Accepted Manuscript

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PII: S0257-8972(17)30771-5
DOI: doi: 10.1016/j.surfcoat.2017.07.069
Reference: SCT 22555

To appear in: *Surface & Coatings Technology*

Received date: 5 March 2017
Revised date: 31 May 2017
Accepted date: 29 July 2017

Please cite this article as: Chaoyue Chen, Yingchun Xie, Christophe Verdy, Hanlin Liao, Zhongming Ren, Sihao Deng , Numerical investigation of transient coating build-up and heat transfer in cold spray, *Surface & Coatings Technology* (2017), doi: 10.1016/j.surfcoat.2017.07.069

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Numerical investigation of transient coating build-up and heat transfer in cold spray

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Abstract: Since cold spray is widely considered as an additive manufacturing and damage repair technology, it is crucial to understand the coating build-up process and the temperature evolution. In this work, a 3D numerical model was developed to simulate the transient coating build-up process as well as the heat transfer in cold spray. By coupling the heat transfer with the ALE (Arbitrary Lagrangian–Eulerian) moving mesh and coating thickness model, this 3D model is able to investigate the temperature evolution of a coating which simultaneously grows according to the nozzle trajectory. The nozzle trajectory that represents the heat source and mass flux of particle impact is generated and simulated in the offline programming software RobotStudio™. By assigning the results of coating thickness distribution, the simultaneous build-up of coating computational domain is achieved by ALE moving mesh method. The validation of the FEA (finite element analysis) model was carried out by measuring the coating surface temperature via an infrared imaging camera. The effects of nozzle traverse speed on the coating surface temperature as well as coating thickness in cold spray were also investigated. With the proposed model, it is able to study the actual coating build-up process as well as the heat transfer phenomena, which may provide more insights for the application in additive manufacturing and damage repair.

Keywords: Cold spray; finite element analysis (FEA); transient coating build-up; thermal analysis; coating thickness

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