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Evaluating and Optimizing Plasma Spray Parameters on Thermal Barrier Coatings Using Response Surface Method

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Effect of plasma spray parameters on hot corrosion resistance of YSZ (Yittria Stabilized Zirconia) thermal barrier coatings using design of experiments (DOE) response surface method was investigated. Three parameters in three levels have been chosen to be studied. First parameter was total number of layers. Three types of coatings were synthesized: a) two layered samples, consisting of a 100% MCrAlY layer and 100% YSZ; b) three layered samples, in which chemical composition was gradually changed from MCrAlY to YSZ; a 100% MCrAlY, 50%MCrAlY-50% YSZ, and 100% YSZ. c) five layered samples consisting of a 100% MCrAlY layer, 75% MCrAlY-25% YSZ, 50%MCrAlY-50% YSZ, 25% MCrAlY-75% YSZ and 100% YSZ. Second parameter was spray distance which was varied from 80 to 120 mm, and last parameter was powder feed rate that was changed between 10 and 30 g/min. All samples were coated on IN 738-LC as a substrate. ANOVA analysis and experimental results showed that all parameters had significant effect, without any interaction with each other. Within the scope of the response surface method, the most important parameter was number of layers; with 99.7% significance (P value=0.3%). It was also observed that hot corrosion resistance is a non-linear function of layers number: the more the number of layers, the better hot corrosion resistance. Moreover increasing spray distance improved the corrosion resistance. Whilst it was decreased by increasing powder feed rate. Maximum hot corrosion resistance was obtained in five layered samples, with spray distance of 120 mm and 10 g/min feed rate, which could endure 120 hours in corrosive atmosphere at 800°C.

Keywords
Thermal barrier coating
Hot corrosion resistance
Plasma spray parameters
Design of experiments
Response surface method