A GEOSCIENTIFIC PERSPECTIVE ON SILICATE MELT INTERACTIONS WITH TBCS

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Combustion in gas turbines requires the ingestion of large amounts of air that possibly contains siliceous material (e.g. volcanic ash). Most types of ingested particles are changing their material properties during high temperature exposure and may behave like liquids for some time, interacting with turbine components like thermal barrier coatings.

To understand a gas turbine engine's response to the ingestion of siliceous material it is necessary to characterize both, the airborne material itself as well as its interaction with all affected parts of the engine. In this talk, we will focus on volcanic ash and show that no two samples are equal. Additionally, a close look at a pristine volcanic ash sample from Tungurahua volcano in Ecuador shows strong intra-sample variations, as strong dependence of chemical composition and glass/crystal presence from grain size was observed. Accordingly, any meaningful experiment requires knowledge of composition, size and petrophysical properties.

Scaled laboratory experiments were designed to characterize the response of state-of-the art TBCs to different silicate melt compositions. For this purpose, 5 different volcanic ash samples were heated to above their melting point on 4 different TBCs. The strongest impact (spreading and infiltration) was found for basaltic composition (approx. 49% SiO_2) and the results will be discussed in the light of explosive eruption probability. Based on YSZ / GZO / REE doped silicate melts (of natural and synthetic origin) a double-couple feedback effect between TBC dissolution and silicate melt viscosity was found. The results reveal the continued need for a holistic volcanic ash and turbine engineering approach for resilient civil aviation in the future.