Abstract of the Dissertation

Inelasticity in Metallic Thermal Spray Coatings:

Continuum and Micromechanical Approaches

by

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Performance and reliability of metallic thermal spray (TS) coatings are strongly depended on their inelastic behavior. Different TS processes produce various degrees of defects including oxide phases, inter-lamella pore and inter-splat cracks on top of biaxial tensile or compressive residual stress. Thus, splat interfacial bonding strength dictates the apparent inelastic deformation mechanism in metallic TS coatings. Investigation of mechanical properties has proven non-trivial, and often the subsequent interpretations are oversimplified to the point where it is no longer applicable to TS coatings. In this dissertation, these concerns were addressed via introduction of new and improved mechanical techniques, assisting characterization of inelastic properties. These techniques were employed to probe diverse inelastic behavior over a range of strain, sampling volume, and fatigue responses. Cold Sprayed (CS) aluminum, and Ni-5%Al sprayed with various processes were chosen based on unique interfacial characteristics produced via different TS processes. They were subjected to various micro/macro static and repeated loading conditions and analyzed with continuum-based and micromechanical approaches. Effects of process-induced dynamic compaction and subsequent post heat treatment were studied on mechanical behavior of CS aluminum coating. Each process-dependent splat interfacial bonding characteristic of Ni-5%Al coating was identified and provided mechanistic description on inelastic deformation mechanisms. Data and discussion are presented in the context of yielding, work hardening, crack propagation and delamination primarily for metallic coatings, thus related to fundamental physics and performance criteria.

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