Mechanical surface treatments confer better local mechanical properties against wear or fatigue service conditions. In the case of impact-based treatments, a local microstructure's refinement in the near surface is produced by a severe plastic deformation of the material, leading to a progressive reduction in the grain size over a few tens of microns, and consequently an increase of the hardness and tribological properties. These zones are known as Tribologically Transformed Surfaces (TTS). In this project Micro-percussion tests are implemented to obtain TTS surfaces on pure iron samples. For this procedure every impact is made at the same position by a rigid conical indenter, controlling the number, angle and velocity of impacts.

The main purpose of this work is to establish a complete description of the transformed microstructures; to understand the mechanisms involved in the formation and evolution of TTS; and discuss the correlation between grain size, dislocation density and the mechanical properties deformed region. According to this, EBSD crystal orientation mapping has been used to determine the size of the plastically deformed zone, the grain size distribution, and an estimate of the GND density gradient in the cross section of the impacted zone. Moreover, micro-pillar compression tests are realized in the same EBSD region in order to quantify the evolution of mechanical properties and match these results with the acquired microstructure data.

The 10000 impacts pattern exhibits the largest TTS thickness (~150 μm), presenting an interesting grain size gradient and consequently the increase of mechanical properties on the near surface. A more detailed EBSD map (3 μm step size) is effectuated in order to estimate the GND density and grain size distribution and compare them with the micro-pillars compression tests on the same region.

Discussion and Conclusions

The GND density is estimated from the XTEM map in the surrounding area of each pillar. An average misorientation angle (θ) is calculated for this purpose. The average grain size is estimated for each pillar.

A pure iron sample is impacted repetitively by a conical tungsten carbide tip. Four prints are created using a different amount of impacts. The angle and the impact velocity are controlled. The microstructure in the near surface is refined below a grain size of 1 μm.

Conclusions

- The GND - compression tests expose the mechanical properties increase due to the microstructure refinement.
- The EBSD map data permits to assess an estimate of the GND density evolution and grain size distribution and correlate this information with the experimental results using theoretical models.

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