Micro-Mechanical Characterization of Tantalum Cold Spray Deposits

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Two different tantalum cold deposits have been prepared with spherical and angular particles. Both deposits possess similar ultra-fine microstructure with sub-micrometer scale grains. Nanoindentation data of both deposits are nearly identical, indicating that supersonic impact leads to a similar final state regardless of the initial geometry of particles. Indentation hardness is about three times higher than that of coarse-grained tantalum. Strain hardening and grain refinement, which occur commonly during cold spray process, could harden each tantalum particle. In addition, spherical indentation was used to obtain uniaxial compressive stress-strain curves. The tip area function, which is needed to calculate the axial stress, was obtained directly by using the continuous stiff measurement and the contact mechanics theory. Parameters in the conversion formula of stress and strain were modified based on micropillar uniaxial stress-strain data. With these corrected parameters, we were able to determine a reliable procedure to obtain local uniaxial stress-strain data accurately. Our method will be useful to probe local uniaxial mechanical properties, which can be used to understand bulk-scale mechanical behavior of cold spray deposits that typically possess a heterogeneous microstructure.

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