NOVEL THERMAL BARRIER COATINGS RESISTANT TO MOLTEN VOLCANIC ASH WETTING

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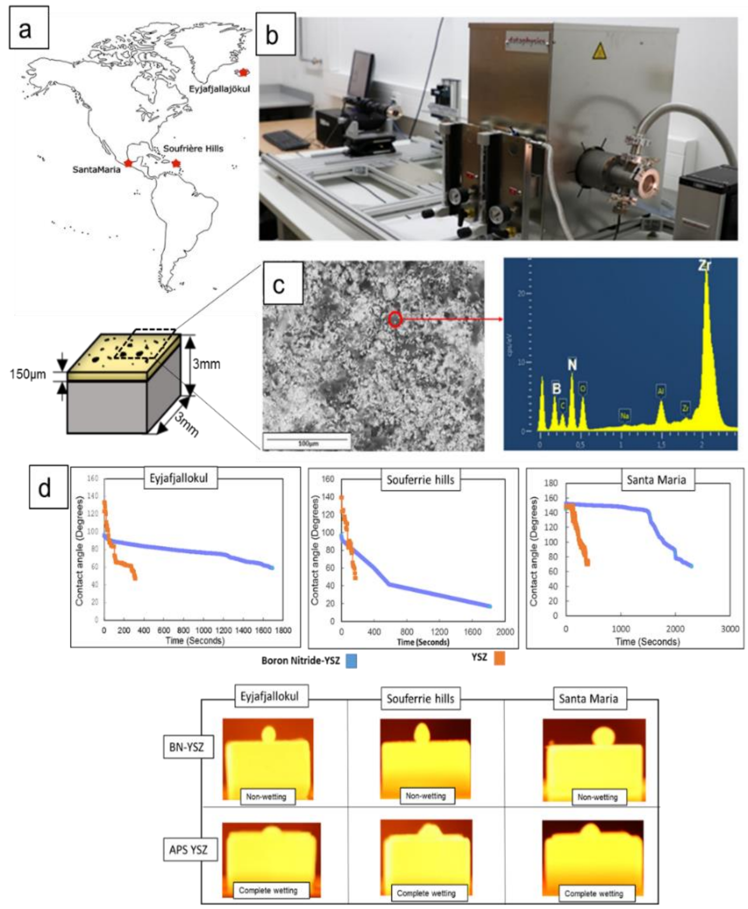

Figure 1. (a) Selection of volcanic ash for this research, (b) Optical dilatometer setup, (c) Surface morphology of BN-YSZ coatings, (d) Contact angle of the molten ash on BN-YSZ and YSZ coatings plotted against time.

Molten environmental deposits primarily emanating from volcanic ash pose a serious threat to aviation safety. When ingested into a jet engine, the volcanic ash melts and adheres to the surface of hot regions (i.e., combustion chamber, turbine blade, and nozzle guide vanes) of jet engines. Virtually, these hot zones in jet engines comprise a two-layer thermal barrier coating (TBCs). These ceramic TBCs provide thermal insulation to the underlying nickel-based super alloy substrate, but these coatings are more vulnerable to the damage caused by molten volcanic ash deposits. Particularly, in the pursuit of high output efficiency, turbine operating temperatures increasingly exceed 1250°C, leading to detrimental effects on the TBCs. Introducing rare-earth oxides (eg. Gadolinium oxide) into TBCs is regarded as one of the main migratory approach to prevent the damage by ash, because the infiltration silica-rich molten volcanic ash deposit is slowed down by crystallising the melt, preventing deeper infiltration into the coating. However, the initial phase of the damage progression of volcanic ash into the porous texture of TBC has become unavoidable. Here, we utilised thermal spray technology to produce a novel thermal barrier coating consisting of the mixture of the hexagonal boron nitride (*h*-BN, 30 vol.%) and yttria stabilized zirconia (YSZ, 70 vol. %) (BN-YSZ coating). Subsequently, we quantitatively analysed the wettability of three different types of volcanic ashes (Figure1a) onto this new TBCs, compared with the traditional YSZ TBCs produced by atmospheric plasma spray (APS), using an optical dilatometer at 1250°C (Figure 1.b) in vacuum condition and dynamic spreading process in air condition. Our results indicate that the BN-YSZ coating (Figure 1.c) exhibits non-wetting ability with mean contact angles ranging from 92º-150º (figure 1.d), compared with the APS YSZ TBC coatings on which the ash was complete spread, for a period between 300-400 seconds in vacuum condition. Because h-BN are easily oxidised in atmosphere and are not stable, the contact angle of the BN-YSZ TBCs gradually decreased once the working environment in the dilatometer was brought to atmospheric condition. Therefore, the degradation of the TBCs are strongly dependent on the wetting nature of the molten volcanic ash. A solution to the mitigation of the molten environmental deposits without damaging the TBCs still remains elusive. This work not only elucidates the difference between BN-YSZ and YSZ coatings but also enables the development of novel materials for the next generation of TBCs.