

THE UTILIZATION OF LASER THERMAL TESTING WITH THERMOGRAPHIC MEASUREMENT FOR TBC LIFETIME PERFORMANCE EVALUATION

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The poster introduces the possibilities of laser thermal testing methods with thermographic measurement for lifetime testing of thermal barrier coatings (TBC) including example results of testing of high temperature materials. The laser thermal testing methods are offered for cooperation in the development and testing of TBC systems.

The TBC are utilized to protect the base material from the effects of high temperatures and thermal shock. The TBC systems are developed and optimized to fulfill the range of TBC applications like gas turbine engines in power generation, gas turbine engines in aerospace and diesel engines in automotive.

Each of these TBC applications have own specific time temperature loading curve, power generation – long-time endurance on the operation temperature, aerospace – medium-time endurance according the aircraft flight, automotive – lower temperatures, fast cyclic change of the operation temperature according the diesel engine cycle. The TBC operation loading conditions are taken into account already in the TBC structure design, deposition method parameters and especially during TBC testing. Testing of lifetime performance belongs to the fundamental testing procedures. The common methods are gas burner rig test and thermal cycle fatigue test.

Laser thermal testing methods have been developed at the New Technologies Research Centre utilizing high power lasers. The methods are suitable for thermal testing of bulk and layered high temperature materials. These methods are commonly used for testing of thermal resistance of developed materials for high temperature thermal insulation for applications in energy industry, plasma facing components of tokamak in fusion research, etc.

Advantages of laser thermal testing methods for TBC lifetime testing are precisely predefined time and space distribution of heat loading, precise and rapid power control, very good repeatability, possibility of thermographic measurements without interference due to flame and soot radiation, possibility of static, dynamic, rapid thermal shock, fatigue thermal loading, etc.

Laser thermal testing is supplemented with thermographic measurement of the analyzed samples both from loaded and opposite faces of the sample. The time dependencies of sample surface temperature and temperature profiles can be further evaluated. The laser thermal testing procedure with thermographic measurements is accompanied by a video recording in the visible range for the analysis of material degradation and cracking.

Photo-thermal properties measurement methods have been developed at the New Technologies Research Centre as the support of thermographic measurements and the analysis of heat transfer radiation process parameters. The methods are suitable for the measurement of reflectivity and emissivity of coatings and bulk materials at high temperature – spectral normal emissivity and effective directional emissivity. The results are usually in the form of spectral, temperature and directional dependent quantities. The knowledge of these properties is utilized for both evaluation of thermography measurements during laser thermal testing and for the characterization of radiation heat transfer from the surrounding environment to the laser tested material.