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## **Bell-Contoured, Parallel Flow Nozzles for Reducing Overspray in Thermal Spray Processes**

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Thermal spray guns which exhaust supersonic plasmas currently employ anodes incorporating conical nozzles. These nozzles do not ideally expand the plasma flow and, therefore, produce disruptive shock waves and expansion fans in the plume. Shock waves and expansion fans turn the flow, allowing injected particles to escape and resolidify. Also, the divergent, linear walls produce tangential flow velocity components that are not parallel to the nozzle center axis. The divergent flow components, in turn, impart divergent trajectories to many injected powder particles which facilitates their escape from the plasma flow. To solve this problem, bell-contoured nozzles were designed and fabricated to ideally expand the plasma and, thus, eliminate disruptive flow phenomena while exhausting a collimated flow. As a result, injected powder particles remained in the plasma, and overspray was reduced substantially. Additionally, the flow exiting the bell nozzles did not impart divergent components to injected particles: therefore, the impact velocities of the particles were maximized. Consequently, test results show that bell-contoured nozzles have reduced overspray by 50 percent.