

# PSP Course 2019



## Application of Pressure/Temperature Sensitive Paint Theory and Practice, February 18 - 22, 2019

### Application of PSP

For investigations of pressure distributions on wind tunnel model surfaces with high spatial resolution, new experimental techniques such as Pressure Sensitive Paint (PSP) and Temperature Sensitive Paint (TSP) are required. Using these non-intrusive optical pressure measurement techniques, spatial structures and/or rapid temporal or spatial changes of aerodynamic phenomena (transition from laminar to turbulent flow, shocks on pitching airfoils in transonic flows, coherent structures etc.) can be investigated. Recently, an increasing number of scientists and engineers has started to utilise the PSP technique to investigate pressure distributions in low speed, transonic, hypersonic and cryogenic wind tunnels, as well as in turbo machines. The PSP technique has also evolved from the measurement of steady state pressures to include both periodic and unsteady phenomena to study the instantaneous structure of pressure fields in various areas of fluid mechanics. This course, which is the eighth one on PSP organised by DLR Göttingen, Germany, will concentrate on both measurement techniques and aspects of the theory of PSP relevant to applications. In addition to lectures on the fundamental aspects of Pressure Sensitive Paint Systems, emphasis is placed on the presentation of practical and reliable solutions for problems faced during the implementation of the technique in wind tunnels and other test facilities. During practical sessions the participants will have the opportunity of carrying out experiments in small groups on PSP/TSP characterisation, coating technique, and the recording and evaluation of PSP data.

Recent developments of the PSP technique will be discussed and demonstrated. In addition the application of Temperature Sensitive Paint (TSP), which is from the technical point of view very similar to PSP, will be covered by this course.

The participants are invited to prepare a poster to present their special interest in PSP or TSP which also can be helpful for discussions with experts about special technical aspects.

### Lecturers

Prof. Keisuke Asai, Tohoku University, Sendai, Japan, having several years of experience in the field of PSP/TSP measurements and paint development, will present lectures on the basics of unsteady PSP.

Prof. Dr. Yasuhiro Egami, Aichi Institute of Technology (AIT), Toyota, Japan, who worked at DLR for several years, will give information about TSP development and application.

Dr. Vladimir Ondrus, University Hohenheim, Germany, will discuss chemical aspects and development of the paint in his lecture.

Marie-Claire Merienne and Yves Le Sant from ONERA, Meudon, France, who have experience of more than 15 years in the field of PSP development, will give detailed information about advanced techniques like corrections of self-illumination, temperature etc. and will speak about Software requirements for PSP data evaluation.

Dr. Youssef Mebarki, National Research Council, Canada, will present a theoretical background on the Pressure Sensitive Paint.

Dr. Ulrich Henne, Institute of Aerodynamics and Flow Technology, DLR, Göttingen, who organises the PSP course will present basics of intensity based PSP systems.

Dr. Rolf H. Engler, who had performed research and development in PSP for more than 25 years, will start the lectures with a general overview of the existing PSP systems and techniques.

Together with Dr. Marco Costantini, Dr. Michael Hilfer, Dr. Christian Klein, Jonathan Ost, Dr. Steffen Risius, Dr. Armin Weiss, and Dr. Daisuke Yorita they will present their knowledge and experience in different areas of the TSP and PSP technique such as coating, calibration techniques, camera operation and adjustment, recording, evaluation, data presentation, unsteady PSP, and calculation of loads using PSP.

### Schedule

(preliminary)

Registration will begin at 8:00 h on Monday, February 18, 2019 in the Lecture Room of Building 7. Lectures (4 half days) as well as experiments and demonstrations in the laboratory (5 half days) will run from 8:30 h to 12:00 h from Monday to Friday and from 13:30 h to 17:00 h from Monday to Thursday. All presentations will be given in English. The participants are welcome to present their projects within a poster session. The course will end on Friday at 12:30 h.

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### Course outline

(preliminary)

#### Monday, February 18, 2019

Registration, Welcome by Dr. Lars Koop, Head of the Department Experimental Methods of the DLR Institute of Aerodynamics and Flow Technology.

General overview, physical and historical background, paint types and properties, lifetime and intensity based PSP, Basic photo molecular chemistry.

#### Tuesday, February 19

Data reduction, Light sources, Camera systems and their properties, Advanced techniques (from angular effects, deformation to pixel wise calibration)

Practical session I.

#### Wednesday, February 20

Basics of unsteady PSP, Principle of Temperature Sensitive Paint (TSP) and its Application in Aerodynamic Testing, Poster session

Practical session II.

#### Thursday, February 21

Practical sessions III and IV.

#### Friday, February 22

Practical session V

Future aspects of PSP technique, final discussion and assessment.

### Practical sessions

(preliminary)

A wind tunnel experiment is planned, covering application of low speed PSP. Other practical sessions deal with the coating procedure including preparation of anodized aluminium, characterization of PSP/TSP samples, PSP for acoustic measurements and application of the PSP technique on a fast rotating propeller and/or TSP application in convection cells.

### Course material

A complete set of course notes will be distributed to the participants at registration.

### Course registration

Preregistration is required due to limited number of places in the laboratory. *Online registration at <http://pspcourse.dlr.de> is desired.* The registration fee of 990 EURO includes course notes, lunches and refreshments during the course. For payments received before January 17<sup>th</sup>, 2019, a reduced registration fee of 890 EURO applies. The organizers reserve the right to cancel the course in case of insufficient registration. A cancellation fee of 200 Euro will be charged from registered persons who cancel their participation after January 17<sup>th</sup>, 2019.

### General information

The latest information about the PSP course can be found at: <http://pspcourse.dlr.de>.

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### Organized by

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