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Method Development for Compensating Temperature Effects in Pressure Sensitive Paint Measurements

by

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Pressure sensitive luminescent paints (PSP) have recently emerged as a viable technique for aerodynamic pressure measurements. The technique uses a surface coating which contains probe molecules that luminesce when excited by light of an appropriate wavelength. The photoluminescence of these materials is known to be quenched by the presence of molecular oxygen. Since oxygen is a fixed mole fraction of the air, the coating's luminescence intensity varies inversely with air pressure. Digital imaging of the luminescence varying across a coated surface produces a pressure distribution map over that surface.

One difficulty encountered with this technique is the temperature effect on the luminescence intensity. Present PSP formulations have significant sensitivity to temperature. At the moment, the most practical way of correcting for temperature effects is to calibrate the paint in place at the operating temperatures by using a few well-placed pressure taps. This study is looking at development of temperature indicating coatings that can be applied and measured concurrently with PSP, and use the temperature measurement to compute the correct pressure.

Two methods for this dual paint formulation are proposed. One method will use a coating that consists of temperature sensitive phosphors in a polymer matrix. This is similar in construction to PSP, except that the probe molecules used are selected primarily for their temperature sensitivity. Both organic phosphors (e.g., europium thenoyltrifluoroacetonate, bioprobes) and inorganic phosphors (e.g., $Mg_4(F)GeO_6$:Mn, La_2O_2S:Eu, Radelin® Type phosphors, Sylvania® Type phosphors) will be evaluated for their temperature sensing potential. The next method will involve a novel coating composing of five membered heterocyclic conducting polymers which are known to show temperature dependent luminescence (e.g., poly(3-alkylthiopene), poly(3-alkylselenophene), poly(3-alkylfuran)).

Both methods will involve applying a bottom layer of temperature sensitive coating followed by a top coating of PSP. An oxygen-impermeable polymer can be used as the temperature sensitive coating matrix, or it can be layered in between the coatings to prevent oxygen quenching of the bottom coating's luminescence. The probe molecules of the coatings will be excited by a broad band of light, with the different emissions detected and measured at their distinct wavelengths. Developmental research of these coatings is still in progress; however, preliminary results look very promising.