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Manufacturing engineering in thermal spray technologies by advanced robot systems and process kinematics

Plasma physics and material science have dominated academic research in thermal spray technologies in recent decades. Value adding by creation and manufacturing of competitive products with advanced coating technologies employed needs a state of the art approach in manufacturing engineering. Thinking in process chains and managing all steps of them with a focus on product performance, reliability and customer satisfaction is an indispensable methodology for modern manufacturing engineering with complex high technologies. Materials mechanics and the understanding of process induced residual stresses and their interaction with operational load stresses are further issues in product development of coatings and layer composite structures. Intensive heat and mass transfer up to supersonic conditions have a distinct influence on coating properties. The same is true for the torch trajectories and robot kinematics programming with their influence on local resolution of these parameters and subsequently on the achievable dimensional tolerances and reproducibility in industrial processes. For high process reproducibility and optimized coating quality in thermal spray applications on complex geometries, APS (Atmospheric Plasma Spraying), HVOF (High Velocity Oxygen Fuel) and further torches are guided by advanced robot systems. The trajectory of the torch, the spray angle and the relative speed between torch and component are crucial factors which affect the coating microstructure and phase composition as well as the mechanical, thermophysical and electrophysical properties and especially the residual stress distribution. Thus the requirement of high performance thermally sprayed coatings with narrow dimensional tolerances leads to challenges in the field of robot assisted handling, and software tools for efficient trajectory generation and robot programming are demanded. By appropriate data exchange, the automatically generated torch trajectory and speed profile can be integrated in FEM (Finite Element Method) models in order to analyze their influence on the heat and mass transfer during deposition. Last but not the least the process variants have to be matched to meet the best fit of functional requirements of the coating product in its specific application field. Modeling and simulation concepts are shown to demonstrate their potential and benefit for industrial product development. Case studies are introduced in the fields of new combustion engines, ship propulsion and nuclear power plant engineering.

Biography

Rainer Gadow has completed his MSc and PhD both in Chemistry at the University of Karlsruhe (TH), Germany, now known as KIT. As Assistant Professor, he was Head of the Ceramics and Composites group at ICT, University of Karlsruhe. In his industrial career, he was Head of R&D and General Manager in world leading companies in technical ceramics, surface technologies and advanced mechanical engineering. Since 1995, he is Full Professor and Managing Director of IFKB, the Institute of Manufacturing Technologies of Ceramic Components and Composites at the University of Stuttgart, Germany. He managed various national and international projects in advanced ceramics, surface and nanotechnologies. He is the Acting Dean of the Faculty of Mechanical, Automotive and Production Engineering with 17 research institutes in Stuttgart. Furthermore, he is Managing Director of New Materials Technologies at TTI GmbH, Stuttgart. He has published more than 700 papers in reviewed journals and more than 60 patents in the field of product development with new materials and manufacturing processes. He is serving as an Editorial Board Member and Peer Reviewer of various scientific journals and Visiting Professor worldwide.

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