Aerodynamic Testing of MEMS Surface Sensors

Robert D. White – Tufts University – Medford MA

E-Mail: r.white@tufts.edu

Abstract

In aerodynamic flow testing, pressure and skin friction (surface shear stress) are the forcing functions that create lift, drag, and structural vibration. Knowledge of the steady and unsteady pressures and shear forces at a surface are needed for predicting and measuring total drag, flow separation, external acoustic generation, and internal acoustics due to structural vibrations. Work at Tufts over the last few years, in collaboration with NASA, Draper Labs, Spirit Aerosystems, and, more recently, Bombardier Aerospace, has resulted in the development of two MEMS sensor technologies targeted at subsonic wind tunnel environments, with a future goal of extending the technologies to flight testing on subsonic aircraft. The first sensor is a 64 element capacitive microphone array surface micromachined from polysilicon. The second is a 16 element surface shear array micromachined using a LIGA-like electroplated nickel process. In terms of packaging challenges, a key issue is surface topology; in order to have little impact on the flow, peak to peak surface topology for the types of tests we are conducting should be kept below 25 microns. In this paper, experiences with system design and packaging for wind tunnel measurement will be described. Specific tests to be described include: (1) Turbulence spectral measurement with the MEMS microphone array in both the Spirit Aerosystems 6” boundary layer flow duct and the NASA Ames 14” inflow tunnel, at speeds up to Mach 0.6, and (2) surface shear measurements in the NASA Ames 15” indraft tunnel, at flow speeds up to Mach 0.2.