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Control of Resonant Flow Inside a Supersonic Cavity Using High Bandwidth Pulsed Micro-actuators

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Active control of high speed flows has been dependent upon the development of simple yet robust actuators that are capable of producing high momentum and are reliable, responsive and have the capability of being integrated easily. This paper presents an experimental investigation of the characterization and implementation of high-bandwidth pulsed microjet-actuators for the control of supersonic resonant flows in a cavity. This pulsed microjet-actuator is capable of producing high momentum mean flow along with an unsteady component where frequency can be adapted. The results show that using this first generation design actuation of the pulsed microjets reduce the amplitude of the cavity tones by upto 7 dB and the overall sound pressure levels upto 5 dB. The effect of actuator pressure ratio was studied over a wide range. A comparison was made with the same actuator working in a steady mode of operation. The pulsed microjet injection alters the shear layer characteristics and significantly reduces the unsteadiness in the cavity as observed from the unsteady pressure measurements. Based on these results the actuator design is being modified to further improve its control authority. This is expected to lead to much improved control in future studies.

I. Introduction

Cavity flow has been the subject of research since the 1950's (Roshko[1]). Although geometrically simple, fluid dynamics in these flows is rather complicated. In practice these large fluctuating surface pressure loads are observed in cavities such as aircraft weapons, cargo and landing gear bays represent a serious concern. Mixing control and enhancement in supersonic combustion has also been a topic of research for many years. Active control of shear and boundary layer flows have attained wide attention in the recent years due to the potential and substantial benefits derived out of such control schemes. In high-speed flows, control of flow oscillations in cavity flows, supersonic impinging jets and jet noise control are areas where various active control methods may lead to dramatic gains in performance. Control schemes that have proved relatively successful in subsonic flow may not be ideal for the effective and efficient control of high speed flow. Effective control of flow and noise requires the use of robust actuators. Although various types of actuators have and are being explored, most designs have shown some limitations either due to their overall performance, range of operation, cost effectiveness and/or integrability into practical systems. There is a clear need for actuators that produce *high-amplitude excitation, over a broad range*. Furthermore, the output of an ideal actuator should be adjustable, both in terms of amplitude and frequency over a large dynamic range. Such actuators would then be useful for implementation in practical flows.

Cavity flows are governed by a flow-acoustic resonance. As the shear layer separates from the leading edge of the cavity, it starts to roll up into large-scale vortical structures. As these structures impinge on the

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