Correlating Pure Titanium Powder Manufacturing Methods and Resultant Particle Morphologies to Microstructural Properties, Particle Flight and Impact Velocity, and Bonding and Deposition Characteristics in Cold Spray Additive Manufacturing

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Abstract

Unlike in high temperature thermal spray processes and other metal additive manufacturing methods that require extensive heat treatment, native particle microstructural properties in the feedstock powder have been shown to dictate the final thermomechanical properties of as-deposited cold spray products (e.g., coatings, repairs, free standing parts). Feedstock powder particle shape has also been shown to have a significant influence on particle flight and impact velocity in CS processes. Thus, powder feedstock thermomechanical properties along with their size and shape distributions need to be coupled with CS process conditions to understand the direct influence of particle shape on bonding and the significance of the parameter for quality control as CS becomes commercialized in a wider spectrum of industrial applications. In this study, bonding, and deposition characteristics of commercially pure titanium (CP-Ti) particles were correlated with their size, shape, and native microstructural properties using optical microscopy, scanning electron microscopy (SEM) methods and their impact velocity data was captured using shadow image particle velocimetry. The CP-Ti powders chosen for this study were gas atomized (mostly spherical), chemically reduced (sponge granules), and chemically reduced and crushed (dense and irregular) powders. Single particle splats were produced using these 3 CP-Ti powders at 3 different CS process parameters. Resultant particle morphology, microstructural properties (within particles and bonding interfaces) were studied using optical microscopy and SEM. Computational fluid dynamics will be used for predicting size and shape dependent particle impact velocity difficult to gather using experimental methods.