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"Development of a portable system for detection of thermally grown oxide layer inTBC"

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Abstract

The formation of a thermally grown oxide (TGO) layer at the interface between the topcoat and the bondcoat of a thermal barrier coating (TBC) is an origin of topcoat damage, which can lead to delamination of the topcoat. The TGO layer contains Al_2O_3 with Cr^{3+} as an impurity, which can be detected by photoluminescence. In this report, a portable system for detection of the TGO layer was developed. This system can be used for screening tests of topcoat delamination inspection, since delamination is likely to occur at locations where the TGO layer has grown. The system uses a Nd:YAG laser of wavelength 532 nm and a compact spectrometer to detect the photoluminescence from Cr^{3+} at 694.3 nm (R_1) and 692.9 nm (R_2). An optical probe is used to illuminate the specimen with laser light and to collect the photoluminescence. The optical probe is coupled to the main body by optical fiber, which allows flexibility to match specimens with curved surfaces or complex structures. The probing region is a circle of diameter 5 mm. The system performance was tested using TBC specimens heated at 1000^0C and 1100^0C, and an as-sprayed, unheated TBC specimen. Photoluminescence (R_1, R_2) was clearly observed from heated specimens and was not observed from the unheated specimen. Furthermore, photoluminescence from the TBC specimen heated at 1100^0C for 1000 hr showed an increase on the long wavelength side of R_1, with a peak at 701.9 nm. This suggests the possibility of identifying regions of the TGO layer with high Cr^{3+} concentration. In addition, a method to correct the photoluminescence intensity for different topcoat thickness is proposed. The attenuation coefficient of the topcoat, which is necessary for the correction, was measured to be 7.3 mm^{-1}. The maximum topcoat thickness for which photoluminescence can be observed was estimated to exceed 600 μm, so the system is applicable to TGO layer detection in most components.