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Direct Numerical Simulation of a Mach 2.25 Turbulent Boundary Layer Over A Compliant Surface[1] CHRISTOPHER OSTOICH, DANIEL BODONY, PHILIPPE GEUBELLE, University of Illinois at Urbana-Champaign —
Future high-speed air vehicles will be lightweight, flexible, and reusable, and thus susceptible to dynamic coupling between the boundary layer and vehicle surface. Current analysis techniques of boundary layer properties based on rigid surface assumptions may be invalid in this flight regime, and experimental approaches are difficult and expensive. Analyses involving accurate numerical predictions are therefore needed to provide data in this high-speed, coupled environment. Results of a Mach 2.25 turbulent boundary layer evolving over a thin, compliant panel are investigated using direct numerical simulation in the fluid coupled to a geometrically non-linear, thermomechanical finite element solver for the solid. The coupled response of the boundary layer-panel system are presented and compared to the rigid panel case. Panel deformation and fluid flow modification due to the presence of the compliant panel are analyzed, with a particular interest in the influence of panel motion on turbulence statistics. The maximum panel deformation extends through the viscous sublayer while space-time data show that the solid supports waves that may be useful for sensing and control.

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Christopher Ostoich
University of Illinois at Urbana-Champaign

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