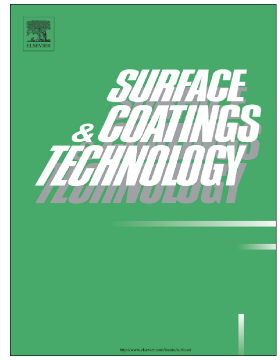

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Integrated testing approach using a customized micro turbine for a volcanic ash and CMAS related degradation study of thermal barrier coatings.

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Abstract:

A volcanic ash (VA) test stand has been built with a precise particle feeder, concentration measuring unit and a mini turbine with an integrated thermal barrier coating (TBC) system on the blisk for the first time in a laboratory scale. This setup has allowed the testing of melting, sticking, corrosion and erosion behaviour of volcanic ash in-situ at high temperature in a realistic manner in a gas turbine. Moreover, this mini engine runs with kerosene which could also bring all the impurities such as sulphur in to system which might change the reaction mechanisms of TBC and VA. The particle size influence on the sticking/escape behaviour in the engine components was tested but a clear statement on the particle size versus its sticking behaviour could not be made, although the particles in the size range of 1-10 µm are more susceptible to melting in the given conditions. The blisks were coated with two different TBC materials such as 7 wt.% Yttria Stabilised Zirconia (7YSZ) and Gadolinium Zirconate (GZO) using Electron Beam Physical Vapour Deposition (EB-PVD) technique. Both coatings were tested in corrosion-erosion regime under VA at high temperature and it was found out that the coating with higher toughness (7YSZ) has performed better than the other coating under the used testing conditions.

Keywords: Volcanic ash, CMAS, TBCs, Turbine blisk, GZO, 7YSZ.

1. Introduction

Ever since the Eyjafjallajökull volcano in Iceland erupted in 2010 which has caused a major shut down of European aerospace, the threat from volcanic ash to aviation has been widely recognised [1-6]. Volcanic ash (VA), can be ingested into jet engines and at higher temperatures adhere to the internal components of the engine causing substantial damage [7-9]. In general each engine does normally contain three functional areas named as compressor, combustion and turbine. The temperature distribution among these areas varies from 100-1600°C depending upon the place of interest. The areas which exceed more than 1000°C in temperature contain metallic parts with functional ceramic coatings on top called Thermal barrier coatings (TBCs) [10]. These ceramic coatings are highly porous and have a very low thermal conductivity and hence they cause a temperature drop through them allowing the metallic parts operate at lower temperatures. In addition to the internal cooling within the metallic parts, these TBCs act as thermal insulators. Because of the relatively lower melting (<1100°C) point than the other sand like particles the thermal hazard from the VA adhesion is