ANALYSIS OF UFG STEELS WITH LOW ENERGY ELECTRON MICROSCOPY

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Abstract

Development of advanced materials requires knowledge of relationship between microstructure and mechanical properties. Traditional high voltage scanning electron microscopy (SEM) can become insufficient for advanced materials exhibiting complex micro- and nano-structure.

Benefits of using slow electrons have been known for more than two decades [e.g. 1,2]. Experiments reported here have been done with a XHR SEM Magellan 400L (FEI Company) equipped with two detectors for secondary electrons (SE), an Everhart Thornley detector and an in-lens TLD detector, and with a solid state BSE detector bellow the pole piece of the objective lens. The microscope is equipped also with the beam deceleration (BD) mode with negatively biased specimen [3]. In this mode, the electric field around the specimen not only retards the primary electrons but also accelerates the emitted signal electrons towards detectors. Furthermore, high angle backscattered electrons (BSE) are collimated towards the optical axis and detected. These electrons carry mainly the crystal orientation contrast. SE and low angle BSE are detected by the TLD detector.

Examined material was X210Cr12 steel subjected to the high-pressure torsion (HPT) process at elevated temperature, leaving material heavily strained. Commercial EBSD device was found unable of resolving grains due to their small size and lattice distortion.

The sample was also observed using the BD mode. These micrographs reveal elongated grains sized about 70 x 1000 nm. Imaging time for the BD mode is comparable with the standard SEM speed and hence much shorter than that of the EBSD mode, providing moreover higher lateral resolution.

Keywords: Ultra-fine grained steel, severe plastic deformation, low energy electron microscopy

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