Novel Combination of 3DXRD and Grain Boundary Tracking for Mapping Polycrystalline Al-alloys
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A novel method that can provide accurate analysis of individual grains has been produced by combining X-Ray Diffraction (XRD) microscopy with grain boundary tracking (GBT) [1]. Since XRD is a non-destructive technique for characterizing bulk materials, in-situ analysis of metals can be performed both with and without applied loads. Loads can also be applied close to the point of fracture whilst still producing practical data. This combination of techniques, known as GBTXRD, provides accurate information about individual grain orientations from near field XRD analysis, whilst the grain boundary tracking accesses 1 micron level analysis of grain morphologies. The experiments used to derive GBTXRD analysis, further developments and possible applications, shall be presented.

An X-ray pencil beam was employed to perform the analysis of two types of materials: Al single crystal wire and Al-4mass%Pb alloy. The single crystal wire was used for alignment purposes and to determine a relationship between the wire’s diameter and the diffraction spots it produced. However, relationships generated employing the data obtained from the single crystal wire were ambiguous; this was believed to be due to extinction factors. A preliminary 3-dimensional X-ray diffraction (3DXRD) grain map of the Al-alloy was produced at the European Synchrotron Radiation Facility (ESRF) [2], after which XRD and computer tomography (CT) was carried out at Spring-8 Synchrotron in Japan. The 3DXRD grain map was used to determine the orientation of the grains so that their respective diffraction spots could be located. The morphology of the grains were then determined from CT images of the sample subjected to a liquid metal wetting method using Ga. These CT images were exploited for grain boundary tracking, which provided a more accurate description of the position and morphology of the grains than can be achieved through 3DXRD. Upon determining which diffraction spots were related to which grain, analysis of the relationship between various parameters describing both the grain and its relevant diffraction spots were determined. Correlation coefficients where calculated for all the groupings of these parameters. By combining results from the parameters with the three best correlation coefficients using the data acquired at Spring-8, it was possible to describe the grain misorientation with an accuracy of 100%.


Keywords: Synchrotron, Aluminium, Alloy