HÖGSKOLAN VÄST

Design of Suspension Plasma Sprayed Thermal Barrier Coatings

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Thermal barrier coatings (TBCs) are widely used on gas turbine components to provide thermal insulation, which in combination with advanced cooling, can enable the gas turbine to operate at significantly higher temperatures even above the melting temperature of the metallic components. There is a permanent need, mainly due to environmental reasons, to increase the combustion temperature in turbines, hence new TBC solutions are needed.

By using a liquid feedstock in thermal spraying, new types of TBCs can be produced. Suspension plasma/flame or solution precursor plasma spraying are examples of techniques that can be utilized for liquid feedstock thermal spraying. This approach of using suspension and solution feedstock, which is an alternative to the conventional solid powder feedstock spraying, is gaining increasing research interest since it has been shown to be capable of producing coatings with superior performance.

The objective of this research work was to identify relationships between process parameters, coating microstructure, thermal conductivity and lifetime in suspension plasma sprayed TBCs. A further objective was to utilize these relationships to enable tailoring of the TBC microstructure for superior performance compared to state-of-the-art TBC used in industry today, i.e. solid feedstock plasma sprayed TBCs. Different spraying techniques, namely suspension high velocity oxy fuel, solution precursor plasma and suspension plasma spraying (with axial and radial feeding) were explored and compared to solid feedstock plasma spraying.

A variety of microstructures, such as highly porous, vertically cracked and columnar, were produced and investigated. It was shown that there are strong relationships between microstructure, thermo-mechanical properties and performance of the coatings. Specifically, axial suspension plasma spraying was shown as a very promising technique to produce various microstructures as well as highly durable coatings. Based on the experimental results, a tailored columnar microstructure design for a superior TBC performance is also proposed.