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Introduction: Roughness and Hypersonic Boundary-Layer Transition

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This issue of the *Journal of Spacecraft and Rockets* contains eight papers on roughness as it relates to hypersonic boundary-layer transition. The papers present a diverse sampling of research on roughness-influenced transition, from the Apollo program to future vehicle concepts. Experiments reported in these papers were carried out both in conventional wind tunnels and in a new, quiet wind tunnel. Analyses include traditional, correlation-based methods and newly-developed direct Navier–Stokes (DNS) approaches and transient growth theory.

Schneider presents a historical review of the database on roughness effects on blunt-body transition. This paper gives special emphasis to reentry capsules, with relevance to the NASA crew exploration vehicle.

Borg and Schneider present results of boundary-layer trip tests for the X-51 vehicle. These tests, performed in the Boeing/U.S. Air Force Office of Scientific Research Mach 6 Quiet Tunnel, provide some of the first data on the effects of wind-tunnel noise on tripped hypersonic transition.

Papers by Alba et al., Berger et al., and Wadhams et al. discuss ground tests and analysis of the Hypersonic International Flight Research and Experimentation Flight One (HIFiRE-1) vehicle. These papers deal primarily with the design of boundary-layer trips, in addition to discussing tolerances on inadvertent roughness arising from joints and instrumentation. This issue of JSR also includes a computational fluid dynamics analysis by MacLean et al. on experiments by Wadhams et al. Although not strictly roughness related, this paper illustrates some of the challenges and recent advances in computing transitional hypersonic flows.

The HIFiRE papers present a traditional, correlation-based approach to predicting boundary-layer transition due to roughness. Papers by Wang and Zhong and Tumin describe newer methods of analyzing the effects of roughness on transition. Wang and Zhong use of DNS simulations to explore the receptivity of roughness elements in a hypersonic boundary layer. Tumin presents a theoretical analysis of nonparallel flow effects on roughness-induced perturbations in a compressible subsonic flow. Although the flowfields considered in this paper are subsonic, the analysis is germane to hypersonic transition on rough, blunt-nosed bodies.

These papers were originally presented at the AIAA 46th Aerospace Sciences Meeting in January 2008. That so many papers on roughness-influenced hypersonic transition were presented at one conference testifies to the complexity and impact of the problem. Considering the advances presented here, we can certainly expect research delivering greater accuracy and physical fidelity to be published in future issues of JSR.

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