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Porous coatings for hypersonic laminar flow control MATTHEW INKMAN, GUILLAUME BRES, TIM COLONIUS, California Institute of Technology, ALEXANDER FEDOROV, Moscow Institute of Physics and Technology —
We present the results of linear and nonlinear simulations of hypersonic boundary layers over ultrasonic absorptive coatings consisting of uniform arrays of rectangular pores. Through direct numerical simulation of the two-dimensional Navier-Stokes equations, we explore the effects of coatings of various porosities and pore aspect ratios on the growth rate of the second mode instability. The performance of deep pores operating in the attenuative regime, in which acoustic waves are attenuated by viscous effects within the pores, is contrasted with more shallow pores operating in the cancellation/reinforcement regime. The results of linear simulations in many cases match the results of linear stability theory and confirm the ability of such coatings to stabilize the second mode. At certain conditions such as high porosity and large acoustic Reynolds numbers, the porous layer leads to instability of slow waves, introducing a new instability due to coupled resonant forcing of the cavity array. We confirm the observed instability arises in the linear stability theory, and suggest constraints on cavity size and spacing. Finally, nonlinear simulations of the same geometries confirm the results of our linear analysis; in particular, we did not observe and "tripping" of the boundary layer due to small scale disturbances associated with individual pores.

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