YTTRIA-STABILIZED ZIRCONIA PRODUCES COATINGS WITH LOW THERMAL CONDUCTIVITY

An independent study by the thermal spray team of the National Research Council of Canada (NRC) has observed low thermal conductivity (K) values for coatings manufactured from Innovnano’s 7 wt-% yttria-stabilized zirconia (YSZ) powder through air plasma spraying (APS) and suspension plasma spraying (SPS).

The powders were produced using Innovnano’s proprietary manufacturing process, emulsion detonation synthesis (EDS). The EDS process transforms precursor chemicals into nanostructured powders through a micro-second exposure to high temperatures and pressures through controlled explosions. Temperatures can exceed 3000 K and pressures are greater than 10 GPa. The process produces nanostructured ceramic powders that can be tailored for unique structures and properties.

Low thermal conductivity thermal barrier coatings (TBCs) are desired as they can increase turbine engine efficiency, reduce emissions, increase durability, and lower costs. A 30% reduction in thermal conductivity translates into an approximately 100°C increase in temperature difference across a 200-micron-thick coating. Alternatively, a 30% reduction in thermal conductivity would require 30% less coating thickness to yield the same surface temperature.

The NRC’s thermal spray team produced YSZ coatings and thermal conductivity measurements. Figure 1A–C shows the various as-sprayed coatings the team produced.

Figure 1A shows the benchmark APS coating. Figure 1B shows the company’s APS coating with regions of partially melted YSZ particles where the nanostructure is retained (dark-grey phase). Figure 1C shows the micro-porosity of the company’s SPS coating. These coating features led directly to the lower thermal conductivity values shown in Fig. 2. To provide more representative thermal conductivity values, the as-sprayed YSZ TBCs were also heat-treated for 10 h at 1300°C prior to measuring. At 1300°C, the SPS and APS TBCs showed an approximately 30% and 20% reduction, respectively, in thermal conductivity when compared to the APS benchmark. Low-thermal-conductivity YSZ coatings can be produced though defect-driven, microporous coating structures, without the use of rare earth oxide additions.

Further studies will investigate other important properties of YSZ coatings, including erosion resistance, thermal cycle durability, phase stability, and structural stability.

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Fig. 1A — APS Benchmark

Fig. 1B — Innovnano APS

Fig. 1C — Innovnano SPS

Fig. 2 — Thermal conductivity values of the different yttria-stabilized zirconia thermal barrier coatings.

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ITSA members invite your company to join us in this endeavor.

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