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Effect of laser surface melting on bulk metallic glass: investigation of microstructure, microhardness, friction and wear properties

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ABSTRACT: 10 × 3 × 80 mm^3 fully dense crack-free plate-like $Cu_{46}Zr_{42}Al_7Y_5$ bulk metallic glass (BMG) samples were successfully prepared by a copper mold casting method in an argon atmosphere and subjected to surface laser surface melting (LSM) under different laser frequencies. X-ray diffraction patterns showed that the degree of crystallization is determined by the crystalline phase in the heat-affected zone and the welding fusion zone; the heat-affected zone is easier to crystallize than the welding fusion zone at the same laser frequency. The microhardness of the welding fusion zones reached a maximum of 508.2 Hv at a laser frequency of 16 Hz. However, the microhardness of the heat-affected zone declined drastically with increasing laser frequency. In addition, the average frictional coefficient dramatically increased and then decreased with an increase in sliding velocity, and the values reached a maximum at the sliding velocity of 500 mm/min. The property of wear resistance was moderately improved at laser frequencies of 12, 14, and 16 Hz. Moreover, the grinding trace widths slightly increased with increasing sliding velocity. The friction and wear mechanisms and morphological representations were completely different under different sliding velocities.

Keywords: Metallic glass; Laser processing; Microstructure; X-ray diffraction; Friction and wear; Scanning electron microscopy

1. Introduction

Bulk metallic glass (BMG) exhibits short-range order, long-range disorder, and a metastable structure, which remains relatively stable within a certain temperature range. Amorphous alloys are characterized by the lack of long-range translational symmetry of an amorphous atomic structure, resulting in a rare comprehensive performance, which is unattainable even in the most advanced crystalline alloys [1–4]. BMG is a high-performance structural material with great potential as a new functional material [4, 5]. BMG has excellent mechanical properties, namely, high fracture strength, good wear resistance, high hardness, and a low Young's modulus [6–9]. Therefore, bulk amorphous alloy materials have become useful as structural and