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Study on the Texture of Zirconium TREX 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 zirconium TREX (tube reduced extrusion) was carried to give a useful information about initial stage of pilgering process.

2. Experimental Method

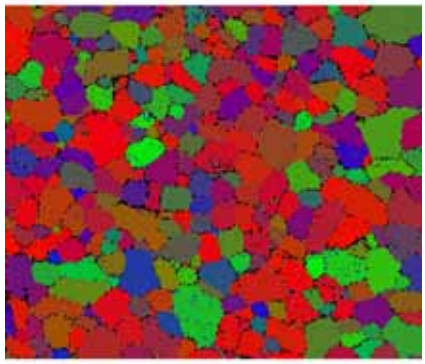
The zirconium TREX supplied by the Korea Nuclear Fuel Company was sectioned with 10x10x10 mm for the preparation the specimen. The specimen was mounted with different deformation direction and polished to remove surface residual stress followed by electro-chemical etching. Microstructure of the tube was observed by scanning electron microscopy (Jeol JSM 2400). Texture of the specimen was analyzed by electron backscattered diffraction (EBCD, Oxford) Texture at local area was determined by usual complete pole figures.

3. Results and Discussion

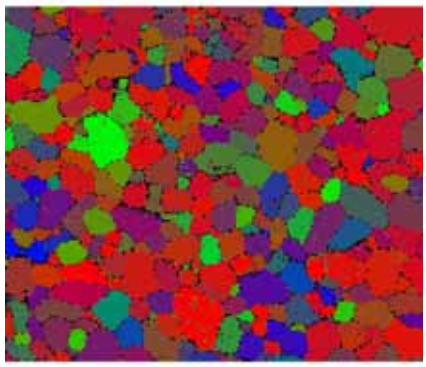
Fig. 1 is microstructure of zirconium TREX. As shown in Fig. 1, the zirconium TREX has equiaxed shape grains in radial, transverse and longitudinal direction.

Fig. 2 is quantitative results for the grain size distribution, which shows that the average grain size of about 2.3 μm. It is quite interesting to determine crystallographic orientation of the zirconium TREX because its atomic arrangement is hexagonal closed packing (HCP) which has anisotropic deformation behavior.

Fig. 3 is crystallographic texture of the zirconium alloys determined by electron backscattered diffraction (EBCD) method. 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)



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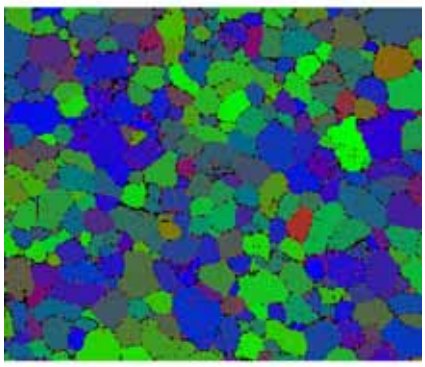


(c)

Fig. 1. Microstructure of zirconium TREX with different deformation condition : (a) radial (b) transverse (c) longitudinal direction

As shown in Fig. 3, the TREX made that most of (0001) poles are oriented along radial and transversal directions, whereas, lots of (100) and (1-10) poles are mainly oriented to longitudinal direction. This means that TREX should have an initial texture to fit final a crystallographic orientation by pilgering, although it have similar grain size and shape along the deformation direction.

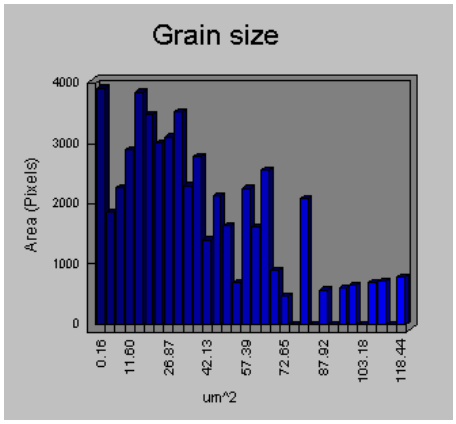
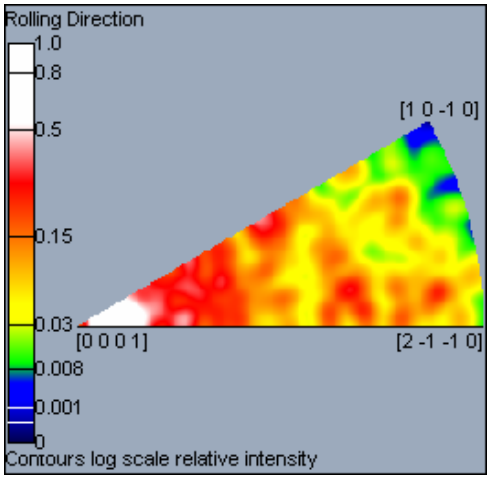


Fig. 2. Grain Size Distribution of Zirconium TREX



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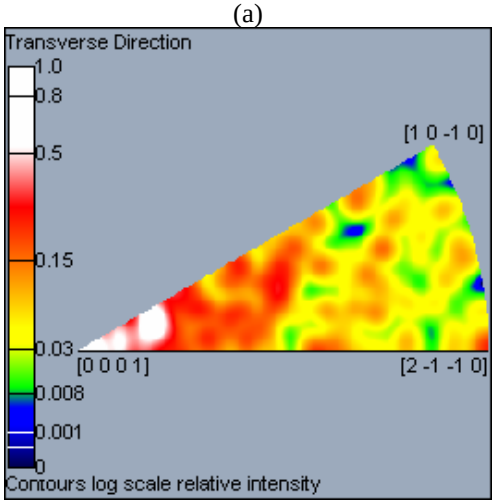

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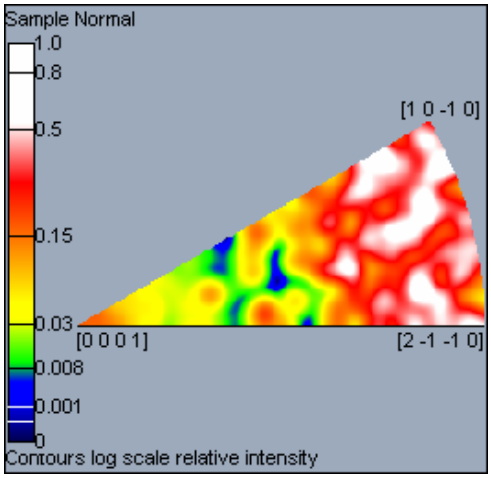

(c)

Fig. 3. Crystallographic Texture : (a) radial (b) transverse (c) longitudinal poles

4. Summary

Zirconium TREX has average grain size of about 2.3 μm. Most of (0001) poles are oriented along radial and transversal directions, whereas, lots of (100) and (1-10) poles are mainly oriented to longitudinal direction.

Acknowledgements

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References

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