Texture Analysis of Zirconium Tube with Position by Electron Back-scattered Diffraction

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1. Introduction

Texture of zirconium is formed by crystallization and plastic deformation. Since the texture is fingerprints of the materials fabrication's history, it is important to analyze the texture for the determination of an optimum processing condition. There are several methods to evaluate the texture based on X-ray, electron beam and neutron diffraction.[1]

One of advantages using electron beam technique is to analyze the texture at a local area, in other words, it is a powerful tool to know the local deformation behavior. In this study, quantitative texture analysis of 2nd pilgered zirconium with position was carried to give a useful information about initial stage of pilgering process.

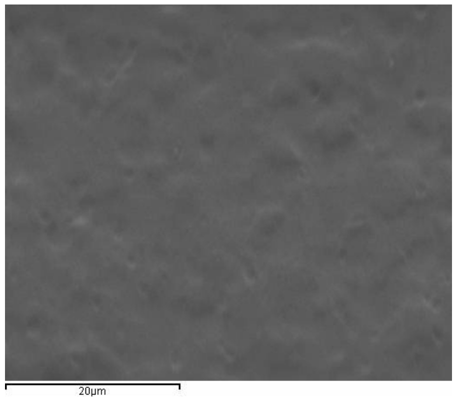
2. Experimental Method

The 2nd pilgered zirconium tube supplied by the Korea Nuclear Fuel Company was sectioned with 2x2x2 mm for the preparation the specimen. The specimen was mounted with different deformation direction and polished to remove surface residual stress followed by electro-chemical etching. Microstructure of the tube was observed by scanning electron microscopy (Jeol JSM 2400). Texture of the specimen was analyzed by electron backscattered diffraction (EBCD, Oxford) with position. Texture at local area such as outer and inner areas was determined by usual complete pole figures.

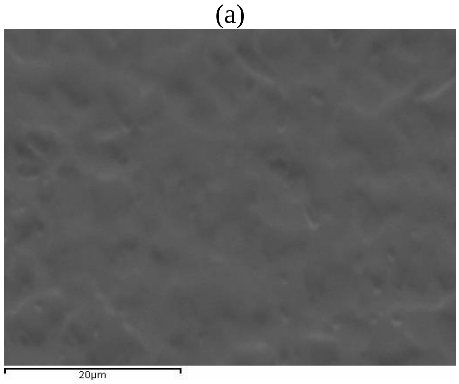
3. Results and Discussion

Fig. 1 is cross sectional view of the microstructure of 2nd pilgered zirconium tube with position. As shown in Fig. 1, the 2nd pilgered zirconium tube has relatively homogeneous and round shape grains in inner and outer region. The average grain size is about 6.7 μm.

Fig. 2 is crystallographic texture of the zirconium alloys determined by electron backscattered diffraction (EBCD) method with position. Since the most common method for representing crystallographic texture is through the construction of stereographic pole figures like inverse pole figure, basal pole (002) or (0001) and prismatic pole (100) or (10-10) and (1-10) or (11-20) were determined with deformation directions such as radial, transverse and longitudinal direction in this study.



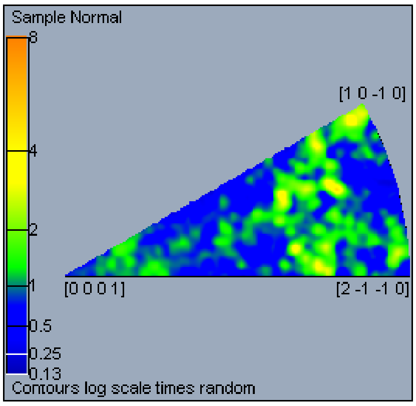
(a)



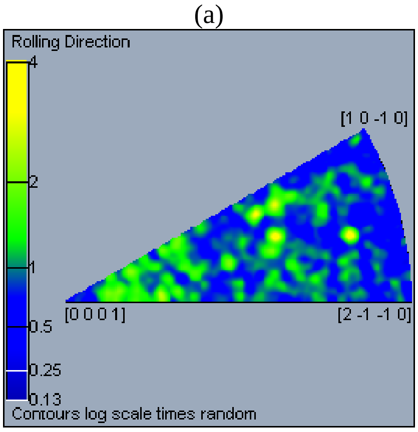
(b)

Fig. 1. Microstructure of zirconium tube with position : (a) inner (b) outer regions

As shown in Fig. 2, the inverse pole figure of zirconium tube at inner region is that most of (0001) poles are sample normal and rolling directions, whereas the (0001) pole less exist in transverse direction. In case of center region of the inverse pole as shown in Fig. 3, most of (0001) poles do not exit in sample normal whereas the (0001) pole exist in rolling direction.. It is interesting to know the reasons why the sample normal has different pole distribution and depends on the position in grains with similar size. It should be related to deformation behavior. Since the pilgering process, tube with thickness has biaxial compression sample normal to at inner region and uni-axial extension to sample normal direction at center region, respectively. This means that the (0001) poles of the zirconium tube at center region moves and are oriented more effectively than the poles at inner region under similar stress. Also this supports that stress conditions are not equal with position of tubes.



(a)



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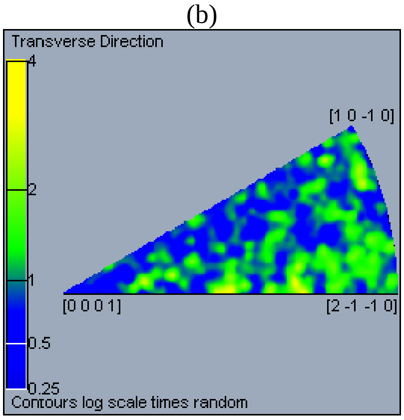
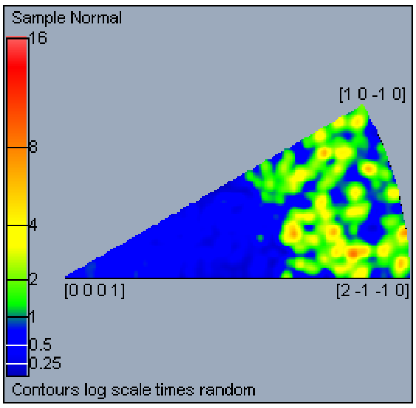
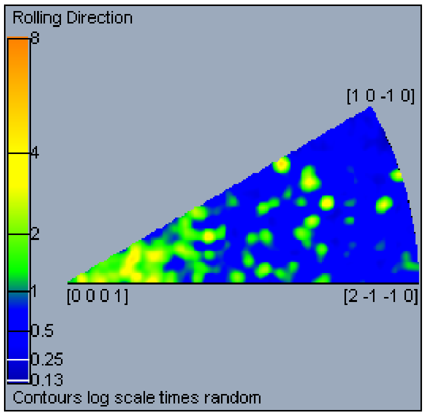


(c)

Fig. 2. Crystallographic texture of inner region: (a) sample normal (b) rolling (c) transverse directions



(a)



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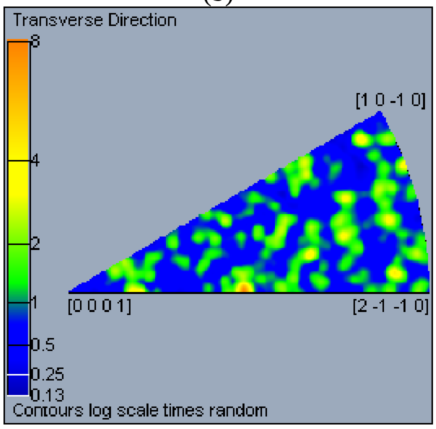

(c)

Fig. 3. Crystallographic texture of center region: (a) sample normal (b) rolling (c) transverse directions

4. Summary

Texture of zirconium tube with average grain size of about 6.7 μm was analyzed with inner and center regions by electron-back scattered diffraction method. Most of (0001) poles at inner region exist along sample normal direction, whereas those at center region do not exist along the direction, which is related to the change of stress conditions with position during pilgering

Acknowledgements

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References

[1] Y. Choi et al. Materials Science Forum, 2006 accepted.