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PII: S0257-8972(17)31240-9
DOI: https://doi.org/10.1016/j.surfcoat.2017.12.023
Reference: SCT 22941

To appear in: *Surface & Coatings Technology*

Received date: 6 October 2017
Revised date: 27 November 2017
Accepted date: 9 December 2017

Please cite this article as: P. Wang, W. He, G. Mauer, R. Mücke, R. Vaßen , Monte Carlo simulation of column growth in plasma spray physical vapor deposition process. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Sct(2017), https://doi.org/10.1016/j.surfcoat.2017.12.023

Monte Carlo Simulation of Column Growth in Plasma Spray Physical Vapor Deposition Process

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Keywords:

Plasma Spray Physical Vapor Deposition; Monte Carlo Simulation; Columnar Coatings

Abstract

Plasma spray-physical vapor deposition is used to produce columnar microstructure coatings under particular operating parameters. Simulations of the growth of columns were carried out through a two-dimensional Monte Carlo model. The modeling was performed using inclined vapor flux impinging onto a substrate due to shadowing effects. An incoming particle travels along a straight line and attaches itself to already deposited particles. Furthermore, the newly deposited particle will relax to a stable surrounding position along the incoming velocity direction. The modeling results predicted the linking of an oblique vapor flux and column orientation. The numerical simulations were validated in three ways. Firstly, the porosity of simulated columns was predicted and compared to that obtained in the experimental columnar microstructure of coatings. Secondly, the morphology of simulated structures is compared to that of experimental coatings produced by plasma spray physical vapor deposition. Finally, the simulated orientation of columns is compared to the experimental one.

1 Introduction

Thermal barrier coatings (TBCs) are increasingly being applied to the surfaces of metallic parts in the hottest part of gas-turbine engines [1]. Coatings of columnar structure can be produced by, suspension plasma spraying (SPS) [2, 3], plasma spray physical vapor deposition (PS-PVD) [4-9] process and electron beam physical vapor deposition (EB-PVD) [10] process. PS-PVD process