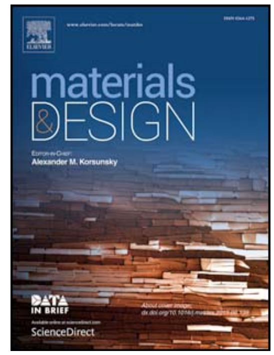
Accepted Manuscript



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PII: S0264-1275(16)30056-9
DOI: doi: 10.1016/j.matdes.2016.01.054
Reference: JMADE 1255

To appear in:

Received date: 26 October 2015
Revised date: 12 January 2016
Accepted date: 13 January 2016

Please cite this article as: Franck Nozahic, Daniel Monceau, Claude Estournès, Thermal cycling and reactivity of a $MoSi_2/ZrO_2$ composite designed for self-healing thermal barrier coatings, (2016), doi: 10.1016/j.matdes.2016.01.054

Thermal cycling and reactivity of a $MoSi_2/ZrO_2$ composite designed for self-healing thermal barrier coatings

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Abstract

Consolidated (relative density of 84%) composite made of molybdenum di-silicide ($MoSi_2$) particles dispersed in a yttria partially stabilized zirconia matrix ($8Y_2O_3$-$Zr0_2$) was prepared by spark plasma sintering. Cyclic oxidation of the composite at temperature ranging from 1000 °C to 1300 °C was studied. Parabolic rate constants (k_p) values of the composite material are in good agreement with those obtained in the literature for the oxidation of bulk $MoSi_2$. Following oxidation exposure, formation of Mo_5Si_3, SiO_2 and $ZrSiO_4$ phases was observed. These observations are compatible with the use of $MoSi_2$ as a self-healing agent in YPSZ thermal barrier coatings.

Keywords: Spark plasma sintering; Ceramic matrix composites (CMC); Intermetallic compounds; Cyclic oxidation; Cyclic Thermogravimetric Analysis (CTGA)

1. Introduction

Thermal barrier coatings (TBCs) made of yttria partially stabilized zirconia (YPSZ), deposited by plasma-spraying, are widely used to increase the durability of hot-section metal components in advanced gas-turbine for aircrafts and power generation **[1-4]**. YPSZ is used for high temperature applications due to its mechanical strength and chemical stability at such temperatures. However, as a ceramic, YPSZ suffers from a relatively low toughness. TBCs failure is governed by a sequence of initiation, propagation and coalescence of cracks that leads to spallation of the TBC, exposing the hot-section metal components to the high-temperature environment **[5]**. Hence, a TBC that is capable of autonomic crack repair and structural integrity recovery in a high-temperature oxidizing environment is highly desirable. Recently, Sloof et al. **[6, 7]** proposed the concept of a new self-healing thermal barrier coating based on the oxidation of boron doped molybdenum di-silicide (B-$MoSi_2$) healing particles embedded in the ZrO_2-based TBC. Healing particles intercepted by cracks will oxidize preferentially, leading to the formation of amorphous SiO_2, which flows into cracks and establishes direct contact with the crack faces. The wetting of the crack faces is followed by a chemical reaction with the ZrO_2-based TBC coating leading to the formation of a load bearing $ZrSiO_4$ phase.
$MoSi_2$ exhibits a high melting point (2020 °C) **[8]**, it has a density close to YPSZ ($MoSi_2$= 6.24 $g.cm^{-3}$, YPSZ= 6.08 $g.cm^{-3}$) **[8, 9]**, it shows a high oxidation resistance at elevated temperature, and its coefficient of thermal expansion (CTE) matches