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Transition of high-speed flow induced by roughness elements PRAHLADH IYER, SUMAN MUPPIDI, KRISHNAN MAHESH, University of Minnesota — Transition induced by isolated and distributed roughness elements at supersonic speeds is studied using DNS on unstructured grids. Flow past a hemispherical bump placed on a flat plate is simulated for three Mach numbers [3.37, 5.26, 8.23] with simulation parameters chosen to match the experiments carried out by Danehy et al. (AIAA-2009-394). Unsteady flow structures were observed for Ma=3.37, 5.26 while Ma=8.23 remained laminar downstream of the trip. Qualitative comparison between the computation and experiment show good agreement. Based on the computed skin friction coefficient values, Ma=3.37 appeared to become turbulent in nature, Ma=5.26 was transitional and Ma=8.23 was laminar. The effect of distributed roughness on transition was studied at Ma=2.9. A laminar boundary layer at Ma=2.9 was observed to transition to a turbulent boundary layer that shows good quantitative agreement with experimental data. The free-stream Mach number and roughness amplitude were seen to strongly influence whether or not the flow transitions. A local Reynolds number based on bump/roughness amplitude is seen to correlate the tendency to transition for both single bump and distributed roughness cases.

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