HIGH TEMPERATURE INFILTRATION BEHAVIOR OF THREE VOLCANIC ASHES OF YSZ APS-DEPOSITED THERMAL BARRIER COATINGS

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Thermal Barrier Coatings (TBC) have enabled the increase of the operational temperature of aero engines. Raise in the turbine inlet temperatures (TIT) poses a threat to phase stability and safety for the state of the art material 7-8 wt% yttria stabilized zirconia (7YSZ). In addition to the inherent physicochemical restrictions of this material at high temperatures, the interaction of 7YSZ with siliceous airborne particles at temperatures above 1200 °C has been a major concern since the last decades. Sediments of Calcium-Magnesium-Aluminum-Silicates (CMAS) have been found in failed engines and have been correlated to the failure mechanisms of high temperature components. In 2010 the eruption of the Eyjafjallajökull volcano in Iceland heavily disrupted air traffic in Europe. This volcanic event lead to regulations regarding volcanic ash (VA) concentrations in the atmosphere at which aircrafts are allowed to safely fly. Also, it brought to sight the risks associated to VA in the safety of aircrafts with routes close to active volcanos. Nevertheless, reports of the assessment of the high temperature risk using real volcanic ashes is still limited in comparison to analyses carried out with CMAS.
Additionally, most reported studies have been focused on the study of electron beam physical vapor deposition (EB-PVD) rather than atmospheric plasma spray (APS) produced TBCs. This contribution addresses the study of the infiltration mechanisms of VA from three sources: Colima and Popocatepetl Mexican volcanoes as well as Eyjafjallajökull Icelandic volcano.
Infiltration experiments were carried out using two microstructures with different porosities (8.5 and 11.6%) produced by APS. 7YSZ was deposited over a ~68 µm NiCoCrAlYTa bond coat, using a M247-graded superalloy as substrate. Characterization of the volcanic ashes include DSC and DRX analyses as well as ICP chemical composition measurements. Infiltration experiments were conducted with a concentration of 20 mg/cm^2 of volcanic ashes in a form of an overlay over 7YSZ TBCs. Infiltration temperature was chosen as 1250 °C for isothermal heat treatments with heating rate of 10 K/min. Such temperature corresponds to the melting range VAs. Infiltration depth was determined as a function of time from 0 to 600 min. From this work, it was found that the chemical composition of the VA is a determinant factor in the infiltration depth of the coatings. For higher values of SiO_2, lower infiltration depths are seen. It was also observed that the greatest infiltration rate took place in the first 120 min of heat treatment (fig. 1). An attempt has been made in co-relating basicity index (B.I) of the VA melt and their infiltration kinetics. It was found out that the infiltration depth vs basicity index curves suggest an almost linear behavior irrespective of infiltration time (fig. 2). Further studies are now in progress in an attempt to set the basis for an infiltration model which may help to predict infiltration behavior for a wider number of VA based in chemical composition and basicity index

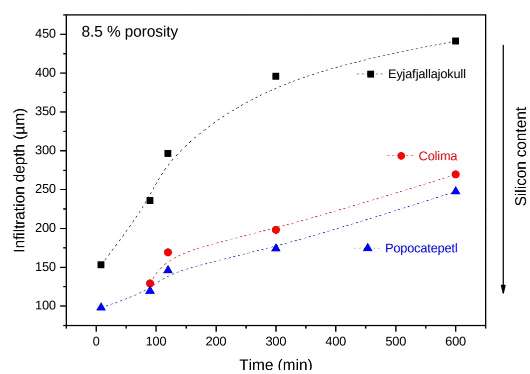

Figure 1 – Infiltration depth of the VA as a function of time on 8.5 % porosity coatings

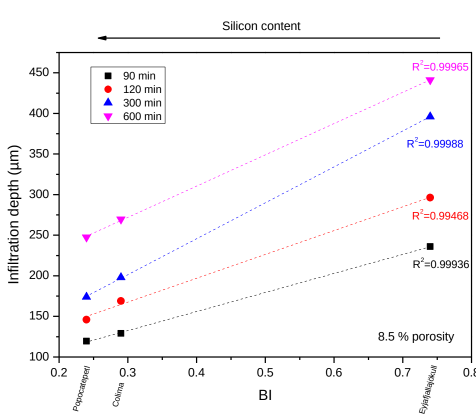

Figure 2 –Infiltration depth as a function of Basicity Index (BI) showing near-to linear correlation