SUPERPLASTIC DEFORMATION OF $\alpha/\beta$ BRASS UNDER FRICTION CONDITIONS

Alexey Moshkovich$^1$, Louisa Meshi$^2$, Lev Rapoport$^{1(*)}$

$^1$Department of Science, Holon Institute of Technology, Holon, Israel
$^2$Department of Materials Engineering, Ben-Gurion University, Beer-Sheva, Israel
$^{(*)}$Email: rapoport@hit.ac.il

ABSTRACT

The dislocation structure and plastic deformation of $\alpha/\beta$ brass were studied under lubrication conditions. Superplastic deformation of $\alpha$-phase under friction is observed. Intragranular sliding in $\alpha$-phase is accompanied with the formation of shear bands and many voids coalesced to cracks. Thickness of the wear particles of brass is close to the thickness of shear bands.

Keywords: superplasticity, dislocation structure, brass, friction.

INTRODUCTION

Friction and wear of Cu and Cu alloys are accompanied by severe plastic deformation (SPD) and fracture in surface layers. The dislocation structure and work hardening of Cu during friction with lubricant were recently studied [1, 2]. Severe plastic deformation (SPD) of thin surface layers under friction is accompanied by formation of nanocrystalline structure ($d = 20$-100 nm) and shear bands in sub-layers of contact spots. Grain refinement is usually achieved through the accumulation of dislocations and subsequent rearrangement by dynamic recovery or recrystallization during SPD of face-centered cubic (F.C.C.) bulk metals and alloys. For these materials, the small grain size and saturated crystalline defects introduced during the SPD can lead to superplastic deformation. Using Equal Channel Angular Pressing (ECAP) as a method of SPD, a superplastic elongation of 640% was recently achieved for 60%-40% CuZn alloy in tension and at a temperature of 673 K [3]. In relation to friction, the similar temperatures can be obtained in contact spots. Thus, it is expected that SPD of $\alpha/\beta$ brass due to friction and relatively high flash contact temperature can also lead to superplastic deformation of surface layers. Therefore, the object of this work is to study the dislocation structure and plastic deformation of $\alpha/\beta$ brass rubbed in the friction conditions.

RESULTS AND CONCLUSIONS

Subsurface deformed section parallel to friction direction is shown in Fig. 1. The brass grains were severely deformed by bending in the direction of sliding. Strong shearing with cracks propagation inside of $\alpha$ phase is appeared in the direction of friction. During shearing, the virgin $\alpha$-grains ($d \sim 30 \mu m$) decreased to the thickness of bands ($1-2 \mu m$) when the length of these bands elongates to the size more than 150 $\mu m$. Since the grains elongated from $d =30 \mu m$ to $d=150 \mu m$, it can be inferred that the superplastic deformation of approximately 500% occurred. If to suggest that the virgin grains transformed into thin shear bands ($\sim 2 \mu m$), the superplastic deformation is probably even larger.
Intragranular slip as the accommodating mechanism occurs in $\alpha$-phase, whereas little deformation is observed in $\beta$-phase. It can be concluded that the intragranular slip in $\alpha$-phase grains is the main mechanism of superplastic deformation under friction of brass. Thus, it can be concluded that friction of $\alpha/\beta$ brass is characterized by superplastic deformation of surface layers. The superplastic deformation of brass is attributed to intragranular sliding inside of the $\alpha$-phase grains.

REFERENCES

