World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:11, No:04, 2017

Characterizing Surface Machining-Induced Local Deformation Using Electron Backscatter Diffraction

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Abstract : The subsurface layer of a component plays a significant role in its service performance. Any surface mechanical process during fabrication can introduce a deformed layer near the surface, which can be related to the microstructure alteration and strain hardening, and affects the mechanical properties and corrosion resistance of the material. However, there exists a great difficulty in determining the subsurface deformation induced by surface machining. In this study, electron backscatter diffraction (EBSD) was used to study the deformed layer of surface milled 316 stainless steel. The microstructure change was displayed by the EBSD maps and characterized by misorientation variation. The results revealed that the surface milling resulted in heavily nonuniform deformations in the subsurface layer and even in individual grains. The direction of the predominant grain deformation was about 30-60 deg to the machined surface. Moreover, a local deformation rate (LDR) was proposed to quantitatively evaluate the local deformation degree. Both of the average and maximum LDRs were utilized to characterize the deformation trend along the depth direction. It was revealed that the LDR had a strong correlation with the development of grain and sub-grain boundaries. In this work, a scan step size of 1.2 μm was chosen for the EBSD measurement. A LDR higher than 18 deg/μm indicated a newly developed grain boundary, while a LDR ranged from 2.4 to 18 deg/μm implied the generation of a sub-grain boundary. And a lower LDR than 2.4 deg/μm could only introduce a slighter deformation and no sub-grain boundary was produced. According to the LDR analysis with the evolution of grain or sub grain boundaries, the deformed layer could be classified into four zones: grain broken layer, seriously deformed layer, slightly deformed layer and non-deformed layer.

Keywords : surface machining, EBSD, subsurface layer, local deformation
Conference Title : ICMMP 2017 : International Conference on Materials and Manufacturing Properties
Conference Location : London, United Kingdom
Conference Dates : April 24-25, 2017