Numerical reconstruction of spalled particle trajectories in an arc-jet environment

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When ablative materials experience high heat rates, they undergo mass-removal mechanisms, collectively termed as “Ablation.” Spallation is one such mechanism where carbonaceous ablative material loses its mass through particle ejections. These ejected particles are likely disconnected carbon fibers or chunks of material, and can also be formed by soot, a by-product of the pyrolysis process. The ejections and presence of spalled particles in the flow field affect the performance of the ablator.

Spallation experiments were conducted at NASA Langley's HYMETS arc-jet facility to quantify and qualify the effect of these particles. High-speed imagery and particle tracking velocimetry analysis were used to obtain the trajectories. However, it was not possible to determine the size and other ejection parameters of the particles through direct measurements. It is essential to know the initial state of the spalled particles to have a better understanding of how and why the ejections take place. Therefore, a hypersonic flow field solution is computed, based on the sample geometry and test conditions, using Kentucky Aerodynamic and Thermal-response Solver (KATS). A Lagrangian particle-tracking code is used to determine the initial size and other ejection parameters for experimentally identified trajectories.