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Abstract:
Severe plastic deformation ($\dot{\varepsilon}$ ~ 10^5/s) occurs during ultrasonic additive manufacturing (UAM) to create solid-state bonding. This allows for UAM to bond foils of dissimilar or difficult-to-weld materials, and create unique structures for nuclear, defense, and aerospace applications. UAM technology development is complementary to an improved understanding of how the metallurgical interface develops. Additionally, UAM builds typically suffer from reduced strength after foil bonding. In this study, we pretreated an aluminum alloy to grow 2nd phase precipitates, then bonded the materials using UAM. Through multi-length-scale characterization techniques, we demonstrated that the total build structure can increase in yield strength as well as individual foil-foil interfaces. This is due to dynamic recrystallization, dynamic recovery, adiabatic heating, precipitate dissolution, and enhanced elemental diffusion through deformation-induced defects, such as vacancies.