Dynamical recrystallization processes in subsurface zone induce by dry sliding detected by EBSD and positron annihilation

Jerzy Dryzek

Institute of Nuclear Physics Polish Academy of Sciences, PL-31342 Kraków, Poland

.

Corresponding author: jerzy.dryzek@ifj.edu.pl

The positron annihilation method is not as popular in tribological researches as SEM including EBSD (electron backscatter diffraction) methods. However, the joint application of these methods allows the identification of the continuous dynamic recrystallization process in the tribolayer adjacent to the worn surface of iron, molybdenum and copper exposed to dry sliding. Apart from this layer, there is also visible the layer in which the geometric recrystallization process took place. Such layers were detected only in the steady-state of the subsurface zone.

Keywords: positron annihilation, EBSD, subsurface zone, tribolayer, dynamical recrystallization

1. Introduction

It well-established fact that during sliding contact below the worn surface the deep structural changes occur. This structure evolves over time to reach a steady-state. In this state, at least three clearly visible zones can be recognized. Right under the worn surface, the so-called tribolayer with significant grain refinement occurs. Its thickness is about 10 µm and size of grains is less than half of micrometer. Experimental evidence indicates that the **continuous dynamical recrystallization** process is responsible for its constitution. Cracks are observed in this layer as well, which initiates the formation of debris.[1].

Beneath this layer the layer with elongated grains is located, its thickness is about a few micrometers only. The observation using EBSD technique shows us that the **geometrical dynamical recrystallization** process takes place there. This layer is well visible in positron annihilation measurements as well, which confirm its specific properties.

In the deeper regions the zone with large grains but with many open volume defects inside is extend at the depth of about hundreds micrometers.

2. Experimental methods

In our measurements the digital positron lifetime spectrometer purchased from TechnoAP with two photomultipliers was used. Its timing resolution (FWHM) is about 190 ps. The EBSD observations were doing on the perpendicular to the worn surface cross-section using FEI Nova NanoSEM450.

3. Results

Figure 1 shows the measured values of the mean positron lifetime (left) and the EBSD image (right) for iron. Very small grains are visible in the tribolayer, which is associated with a significant increase in the mean positron lifetime. Detailed analysis suggests that the grains are the result of a continuous dynamic recrystallization process. Below is a layer with elongated grains.

4. References

[1] Dryzek, J., Wróbel, M.,"Detection of Tribolayer in Pure Iron Using Positron Annihilation and EBSD Techniques ",Tribol. Inter. 144 , 2020, 106133-9.

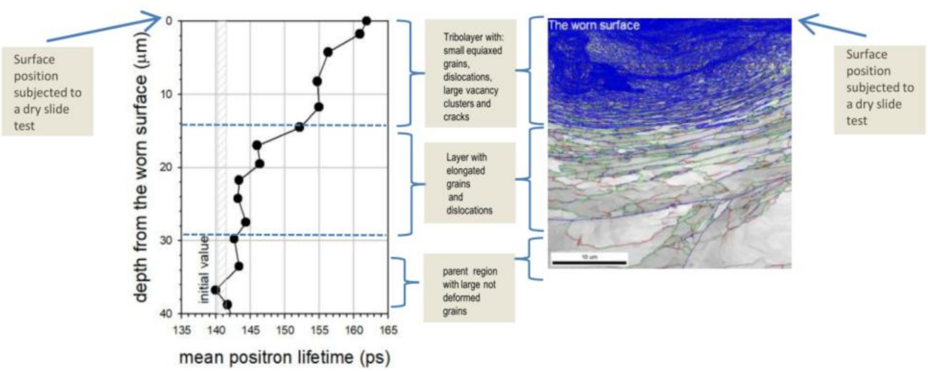

Figure 1. The depth profile of the mean positron lifetime (in the left) obtained for the work-hardened iron sample subjected to the dry sliding test. In the right the EBSD image of the correspon-ding region below the worn surface of the iron sample.