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Letter

Effects of the dissolution of thermal barrier coating materials on the viscosity of remelted volcanic ash

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Abstract

The chemical interaction between remelted volcanic ash and ceramic coatings of yttria-stabilized zirconia (YSZ) and/or gadolinium zirconate (GZO) is of special importance for the design of volcanic ash melt-resistant thermal barrier coatings (TBCs) for aviation turbine technologies. The spreading and infiltration potential of the melts is strongly influenced by the melt viscosity. Thus the interpretation of infiltration experiments and modeling of infiltration processes both rely on accurate viscosity data. Melt viscosity may be significantly altered by the dissolution of the YSZ or GZO thermal barrier coatings during the infiltration process. Here, we have determined the influence of YSZ and GZO additions to the viscosity of a series of volcanic ash melts using high-temperature concentric cylinder viscometry. All samples have been characterized fully after viscometry. At 6.5 wt% of YSZ or GZO, both dopants lead to a reduction of viscosity in a temperature range between 1297–1640 °C in air. The magnitude of the decrease in viscosity depends weakly on volcanic ash melt composition. The viscosity effect has been parameterized in the following form:

$$\Delta\eta = x \cdot m_{\text{dopant}}$$

whereby x is a melt-composition specific coefficient of viscosity decrease, and m_{dopant} represents the added amount of YSZ/GZO (wt%). This viscosity reduction should contribute to an acceleration of the physical infiltration of TBCs via remelted volcanic ash.

Keywords: Gas-turbine, aviation, rare earth oxides, yttria-stabilized zirconia (YSZ), gadolinium zirconate (GZO)