Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

Turbulence behavior in supersonic channel flows with two- and three-dimensional sinusoidal roughness MOSTAFA AGHAEI JOUYBARI, JUNLIN YUAN, FARHAD A. JABERI, GILES J. BRERETON, Michigan State University — Direct numerical simulations were performed to study supersonic turbulent channel flows over isothermal rough walls. The effect of roughness was incorporated as a body force in the momentum equations and a heat source in the energy equation, using an immersed boundary method. The rough surfaces included four sinusoidal geometries—two two-dimensional (2D) geometries (sine waves in the streamwise direction) and two three-dimensional (3D) geometries (sine waves in both streamwise and the spanwise directions). The surfaces shared the same roughness height but differed in their wavelengths. Simulations were carried out at bulk Reynolds number of $\mathrm{Re} = 3000$ and Mach number of $\mathrm{Ma} = 1.5$. Comparison of flow statistics shows a strong dependence of mean flow properties, turbulence anisotropy, and Reynolds stress budgets on the roughness wavelengths. Results also revealed major differences in the shock patterns induced by 2D and 3D roughness geometries, the effects of which were propagated over the entire channel and modified coherent turbulent motions.

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Date submitted: 10 Aug 2020 Electronic form version 1.4