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Introduction to Aerodynamic Measurement Technology Special Section

ON behalf of the AIAA Aerodynamic Measurement Technology Technical Committee (AMT-TC), I am pleased to introduce this special section of the *AIAA Journal.* The AMT was formed in 1990 with the goal of assembling a group of specialists in measurement technology in order to improve the capabilities, quality, and productivity of aerodynamic testing and to disseminate this information to the aerodynamic community at large. Since its founding, the AMT has participated in the annual AIAA Aerospace Sciences Meeting, sponsoring a yearly set of sessions that focus on recent advances in instrumentation techniques, demonstration of novel applications, and identification of promising new technologies.

This is the fourth in a series of triennial special sections, the first of which appeared in March of 1993. The papers presented here represent a cross section of papers presented in AMT-sponsored sessions at the 39th Aerospace Sciences Meeting, held in Reno, Nevada, 8–11 January 2001. It is a metric of the rapid rate of evolution of this field that virtually none of the techniques or applications highlighted in this issue were represented in the first special issue, which appeared less than 10 years ago.

The first six papers illustrate recent innovations in quantitative velocimetry methods. Particle imaging velocimetry (PIV), which uses image correlation techniques to track the motion of small seed particles, continues to demonstrate its power and versatility to probe a wide range of challenging fluid flows. Recent trends include the development of digital PIV, which takes advantage of new, high-resolution, charge-coupled imaging devices, and stereoscopic PIV, which provides the capability to determine three components of velocity. Also presented in this issue are technical issues related to important new applications of PIV, ranging from microfluidics to full-scale supersonic shock tunnels. New techniques and applications based on molecular tagging velocimetry (MTV) also continue to evolve rapidly. MTV is a time-of-flight–based technique in which the temporal evolution of patterns, written into a flow by means of an optical resonance, are tracked using laser imaging techniques. This section includes new tagging techniques that demonstrate promise for measurement in reacting flows and in cold flows at micron-scale spatial resolution.

Quantitative determination of scalar flowfield quantities, such as temperature, pressure, and composition, continues to be an important aerodynamic technology focal area, represented by three papers in this special section. Transient grating spectroscopy (TGS) probes fluid flows by inducing a periodic spatial modulation in the local index-of-refraction, which is monitored directly in the time domain. The temporal decay of this index grating can be related to local transport and thermodynamic properties. Conceptually similar grating techniques, which probe in the frequency regime, can also be employed. One such example is coherent anti-Stokes Raman spectroscopy (CARS), which can be employed for measurement of temperature in a wide range of flow environments. For characterization of ionized flows, a new molecular filter-based Thomson scattering approach is presented, which is shown to have significant potential for measurement of electron number density and electron temperature.

The last three papers describe recent advanced surface measurement technologies that have provided new capability for determination of important aerodynamic properties such as shear stress, surface pressure, and integrated force and moment. Pressure-sensitive paint (PSP) measures surface pressure distribution by diffusion of oxygen through a supporting matrix to an active lumophore, for which optical emission is subsequently rapidly quenched. The development of porous supporting media has led to PSPs with temporal bandwidths of order 10 kHz, suitable for measurement in a wide variety of important unsteady flows. The incorporation of silicon MEMS technologies has led to similar advances in the temporal bandwidth of wall shear stress measurements. Finally, optical imaging techniques have also been developed that show potential for measurement of aerodynamic load, by direct determination of material deformation.

I would like to thank all of the contributing authors and the technical reviewers for making timely presentation of this special section possible. I am also grateful for the assistance of the editorial staff of the AIAA and Robert Lucht, the Associate Editor. Finally, on behalf of the AMT, I would like to thank Gerard Faeth, the *AIAA Journal* Editor-in-Chief, for once again supporting the publication of this special section.

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