LINEAR LASER FAST SCANNING THERMOGRAPHY NDT FOR DISBONDS IN THERMAL BARRIER COATINGS

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Keywords: Thermal barrier coatings, Disbond defect, Linear laser fast scanning thermography, Directional temperature field carrier

ABSTRACT

Currently, turbine blade made by directional solidification alloy and single crystal alloy can only withstand prolonged exposure to high temperature of 1000℃. when it works, which cannot meet the needs of the modern engine's working temperature. In order to solve this problem, people have developed TBCs technology to protect metal substrate of blade. The engine turbine blade coated with TBCs can run at high temperatures of 1600℃. It can improve the engine thermal efficiency more than 60% and effectively increase the thrust weight ratio. This makes the coating structure gradually applied in many fields such as nuclear reactor, aviation engine and so on. The fabricating procedure of its complex structures and extremely harsh working conditions result in defects in TBCs, which is the main factor for causing premature failure of TBCs. Therefore, it is of great significance for the defect detection of TBCs structure. Herein, this work is only focused on NDT for disbond defects in TBCs

Interface disbond in Thermal Barrier Coatings (TBCs) is one of key issues of causing its premature failure, so detecting these defects is particularly important. Aiming at accurately detecting disbond defects in TBCs, a Linear Laser Fast Scanning Thermography (LLFST) method, combing with novel post-processing algorithms for thermal images, such as constructing and removing directional carrier of temperature field, three-moment windowing amplitude method for noise suppression, etc., is developed here. A multi-mode laser scanning system is built firstly. A point laser or line laser can be formed and focused on the tested specimen surface with this system, and its speed and direction can be controlled, thus, multi-mode scanning thermal excitation, such as the rough scanning and fine scanning, can be realized. Linear laser fast scanning and heating can arouse some unique thermal response features of disbond (here flat bottom hole is used to simulate disbond) in space and time domain, Such as a significant increase of temperature near disbond followed by a distinct 'tailing' phenomenon(Fig.1). Based on this typical characteristic, a post-processing method "variable weighting filter combined with temperature amplitude" is developed, which can reduce image marginal noise, highlighting the thermal response characteristics. Validation tests indicate that using LLFST method can fast detect the disbond based on these thermal response features with higher efficiency (Fig. 2)and the combination of the rough and fine scanning can detect the defects of FBH which a diameter of larger than 1mm.

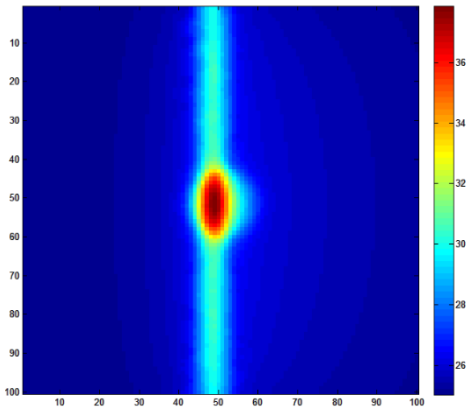

Figure.1 The thermal response image of defect

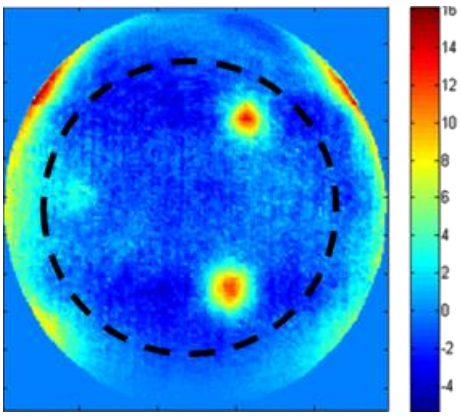

Figure.2 Superposed amplitude results

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