SUBSURFACE DYNAMIC RECRYSTALLIZATION DONINATED WEAR MECHANISM OF NANOSTRUCTURED COPPER IN LOW-AMPLITUDE OSCILLATING

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ABSTRACT
The increase in hardness of metals induced by grain refinement is of interest from a tribological point of view. Correspondence between the wear resistance of a material and its hardness has been proposed by Archard for a few decades, known as Archard wear equation [1]. This empirical relation suggested that the wear resistance is proportional to a material's hardness. Most of nanostructured metals show an enhanced wear resistance in comparison with their corresponding coarse-grained (CG) counterparts. However, nanostructured metals with high hardness do not always correspond to high wear resistance in some cases [2]. In fact, wear of materials involves many solid state processes, including plastic deformation and microstructure refinement, interactions with the environment, transfer and mechanical mixing, and fracture, etc. Identifying the key important process of wear from other concurrent solid state processes under a certain wear condition is crucial to quantify materials' wear resistance.

Nanostructured materials are structurally characterized by a large volume fraction of grain boundaries, the increased energy associated with increased grain boundary areas makes them have a low thermal stability at lower temperatures. The structural evolution beneath the sliding surface of nanostructured materials might be quite different from that of the CG counterparts. During the wear process, dynamic recrystallization (DRX) and grain growth under the worn surface plays an important role on the wear resistance, as investigated in nanostructured copper and Ni-W [3] when sliding and scratching at dry conditions.

In fact, the correlation between the wear resistance and the worn subsurface structure of nanostructured copper under dry sliding condition has been identified in our previous paper. However, it is well known that the wear resistance of a material is correlated with the wear conditions, such as oscillating amplitude and lubricated conditions. It is necessary to understand the related wear mechanism of nanostructured copper in low-amplitude oscillating process as a special wear mode. Therefore, the tribological behavior and the worn subsurface structure of nanostructured Cu prepared by dynamic plastic deformation (DPD) were investigated when oscillating at a low amplitude under both dry condition and oil lubrication.

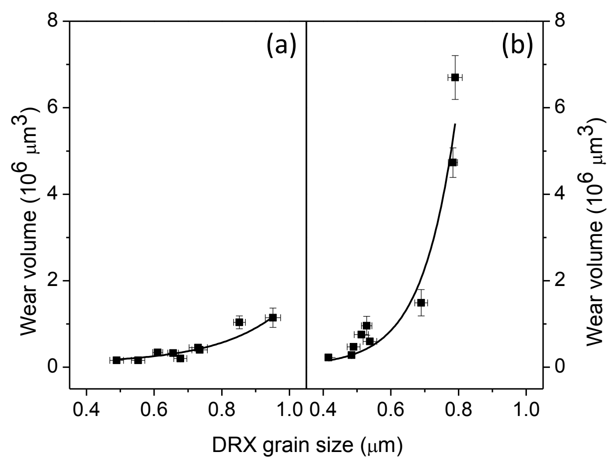

Fig.1 Correlation of the wear volume with the average grain size within DRX layer for DPD Cu sample under (a) oil lubricated and (b) dry conditions

In this investigation, the results indicate that nano-structured copper also exhibits a dynamic recrystallization dominated wear mechanism under both oil-lubricated and dry conditions in low-amplitude oscillating wear. A correlation is identified that wear volume increases obviously with an increasing grain size of DRX structure.

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