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Quantification of Mixing of a Sonic Jet in Supersonic Crossflow due to Thick Turbulent Boundary Layer Interaction TOBIAS ROSSMANN, Lafayette College, ADAM PIZZAIA, Rutgers University — The upstream injection surface boundary layer is shown to have a significant effect on the mixing characteristics of a sonic jet in supersonic cross flow. A circular, high-pressure, sonic jet is injected into a M=3.5 supersonic crossflow through different boundary layer thickness (δ/D = 7.5 and 1), with variable injection angles (-20 to +20 degrees), and variable momentum ratios (J = 2, 5, and 10). Planar Laser Mie Scattering of condensed ethanol droplets is used to quantitatively image the injected fluid concentration in both the side and end views. Jet fluid concentrations PDFs are constructed to better understand the mixing dynamics. These PDFs are integrated to create mixed fluid fraction profiles that are then reduced to mixing efficiency. Mixing efficiency values are computed from different two-dimensional planes to determine if centerline mixing efficiencies are characteristic of the entire three-dimensional flow. Through these analyses, it is seen that thick boundary layers tend to marginally alter jet penetration and spread, but significantly worsen jet mixing capabilities, regardless of momentum ratio or injection angle.

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