Assessment of EBSD regarding cyclic plasticity: a point a view

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Abstract

EBSD is a powerful tool for investigating misorientations evolution in the microstructure of metallic alloys undergoing various types of loading. One can wonder if the measurements of such misorientations as well as their related markers (KAM, GROD, GOS) are relevant when describing the cyclic plasticity.
Within the last decades, the EBSD technique has been optimized in terms of speed acquisition (large areas) as well as angular and spatial resolutions leading to high levels of accuracy. Several researchers have tried to correlate their measurements with the local plastic strain and/or dislocations densities evolution. Nevertheless, there is often no direct correlation with the underlying microstructure by itself. The work presented here tends to validate such EBSD measurements on various microstructures that undergo low cycle fatigue and points out the limitations if those latter exist.

Taking the benefits of the techniques evolution, martensitic and Fe-Si steels as well as a bronze alloy have been investigated by means of EBSD, ECCI, TEM and DIC. The purpose of such an approach is to confront the misorientations based criteria determined by EBSD to the "real" microstructure, i.e. the direct observation of dislocations structures within loading. In addition, the work done focuses on the cyclic accommodation by the microstructure as well as the crack initiation.
Hence major trends have been observed. The validity of the measurements is highly dependent of the microstructure complexity (e.g. former presence of high densities of dislocations and nature of the interfaces in martensitic steel). Also, misorientation criteria taken alone cannot suggest unambiguously the observed dislocations structuration. Despite such limitations, the combination of the complementary techniques mentioned above gives a clear indication on the cyclic accommodation (e.g. strain localization) and help to understand the mechanisms behind the microstructure evolution and onset of crack formation.

Keywords: Fatigue, Misorientations, ECCI, DIC

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