ON WEAR BEHAVIOR OF MN-MODIFIED AL-CU-MG-SI-TI ALLOY FABRICATED BY LASER POWDER-BED FUSION

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ABSTRACT
In recent years, specialized aluminum alloys tailored for laser additive manufacturing (LAM) have been developed, which has facilitated the manufacturing of lightweight components with high performance and complexity. These alloys have gained increasing recognition and have been applied in various complex scenarios. In our previous work [1-2], a novel Al-Cu-Mg-Si-Ti alloy demonstrated great formability, high strength, and wear resistance. To further expand the service performance of these materials in medium- to high-temperature wear environments, we report a new Mn-modified Al-Cu-Mg-Si-Ti alloy processed using laser powder bed fusion (LPBF) technology. In this study, the addition of Mn to the solidification microstructure of a material was investigated using multiscale characterization methods. Simultaneously, the wear behavior of the new alloy was assessed using a ball-on-flat tribometer sliding against 100Cr6 steel in four different service environments: a smooth plane at room temperature, a smooth plane at medium temperature, an as-built surface at room temperature, and an as-built surface at medium temperature. The alloy modification involved partial substitution of Mg with Mn. Through this approach, we successfully preserved the fine duplex structure, including fine equiaxed grain zones at the bottom and coarse columnar grains at the top, and significantly enhanced the wear resistance of the alloy. The results indicate that the formation of fine equiaxed grains is attributed to the precipitation of Al3Ti, which acts as a heterogeneous nucleation site, and that Mn is oversaturated and solid-solved in the matrix, with no apparent Mn precipitation observed. The oversaturation of Mn increases the distortion of the Al matrix, improving the material's strength and strain hardening ability while increasing its resistance to recrystallization at high temperatures. Consequently, this approach enhances the alloy's wear resistance not only at room temperature but also at intermediate temperatures, improving the overall performance in wear environments.

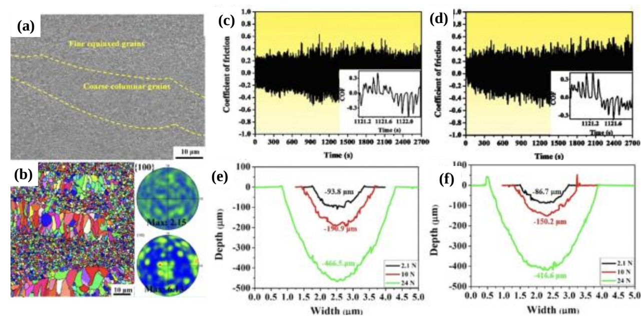

Fig. 1 (a-b) The microstructure of the alloy shows the duplex structure. (c-d) Schematic diagram of wear performance comparison. (e-f) Schematic diagram of wear morphology comparison.

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