Introduction to Atmospheric Plasma Spray and Overview of Process Control Technologies

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Abstract

The atmospheric plasma spray (APS) process is a versatile coating technology used for thermal insulation, wear and corrosion protection, and repair of industrial gas turbines. APS is the most flexible thermal spray process rendering it capable of depositing coatings from a wide variety of powder stocks onto complex part geometries. The APS process generates a high-temperature plasma plume after pressurized gasses flow through a high-amperage arc sustained between an electrode and a nozzle inside a water-cooled torch. Powder stock is then injected into the plasma plume which melts, sprays, and deposits micron sized droplets to form coatings.

The challenges associated with the variability of APS coatings, number or process parameters, instability of the high-amperage arc, and degradation of torch components has driven the thermal spray industry to advance APS technology by utilizing feedback control loops. The research presented targets sensor technologies, off-line robotic programming, and automation of data collection and analyses for improved process control and repeatability of APS coatings for gas turbine engines in the aerospace industry. Sensor technologies currently being investigated include optical and thermal vision systems, acoustic monitoring, and run-to-run coating thickness measurements. Statistical analysis and modeling of intrinsic coating properties (hardness, porosity, thickness, etc) with inputs provided by advanced sensor technologies show promising control strategies. Implementation of control strategies has issued the challenge of adapting existing APS hardware and these new sensors to a network based (internet of things) communication protocol so real-time analyses can be performed on a centralized database.

Biography

Marshall L. Sweet joined the Commonwealth Center for Advanced Manufacturing in the Greater Richmond, VA area in November 2015. His work focuses on atmospheric plasma spray coatings and the robotic abrasive blasting cell to conduct research for experimental and production purposes. Additionally,
his responsibilities include collaboration with industry partners, troubleshooting electrical and mechanical issues, daily and long-term equipment maintenance, advising graduate student research assistants, and expanding the surface engineering team’s research capabilities.

Marshall previously worked as a Research Engineer at Southface Energy Institute in Atlanta, GA conducting building science research on residential and small commercial buildings. He assisted research efforts for the U.S. Department of Energy’s Building America and Advanced Commercial Building Initiative programs. Research topics included envelope air tightness, indoor air quality, in-situ monitoring of HVAC systems and heat pump water heaters, building custom low-cost Arduino based sensors, and robust handling of large datasets.

Marshall graduated with a B.S. from James Madison University in Harrisonburg, VA where he majored in Integrated Science and Technology with minors in mathematics and physics. He received his M.S. and Ph.D. in Mechanical Engineering at Virginia Commonwealth University (VCU) in Richmond, VA. Marshall concluded his academic career as an adjunct instructor at VCU and as an assistant professor at J. Sargeant Reynolds Community College teaching thermodynamics and entry level engineering courses.