Air Force SBIR/STTR

Transition

Air Force SBIR/STTR Transition Story

Topic Number:
AF04-T001

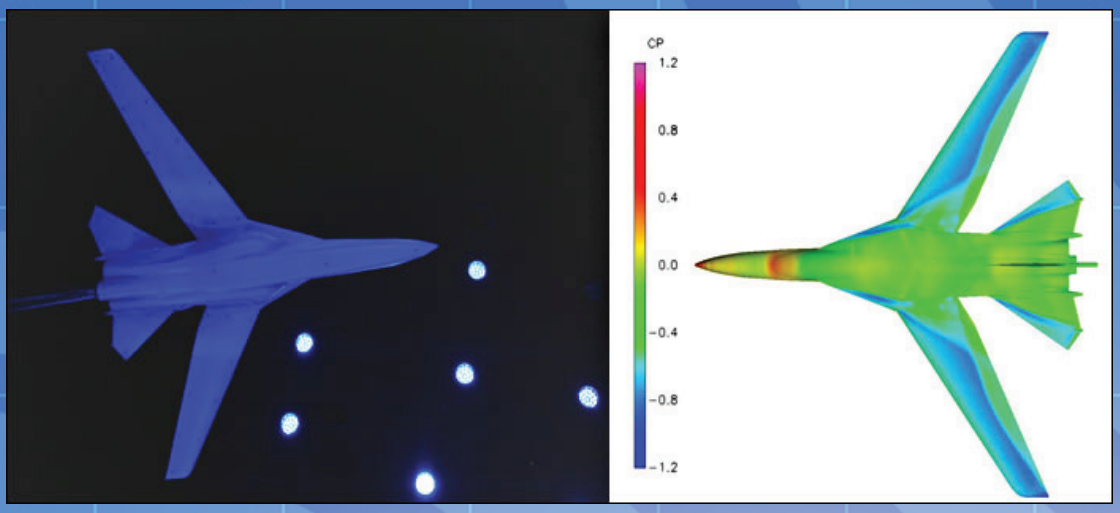
Title:
Improved Pressure- and Temperature-Sensitive Paint

Contract Number:
FA9550-06-C-0014

Company Name:
Innovative Scientific Solutions Incorporated, Dayton, OH

Technical Project Office:
Air Force Office of Scientific Research, Arlington, VA

An example of Air Force supported SBIR/STTR technology that has been transitioned into an Air Force or other DoD system or subsystem or used by Air Force test ranges and facilities or maintenance depots.



Left: Facility Aerodynamics Validation and Operations Research (FAVOR) model in AEDC wind tunnel illuminated by ISSI high-power LEDs; Right: Resulting pressure map on model using ISSI pressure sensitive paint

Improved Pressure- and Temperature-Sensitive Paint

- The Air Force has a requirement for a paint formulation that provides simultaneous measurements of both pressure and temperature using a lifetime-based detection scheme for near real-time data presentation
- Innovative Scientific Solutions, Inc. (ISSI) has developed a light activated dual-probe lifetime pressure- and temperature-sensitive paint as well as a high-power light emitting diode (LED) system for excitation of the probes
- More than 40 of the high-power LED systems were transitioned to Arnold Engineering Development Center for use in their 16-foot transonic wind tunnel; overall data acquisition time was reduced by a factor of six
- These technologies are currently in use by NASA, Sandia National Laboratories, AFRL's Air Vehicles Directorate, many U.S. universities, and aeronautical agencies in South Korea, Japan, Brazil and the UK

Commercialization Pilot Program Series

88ABW-2011-3672

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Air Force Requirement

The measurement of surface pressure and temperature distributions on wind tunnel models is required for the assessment of aerodynamic performance and aero-thermal effects during the development of new aircraft and aircraft component designs. Pressure transducers and thermocouples do not provide adequate spatial resolution and require costly machining of the model and routing of sensor leads to incorporate them in a test. Pressure- and temperature-sensitive paints (PSP and TSP) overcome these limitations since they are simply sprayed onto the model surface. However, they can still be compromised by the undesired temperature sensitivity of most PSPs and by the complications of combining PSP and TSP measurements in a single test. Specifically, the Air Force required a paint formulation that provided simultaneous measurements of both pressure and temperature using a lifetime-based detection scheme. This process is highly desirable in costly Air Force wind tunnels, such as those at the Arnold Engineering Development Center (AEDC), as well as in commercial tunnels because the process allows near real-time data presentation. This represents a significant advantage in production testing.

STTR Technology

During the Phase II STTR effort, Innovative Scientific Solutions Inc. (ISSI) teamed with the University of Washington to improve PSP/TSP technology in order to better support Air Force and commercial test facility requirements. These paints operate by incorporating a pressure- (PSP) or temperature- (TSP) sensitive probe in the paint that is activated by light of a specific wavelength. The probes then emit light at a different wavelength and the amount of light emitted is directly proportional to the air pressure or temperature on the model surface. A digital camera system captures images of the model and the intensity pattern is converted to a map of pressure or temperature on the model surface.

The team's primary technical accomplishment was the development of a dual-probe lifetime paint that provides pressure measurements with very low temperature sensitivity using the lifetime-based detection scheme. The second accomplishment was the development of an LED system for excitation of the PSP and TSP probes with eight times the power output of their previous components. The new LEDs result in higher signal-to-noise from the paint leading to significantly reduced wind tunnel operational time. By maintaining the original LED package dimensions, ISSI enabled direct replacement of currently fielded LED systems. Both products achieved the TRL 8 level of maturity required for transition.

Transition Impact

More than 40 of the high-power LED systems shown here were directly transitioned to AEDC for use in their 16-foot transonic wind tunnel operations. The ultra-bright LED's reduce overall wind tunnel data acquisition time by a factor of six. This results in a significant improvement in system productivity and cost savings for the Air Force. The productivity improvement was demonstrated by AEDC using their Facility Aerodynamics Validation and Operations Research (FAVOR) model shown on the previous page. Over 30 of the LEDs were also delivered to NASA test facilities (Langley, Glenn, and Ames) and to Sandia National Laboratories for use in their binary lifetime-based measurement systems.

NASA/Ames and AEDC employed the new dual-lifetime paint and LEDs and in support of the Orion Launch Abort System testing. High temperature air was circulated through the model to the abort motor exhausts resulting in significant variations in temperature on the model surface. The new dual-probe lifetime paint successfully minimized the effect of these temperature variations. In addition, the AFRL Air Vehicles Directorate is also using ISSI PSP/TSP components in their wind tunnel research.

Company Impact

In addition to the U.S government transitions, PSP/TSP systems that grew out of this STTR investment have been delivered to numerous U.S. universities, the Agency for Defense Development in South Korea, the South Korean Aeronautical Institute, Tohoku University and the Japanese Aerospace Exploration Agency, the University of Singapore, the Aircraft Research Association in the United Kingdom, and the Brazilian Aeronautical Commission, to name a few.

In summary, these STTR-developed technologies have been a key factor in ISSI achieving the position of world-wide leader in the development and sales of pressure- and temperature-sensitive paint technologies.

U.S. AIR FORCE

SBIR/STTR

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