An intensity-based and a lifetime-based PSP imaging method with enhanced sensitivity

S.Someya[1], S.Yamashita[1,2], T.Munakata[1], H.Ito[1],

[1] National Institute of Advanced Industrial Science and Technology, 1-2-1 Namiki, Tsukuba, Ibaraki 305-8564, Japan

[2] The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa, Chiba 277-8563, Japan

A pressure-/temperature-sensitive paint (PSP/TSP) has been developed and used as a measurement tool for the two-dimensional distribution of pressure and temperature on aerodynamic surfaces. In recent years, although the concern with measuring a pressure difference of several Pa, such as countermeasures against the noise of small fans, has been growing, the resolution of current PSP measurements is limited to several 10 Pa, even with carefully conducted measurements. For highly accurate measurements, researches on the advanced coating films in PSP/TSP have eagerly been conducted to date. However, measurement resolution and accuracy deteriorate when quantum efficiency or lifetime decrease under high pressure or high temperature conditions.

In this study, we propose an advanced evaluation method by improving an imaging procedure, by combining intensity-based and lifetime-based methods. It is expected to improve accuracy as compared to the case where a single method is used. We evaluated the pressure sensitivity and temporal fluctuation of measured values, with comparing to a standard intensity-based method and a standard lifetime-based method under steady and unsteady pressure conditions.

Due to the limitation of the length of extended abstract, two standard and two proposed concepts of imaging procedure were illustrated in figure 1 and 2. Here, we defined the method which required a reference image as the intensity-based method, and the method without any reference image as the lifetime-based method.

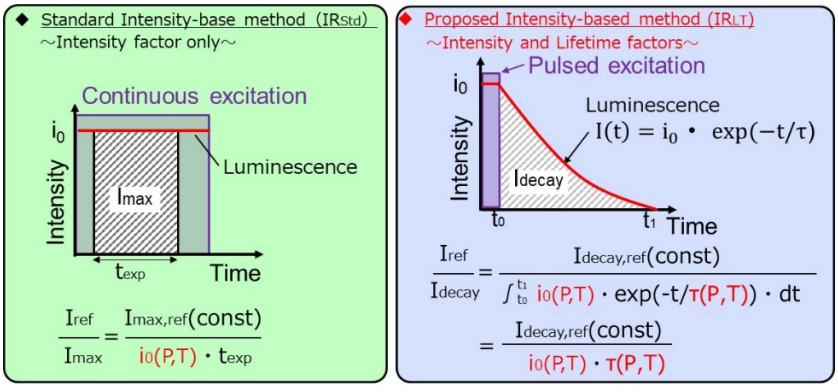

Fig.1 A concept of revised intensity-based method with a reference image.

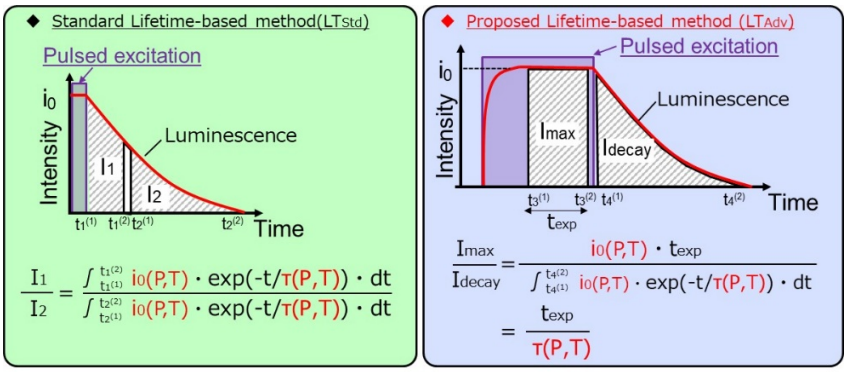

Fig.2 A concept of revised lifetime-based method without a reference image.

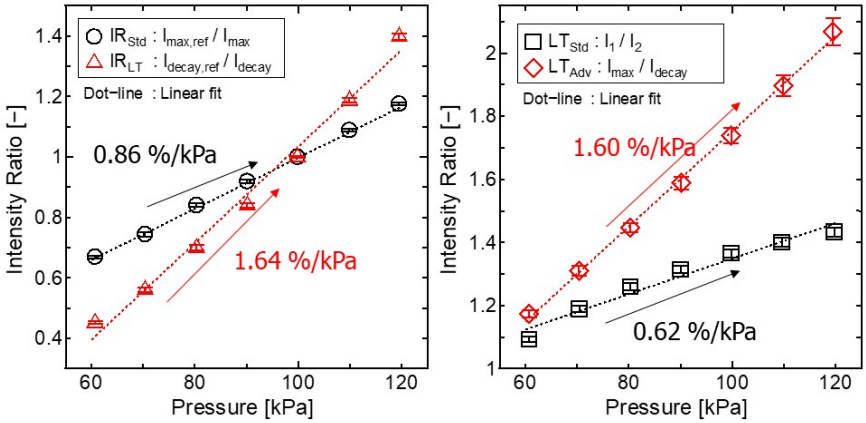

Fig.3 Pressure sensitivities of standard and proposed imaging methods near the atmospheric pressure condition.

Figures 3 show pressure sensitivity of each method near the atmospheric pressure. As shown in figs.3, proposed methods had higher pressure sensitivity than those of standard methods. The high sensitivity leads to a large value of the signal-to-noise-ratio and clear visualization of pressure distribution.

In the full length paper and the presentation, detail of these methods and results are shown.