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EFFECT OF BONDCOAT ROUGHNESS ON LIFETIME OF APS-TBC SYSTEMS IN DRY AND WET GASES

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Low pressure plasma spraying (LPPS) is a process commonly used for deposition of MCrAlY (M=Ni,Co) bondcoats for air plasma spray thermal barrier coatings (APS-TBCs). LPPS produces bondcoats with a high roughness and good oxidation resistance, which are known to play a key role for long lifetimes of APS-TBC's. An alternative process for the bondcoat deposition is high velocity oxy-fuel (HVOF), which is substantially cheaper than LPPS but even with well optimized spraying parameters generates intrinsically lower bondcoat roughness.

In the present work it is shown that a bi-layer MCrAlY-bondcoat consisting of an HVOF-base layer and an upper, thin APS-flashcoat of the same chemical composition can provide cyclic oxidation TBC-lifetimes, which are similar to those obtained with well optimized LPPS bondcoats. The key points for the extended lifetime are the specific roughness profile and microstructure of the flashcoat, which allow good adhesion of the topcoat combined with an excellent oxidation resistance. Testing of the TBC-system with the APS-flashcoat in the atmosphere with increased amount of water vapour relevant for gas-turbine operation on alternative, hydrogen rich fuels revealed some lifetime shortening with respect to the drier test gas. However, even under these more aggressive conditions, the measured cyclic furnace lifetimes of samples with APS-flashcoat are a factor of 2 to 3 longer than those of the reference TBC-system with the state of the art HVOF bondcoat. Depending on the actually prevailing coating system and test conditions, the life times of the coatings were even longer than for coating systems which were completely manufactured using LPPS.

In order to correlate the bondcoat roughness profile with the APS-TBC-lifetime an alternative method based on fractal analysis is proposed. Using this method, a more accurate description of complex bondcoat surface morphologies and a better correlation with the TBC-lifetime are obtained than with the commonly used mean roughness amplitude (Ra) approach.