FEM FOR ASSESSING THE CRITICAL VELOCITY IN COLD SPRAY PROCESS

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Abstract

In cold spray coating, deposition of particles happens when their velocity certain value so called 'critical velocity (CV). Due to the affection of CV by many process parameters, it serves as a representative parameter for verification of coating quality. Formerly, researchers have demonstrated that lower CV for a process leads to a better coating quality and demands less energy consumption. In this study, based on the well-recognized hypotheses that the CV is related to adiabatic shear instability induced by high strain rate deformation during the impact, a numerical model of cold spray process is developed aimed to calculate the CV. The problem of detecting the CV using the discrete output of numerical simulation has been solved applying Wavelet transformation and the second derivative of the physical parameters in Sobolev space. The results are compared with the other numerical models and the experimental results available in the literature.

Keywords: Cold spray coating, critical velocity, FEM analysis

1. Introduction

Cold spraying is an emerging coating process in which in contrast to the well-known thermal spray processes such as flame, arc, and plasma spraying, the powders does not melt before impacting the substrate (Champagne, 2007). This makes cold spray process commendable for many different coating applications dealing with various materials not only metals but also polymers, composites, etc. Bonding of the particles in this process occurs due to the high kinetic energy upon impact; therefore, the velocity of the particle plays the most important role in material deposition. During the process, powders are accelerated by injection into a high velocity stream of gas. The high velocity stream is generated through a converging-diverging nozzle. As the process continues, the particles impact the substrate and form bonds with the substrate, resulting in a uniform almost porosity-free coating with high bonding strength (Champagne, 2007). Low temperature also aids in retaining the original powder chemistry and phases in the coating, with only changes due deformation and cold working. Bonding of particles in cold gas spraying is presumed to be the result of extensive plastic deformation and related phenomena at the interface (Mccune *et al*, 1996). It is to be underlined that the particles remain in the solid state and are relatively cold, so the bulk reaction on impact and the cohesion of the deposited material is accomplished in solid state. Schematic diagram of the cold spray equipment is shown in Fig. 1. As mentioned, it is well recognized that particle velocity prior to impact is a key parameter in cold spray process (Papyrin, 2007). It determines what phenomenon occurs upon the impact of spray particles, whether it would be the deposition of the particle or the erosion of the substrate. CV for a given powder is defined as the velocity that an individual