Development of Non-destructive Inspection for the Performance of Thermal Barrier Coating

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A gas turbine will be run at ever higher temperatures to obtain high efficiency. On this account, thermal barrier technology to protect hot parts from high-temperature gas becomes increasingly important. Accordingly, the evaluation of the thermal barrier performance of the thermal barrier coating (TBC) becomes important, too. To date, however, no effective inspection method for the performance of TBC has been developed.

In this paper, we describe an effective nondestructive inspection method to evaluate the thermal barrier performance of TBC[1-2]. The thermal barrier performance of TBC (in other words, the thermal resistance of TBC) is degraded by decreases in TBC thickness, rises in TBC density, and peeling of TBC. In this nondestructive inspection method, a laser heats the part to be inspected and the surface temperature of the heated part is measured with a radiation thermometer or infrared camera. The thermal resistance of the TBC is evaluated from the measured temperature. An important requirement in this nondestructive inspection method is to divide the heating wavelength and measuring wavelength in order to remove influence of the reflected light. Another requirement is to perform the heating and measurement of the target part continuously and at a fixed speed. Depending on the heating condition selected during heating and measurement, we can exclude the influence of the change in the thickness of a metal part coated with TBC. This method is believed to be effective for complexly shaped metal parts of actual gas turbines coated with TBC.

Fig. 1 shows a trial application of this nondestructive TBC inspection method to a gas turbine combustor. In this application, we performed a laboratory experiment and numerical analysis by a finite element method[3] to evaluate the practicability of this nondestructive TBC inspection method[4]. Fig. 2 shows an examination result from an experiment adopting the thermal resistance of the TBC as a parameter. As the thermal resistance of the TBC rises, the measured temperature rises at the rate shown in the figure. Numerical analysis yielded a

similar result. A linear correlation was found between the thermal resistance of the TBC and the detected temperature when the thermal resistance was arranged by the detected temperature (Fig. 3), and the dispersion of the measured value was ± less than 5%. Based on the results of numerical analysis and laboratory examination, our proposed nondestructive inspection method was judged to be an effective measurement method for the evaluation of the thermal barrier performance of TBC.

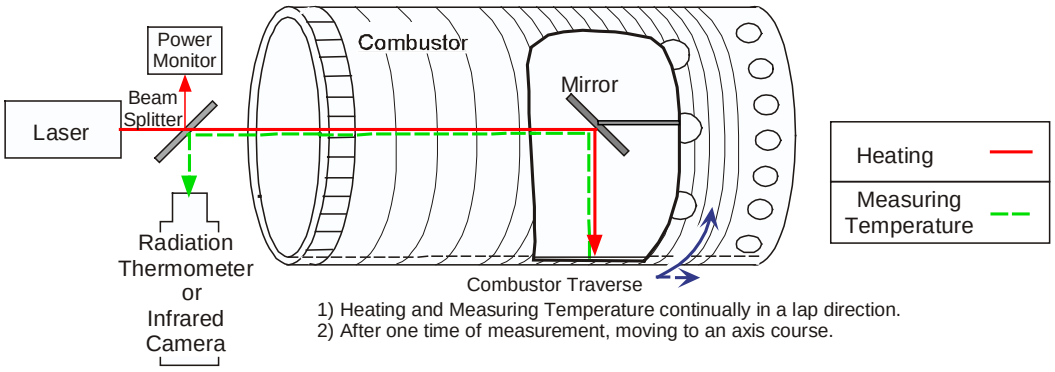


Fig.1 Conceptional Figure of Our Proposed Non-destructive Inspection Method applied to Gas Turbine Combustor

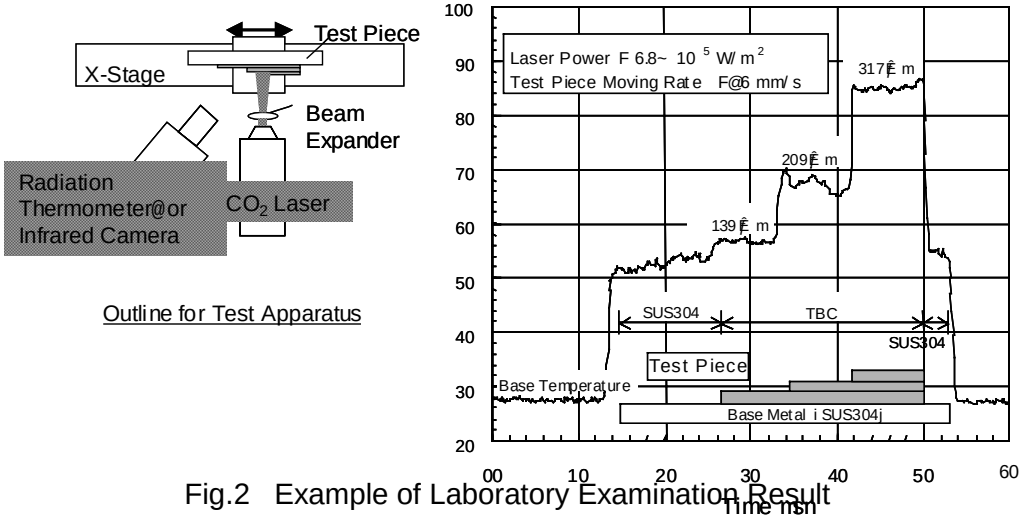
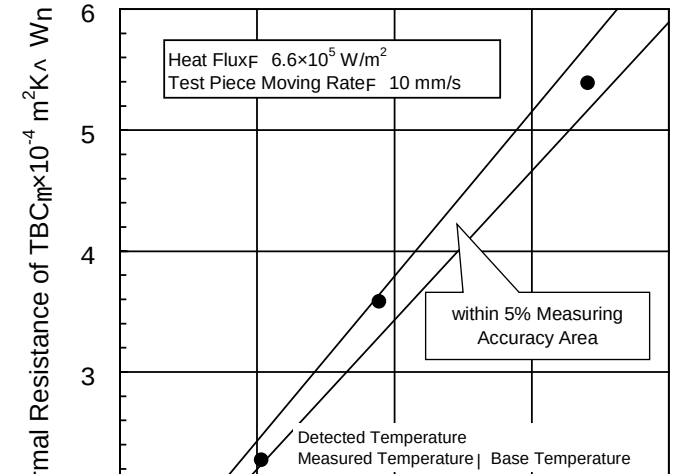


Fig.2 Example of Laboratory Examination Result



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