Cold Spray additive manufacturing (CSAM) of aluminum alloys produces highly heterogeneous microstructures characterized by elevated dislocation densities, sub-grain formation, and non-uniform intersplat bonding due to the severe plastic deformation induced by high-velocity particle impacts. These microstructural phenomena introduce significant residual stresses, anisotropic mechanical properties, and localized deformation heterogeneities. Post-deposition thermal treatments mitigate these effects by promoting intersplat diffusion, reducing dislocation densities, and homogenizing internal stress distributions, ultimately enhancing the alloy's mechanical performance. Previous mean-field viscoplastic self-consistent (VPSC) modeling efforts incorporated intersplat boundary effects, Hall-Petch strengthening, and residual stress contributions to capture the anisotropic plasticity of CSAM aluminum. However, microstructural analyses of CSAM Al 7050 reveal that precipitation phenomena significantly influence the material's deformation response as well. Scanning transmission electron microscopy (STEM) and energy dispersive spectroscopy (EDS) indicates that $MgZn_2$ precipitates alter local stress distributions and impede dislocation motion. These precipitate-induced mechanisms contribute to grain boundary strengthening, slip system activity modification, and strain localization. The present work extends the VPSC framework by empirically incorporating precipitate-mediated strengthening mechanisms and accounting for their effects on critical resolved shear stress, intersplat boundary relationships, and strain hardening effects, improving the predictive accuracy in modeling the deformation response of CSAM Al 7050.

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