HÖGSKOLAN VÄST

Functional Performance of Gadolinium Zirconate/Yttria Stabilized Zirconia Multi-Layered Thermal Barrier Coatings

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Abstract

Title: Functional Performance of Gadolinium Zirconate/Yttria Stabilized Zirconia Multi-Layered Thermal Barrier Coatings
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This work presents a new approach of depositing multi-layered (double and triple layered) Gadolinium Zirconate (GZ)/YSZ TBCs using the recently developed suspension plasma spray (SPS) process. Single layer YSZ TBCs were also deposited by SPS process and used as a reference.

The primary aim of this work was to improve the durability of GZ based multi-layered TBCs. Durability tests were performed in the temperature range 1100 °C - 1400 °C. The results indicate that multi-layered GZ based TBCs improve durability compared to the single layer YSZ TBCs. Failure analysis of the multi-layered GZ/YSZ TBCs revealed spallation within the GZ layer close to GZ/YSZ interface and the reason was believed to be the inferior fracture toughness of GZ. In order to improve the fracture toughness in the region of failure, a composite approach comprising multi-layered GZ+YSZ based TBC was considered. It was shown that the composite GZ+YSZ based TBCs did not improve the thermal cyclic lifetime, although improvement in fracture toughness was observed. As a further extension of this work, the influence of YSZ layer thickness on the durability of GZ/YSZ TBCs was investigated. It was shown that an increase in YSZ layer thickness in the GZ/YSZ TBC led to poor durability. Additionally, the other important performance criteria for TBCs, i.e. thermal conductivity, was measured experimentally and compared with the YSZ single layered TBC. It was shown that the GZ based TBCs showed lower thermal conductivity than YSZ.

The second aim was to investigate and compare the erosion performance of multi-layered GZ based TBCs and single layered YSZ TBCs. In the erosion test, the GZ based TBCs showed lower erosion resistance compared to the single layer YSZ TBC. The main reason for this difference was attributed to the inferior fracture toughness of GZ. In case of the composite GZ+YSZ based TBC, an improvement in erosion resistance was observed compared to the multi-layered GZ based TBC.

Based on the results obtained, this work has demonstrated that SPS is a promising processing technique to produce columnar microstructured TBCs irrespective of the composition (GZ, YSZ, GZ+YSZ). It was also shown that GZ/YSZ multi-layered TBCs are promising for high temperature TBC applications due to their low thermal conductivity and high thermal cyclic fatigue lifetime. However, low erosion resistance for certain applications might be an issue for the GZ based TBCs.