

Recent Research Progress in High-Entropy Ceramic Thermal Barrier Coatings

F. Borzooei¹, M. Parchovianský¹, A. Sekar¹, I. Parchovianská¹, A. Pakseresht¹

¹Centre for Functional and Surface Functionalized Glass, Alexander Dubček University of Trenčín, 911 50

Trenčín, Slovakia

Email: fatemeh.borzooei@tnuni.sk

ABSTRACT

High-entropy ceramics have recently gained significant attention as promising top-coat materials for thermal barrier coatings (TBCs) to protect hot sections of gas turbines against high temperatures, hot corrosion, and oxidation. However, their thermal cycling performance depends on both the ceramic composition and the coating architecture. In this study, a novel high-entropy ceramic (HEC) powder with composition of $(\text{La}_{0.2}\text{Sm}_{0.2}\text{Eu}_{0.2}\text{Gd}_{0.2}\text{Yb}_{0.2})_2(\text{Zr}_{0.5}\text{Ce}_{0.5})_2\text{O}_7$ was prepared via high-energy ball milling and a solid-state reaction. The synthesized powder was then utilized as a feedstock to deposit high-entropy TBCs via suspension plasma spraying (SPS). Two different coating systems, comprising a single HEC layer and a dual HEC/yttria-stabilized zirconia (YSZ) layer, were developed. This comparison aimed to evaluate the effect of introducing a YSZ inner layer on the thermal cycling durability of the HEC coating. X-ray diffraction (XRD) confirmed a single-phase defect fluorite structure in both the single and dual-layer coatings. Microstructural characterization and elemental mapping performed via scanning electron microscopy (SEM)/energy dispersive X-Ray spectroscopy (EDXS) revealed crack-free and well-adhered coatings with a homogeneous elemental distribution. To predict the lifetime of TBCs, the samples were subjected to furnace cycling test at 1100 °C. The results showed that the single-layer coating failed after 6 cycles, while the dual-layer HEC/YSZ had a noticeable thermal cycling lifetime of 400 cycles. Furthermore, this study demonstrates the feasibility of depositing high-entropy ceramic TBCs by SPS and their potential as strong candidates for next-generation TBCs.

Keywords: Dual-layer ceramic, Furnace cyclic test, High-entropy ceramic, Suspension plasma spraying, Thermal barrier coatings.

Acknowledgement

The authors gratefully acknowledge financial support from the projects VEGA 1/0242/23 and APVV 22-0070.