In-house Fabrication of Temperature Sensitive Paint

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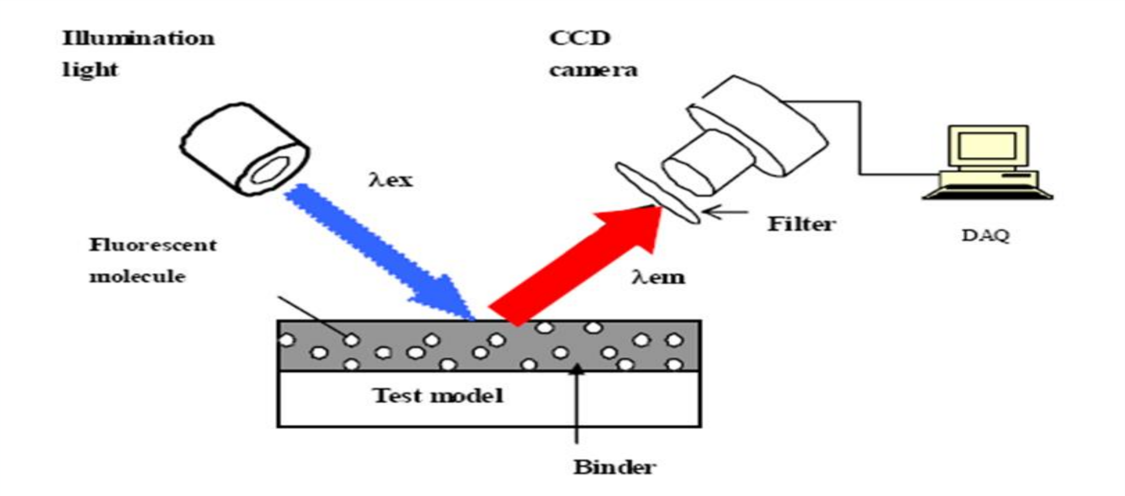
MOTIVATION

- Temperature Sensitive Paint (TSP) is major method of measuring boundary layer transition and heat transfer.
- TSP is accurate and cheaper alternative to conventional tube measurement techniques
- However, use of commercial available TSP is limited by cost and time factors.

GOAL

- Develop Standard Operating Procedure for fabrication of TSP in house for Aerospace Research
- Study illumination and response time of fabricated TSP with commercial TSP and CFD Simulations
- Implement fabricated TSP as cost effective alternative with future fabrication of Pressure Sensi-

BACKGROUND

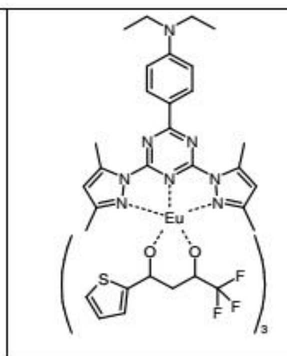


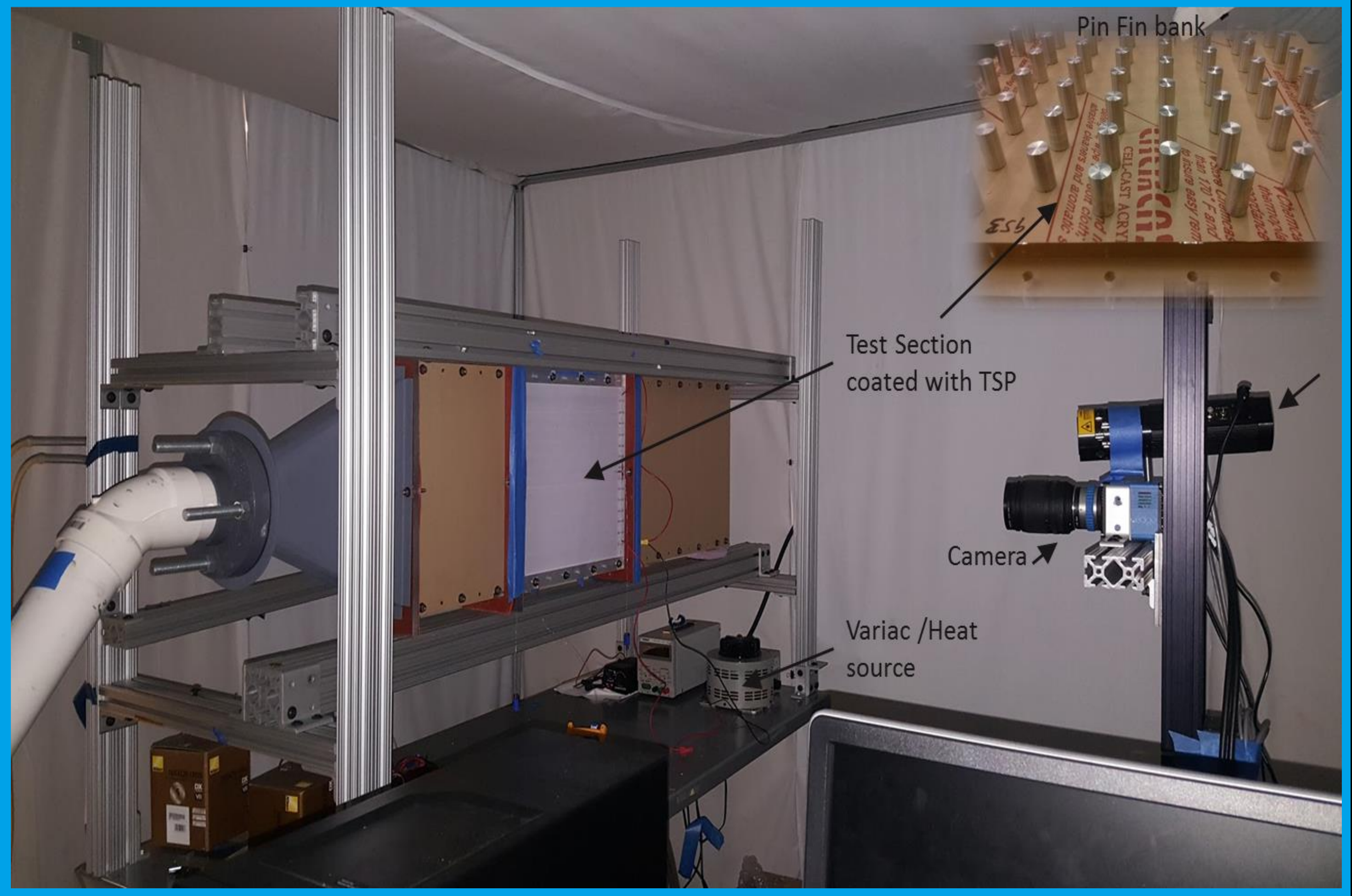
- Developed to replace old method of thermocouples.
- TSP uses optical sensors such as CMOS camera to measure temperature on small and remote surfaces
- Based on quenching of luminescent molecules which are sensitive to local temperature.

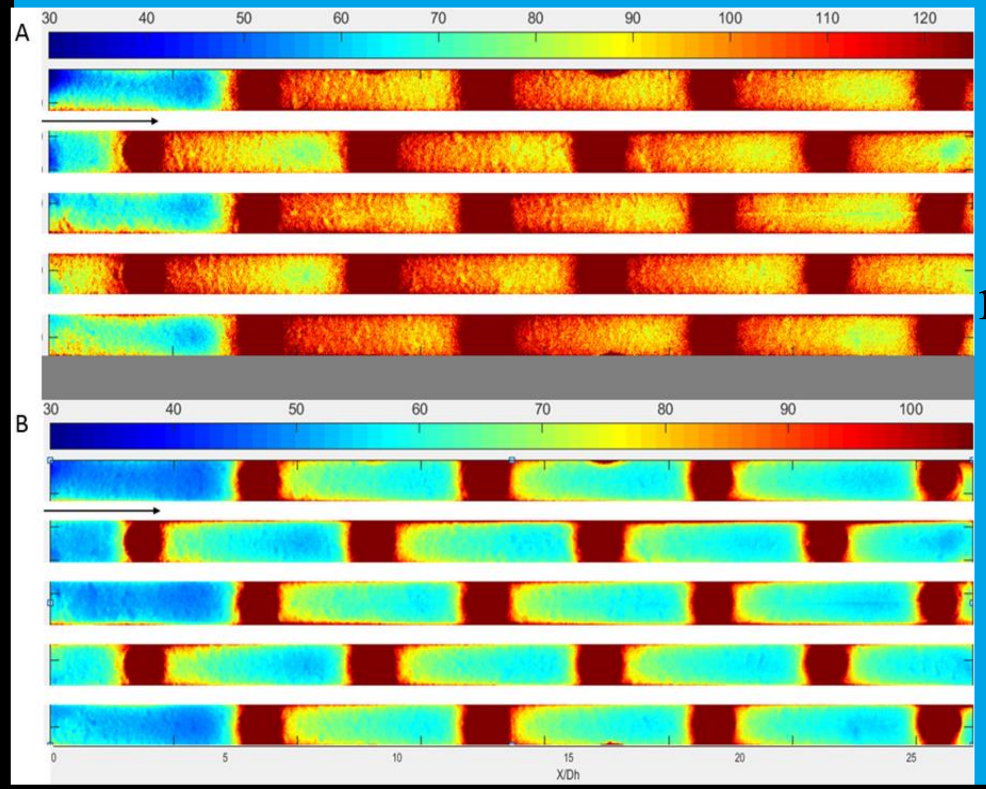
CURRENT DESIGN

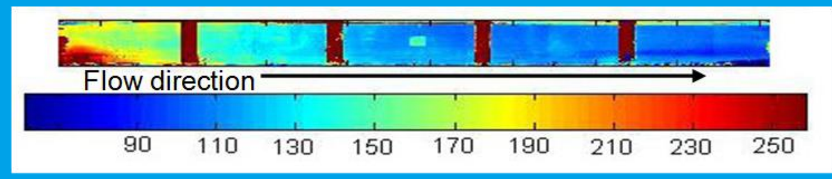
- Based on literature research, Europium (III) tris (thenoyltrifluoroacetylacetonato) diethymaninophenyl (EuTTA) chosen as Luminophore.
- Excitation wavelength of UV light and emission wavelength of 612 nm allowed for use available CMOS CCD camera.
- Oxygen binder was chosen to be Model Airplane Dope and Dope Thinner.
- Standard Operating Procedure was developed to meet the Nitrogen storage requirement of EuTTA as well as Acetone and Dope's chemical requirements during the fabrication of paint.
- Cost analysis determined that in house fabricated TSP will cost **10%** of the commercially available TSP.

Luminophore	Binder	Excitation wavelength (nm)	Emission wavelength (nm)	Useful temperature range (degree C)	Max. log slope (%/°C)	Lifetime at room temp. (micro s)
Coumanin	PMMA	UV		20 to 100	-0.4	
CuOEP	GP-197	480-515		-180 to 20	-2.9	
EuTTA	Dope	350	612	-20 to 80	-3.9	500
Perylene	Dope	330-450	430-580	0 to 100	-1.9	0.005
Perylenedicarboximide	PMMA	480-515		50 to 100	-0.7	
Pyronin B	PMMA	460-580		50 to 100	-4.6	
Pyronin Y	Dope	460-580		0 to 100	-5.5	
Rhodamine B	Dope	460-590	550-590	0 to 80	-1.8	0.004
Ru(bpy)	Shellac	320, 452	588	0 to 90	-0.93	5
Ru(bpy)/Zeolite	Poly	320, 452	588	-20 to 80	-4.1	

Europium(III)-tris(thenoyltrifluoroacetylacetonato)-(2-(4-diethylaminophenyl)-4,6-bis(3,5-dimethylpyrazol-1-yl)-1,3,5-triazine) **[Eu(tta)$_3$(dpbt)]**		417 nm	614 nm	50 69 72

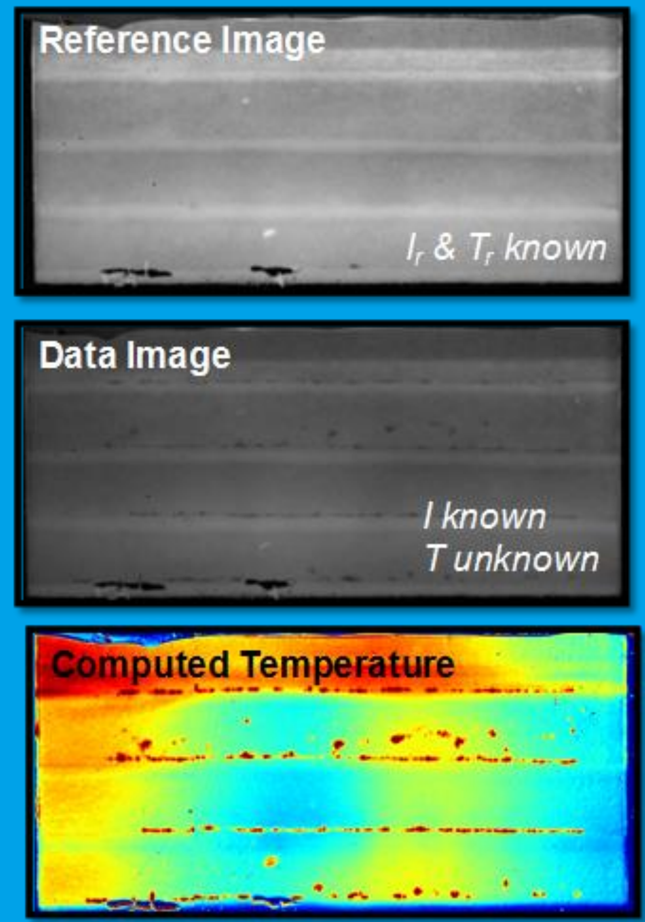






PROGRESS

- Standard Operating procedure has been developed, accounting for safety and chemical risks.
- Data capturing test section was used to test and record results for commercially available TSP.
- Fabrication of in-house TSP is in process and will be tested to prove its effectiveness.
- In-house TSP will be calibrated to adjust for intensity ratios and compared with commercial TSP.
- Right shows the results of commercial TSP with temperature varia-



FUTURE/ TEAM

- Repeat the experiment by developing in house Pressure Sensitive Paint.
- Transition fabrication process of TSP to College of Engineering to reduce errors associated with exposure to UV light.
- Perform experiment on aircraft model using wind tunnel and compare with CFD simulation results.

From Left to Right
-Mayur Patel (PI)
-Dr Mark Ricklick (Research Advisor)
- Dr Emily Faulconer (Chem Lab Manager)
- Justin Grillot (Director Health & Safety)

- Dr Ricklick is an Assistant Professor of AE with research focus on Jet Impingement behavior.
- Mayur is a senior in AE with experience as engine test engineer and experimental research.