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Strengthening mechanisms and deformation behavior of cryomilled Al-Cu-Mg-Ag alloy

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Abstract

In the last decade, the commercially available heat-treatable aluminum alloy (AA) 2139 (Al-Cu-Mg-Ag) has generated interest within the aerospace and defense communities because of its high strength and damage tolerance as compared to those of other AA 2XXX alloys. In this work we investigate the possibility of enhancing the performance of AA 2139 via a nanostructuring approach involving the consolidation of cryomilled powders. For comparison purposes, two types of feedstock powders (cryomilled and unmilled, gas-atomized powder), were consolidated via dual mode dynamic forging. Our results show that, following heat treatment (HT), the strength of the cryomilled material increases in the range of ~25% to ~200% relative to that of the unmilled counterparts, depending on specific processing parameters. We present microstructural data, including grain size and precipitate chemistry, to provide insight into the underlying strengthening mechanisms. Vickers microhardess tests are used to evaluate peak heat treatments, and tensile testing is performed to characterize mechanical behavior. The kinetics of precipitation, strengthening mechanisms and deformation behavior are discussed. It is proposed that the combination of elemental segregation with the presence of oxides along grain boundaries, both facilitated by enhanced diffusion paths, are responsible for the observed change in HT kinetics in the cryomilled material.