VOLCANIC ASH VERSUS THERMAL BARRIER COATINGS OF JET ENGINES – A HOLISTIC EXPERIMENTAL APPROACH

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Since the heavy interruption of North Atlantic air traffic by volcanic ash in 2010 many experimental investigations have been done in order to better understand the influence of volcanic ash on the functionality of jet engines and in particular thermal barrier coatings (TBCs) on turbine blades within them. Some of these studies used natural volcanic ash while others used a synthetic mixture from the Calcium-Magnesium-Aluminum-Silicon system (CMAS). To this day, a holistic experimental investigation on TBCs, using various natural volcanic ashes, is missing. In the framework of the CORNET research project VAsCo ("Volcanic Ash resistant thermal barrier Coatings for jet engines" – www.vasco-cornet.eu), we are going to close this gap. We use four different volcanic ashes, which represent the chemical range of possibly produced ash by explosive volcanic eruptions. As TBCs, atmospheric plasma sprayed (APS) and electron-beam physical vapor deposited (EBPVD) coatings of yttria-stabilized zirconia (YSZ) and gadolinium zirconate (GZO) were chosen as state-of-the-art materials for first experiments. While YSZ EB-PVD coatings are prone to be fully infiltrated by molten silicates, GZO exhibits a higher resistivity against the infiltration through a rapid re-crystallization of the dissolved coating, thus closing the pathways of infiltration. This contrasting behavior of both materials makes them good candidates to study the influence of different chemical and mineralogical compositions of various volcanic ashes. The experiments are based on static and dynamic experiments: Static experiments include measurements with the heating microscope, to study the wetting and spreading of the molten ash sample on the TBC surface, and muffle furnace experiments with ash covered TBCs to study their chemical interactions. For dynamic experiments we thermally spray the ash on the TBC surfaces in order to simulate real conditions within the combuster/turbine section of a jet engine. Findings are used to modify TBCs and to improve their resistivity against molten volcanic ash. In addition to that, a feasibility study will be conducted in order to create a model synthetic volcanic ash for standard tests in the aviation industry.