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The Effect of Plasma Gas Composition on Transport Properties, Feedstock Treatment, and Torch Dynamics Using a Spraying Torch with Axial Suspension Injection

Abstract:
Three different plasma gas compositions, a ternary argon-based plasma parameter, a ternary nitrogen-based parameter, and a binary nitrogen-based parameter without any argon, were used with the Axial III™ plasma torch for suspension plasma spraying. Thermodynamic and transport properties of the plasma gas mixtures were calculated and compared. Based on this, Ability of Acceleration Factors (AAF) and Ability of Heating Factors (AHF) were calculated and correlated with measured in-flight particle velocities and temperatures.

The computational and experimental results show that the transport properties, namely the thermal conductivity and the viscosity of the plasma gas, are key factors for the feedstock treatment. In this respect, a high nitrogen content is advantageous, especially for the heating of the particles. Therefore, nitrogen can be considered as a high heat transfer component of the plasma. However, the use of nitrogen requires a thermally robust plasma torch design.

Nitrogen also has a relatively high enthalpy. Enthalpy describes the amount of energy stored in the plasma gas that can be released. If the amount of this energy is not sufficient to heat the feedstock as required, e.g. at high feed rates of solid or liquid feedstocks, an insufficient enthalpy of the plasma gas is a limiting factor. Again, the computational and experimental results in this study show that a high nitrogen content can be advantageous.

Biography:
Georg Mauer graduated with a degree in mechanical engineering from RWTH Aachen University, where he also received his Ph.D. After serving as a scientific assistant, chief engineer, and industrial manager, he joined Forschungszentrum Jülich's Institute of Energy, Materials, and Devices, where he currently leads the Thermal Spraying Team. He is also a professor at TU Dortmund University.