniform Thermal Barrier Coatings (TBCs)
- Damping and Wear Resistant Coatings
- Thick Repair Coatings up to 1-2 mm



Typical microstructure of ZrO_2-YSZ coatings

TBC coated HP Turbine blades

Technology Readiness Level (TRL)

- Application development in aero engine and power sector turbine blade and sponsored project on development of TBC coating rotor HP rotor turbine blades for helicopter engine is currently in progress at ARCI.

IPDI*	1	2	3	4	5	6	7	8	9	10
Activities	*Basic concepts and understanding of underlying scientific principles*	*Short listing possible applications*	*Research to prove technical feasibility for targeted application*	*Coupon level testing in stimulated conditions*	*Check repeatability/ consistency at coupon level*	*Prototype testing in real-life conditions*	*Check repeatability/ consistency at prototype level*	*Reassessing feasibility (IP, competition technology, commercial)*	*Initiate technology transfer*	*Support in stabilizing production*
Status			**6-7**							

Major Patents / Publications

- D. Srinivasa Rao et al, Processing-Structure-Property Relationships in EB-PVD Yttria Stabilized Zirconia (YSZ) Coatings, Journal of Vacuum Science & Technology A 29, 2011
- Dipak K. Das, D.Srinivasa Rao et al, Singh, Microstructure, Texture and Thermal Cycling Performance of EB-PVD TBCs Deposited under Different Processing Conditions, Journal of High Temperature Materials and Processes, Vol.30(2011),pp.539-548

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