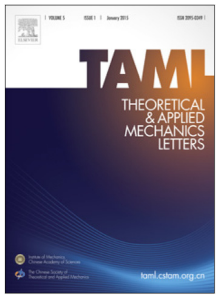
Accepted Manuscript



Interfacial toughness evaluation of thermal barrier coatings by bending test

Qi Zhu, Wei He, Lei Chen, Jianguo Zhu, Wenfeng Hao

PII: S2095-0349(17)30105-8
DOI: https://doi.org/10.1016/j.taml.2017.09.007
Reference: TAML 182

To appear in: *Theoretical & Applied Mechanics Letters*

Received date : 16 July 2017
Revised date : 11 September 2017
Accepted date : 14 September 2017

Interfacial toughness evaluation of thermal barrier coatings by bending test

Qi Zhu[a], Wei He[b], Lei Chen[a], Jianguo Zhu [a,*] Wenfeng Hao[a,*]

[a] Faculty of Civil Engineering and Mechanics, Jiangsu University, Zhenjiang 212013, China

[b] AML, Department of Engineering Mechanics, Tsinghua University, Beijing 100084, China

* Corresponding author. E-mail: zhujg@ujs.edu.cn，haowenfeng2007@163.com

Highlights:

1. A modified three-point bending test is proposed for thermal barrier coating (TBC) interfacial cracking.
2. Crack length is obtained by an optical microscope observing on the cross-section.
3. Adhesion energy of topcoat/bondcoat (TC/BC) interface is determined with a good repeatability.

Abstract To determine the interfacial properties of thermal barrier coatings (TBCs) is imperative for their durability evaluation and further improvements. A ceramic coating (topcoat) and a NiCoCrALY bondcoat were atmospheric-plasma-sprayed (APS) on a stainless steel substrate. A modified three-point bending test was adopted to initiate and propagate the topcoat/bondcoat (TC/BC) interfacial crack. After a complete delamination, the fracture surfaces were examined by an optical microscope, which shows that the cracking plane was merely on the TC/BC interface. Based on the experimental results of load-displacement and crack length-displacement, the strain energy release rate *G* for crack propagation was calculated, and the averaged magnitude was 77.1 J/m^2. Repeatable results have indicated that the method can be used for the evaluation of interfacial fracture toughness in thermal barrier coatings and other multi-layer structures.

Keywords Thermal barrier coatings, Three-point bending, Interfacial fracture toughness

Thermal barrier coatings (TBCs) made of low-thermal conductivity ceramics are used to insulate metallic turbine and combustor engine components from the hot gas stream [1], and to improve their durability and energy efficiency. TBCs can protect a variety of structural engineering materials from corrosion, wear and erosion, and provide lubrication and thermal insulation in aviation, shipping, nuclear, etc. Generally, TBC system is comprised of a superalloy substrate, a bondcoat (BC), and a ceramic topcoat (TC) [2]. During service, the demanding operating conditions could lead to an interfacial delamination of TBC [2]. The spallation of the topcoat is one of the most serious issues among the premature failure modes, which can expose the bare metal to harsh environment [3]. Moreover, the residual stresses arise during thermal spraying process could also result in a premature damage or failure, which is due to the remarkably different properties of each layer, such as the thermal expansion coefficient. Many experiments have revealed that the TBCs often fail from interfaces between TC and BC layers with the damage initiation and progression in the form of microcracks [4]. Consequently, as an important property to analyze the as-deposited TBC failure, the interfacial fracture toughness of TC/BC is highly concerned recently, and various experimental methods have been proposed