

# Neutron diffraction examination of the textures of zirconium based alloys

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## Introduction

Neutron diffraction texture analysis is used extensively in research into the preferential orientation of zirconium based alloys used in nuclear technique [1]. Textures of five zirconium samples labeled as ZZ were investigated by using inversion pole figures. The texture measurements were performed on the KSN-2 neutron diffractometer located at the research reactor LVR-15 in the Nuclear Research Institute, plc. Rez, Czech Republic. Collected data were processed by software package GSAS. The wavelength used was  $\lambda = 0.1362$  nm.

## Samples

We had series of five zirconium samples labeled as ZZ. Fig. 1 shows shape and dimensions of samples. Four samples (ZZ14, ZZ19, ZZ16 and ZZ17) were deformed by uniaxial tension by using mechanical testing system ISNTRON 5882. Tab. 1 shows parameters of the experiment. Structure of the initial (non-deformed by uniaxial tension) sample ZZ13 observed by using light microscope Zeiss Axio Imager ZM1 is in Fig. 2.

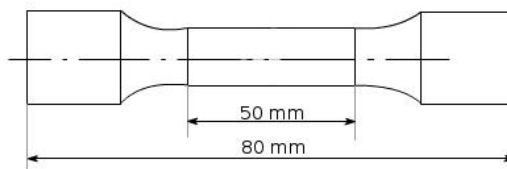


Figure 1. Shape and dimensions of ZZ samples.

Table 1. Parameters of uniaxial tension experiment.

Sample	$\varepsilon$ [%]	$\sigma$ [MPa]
ZZ14	6	121
ZZ19	10	124
ZZ16	15	134
ZZ17	20	146

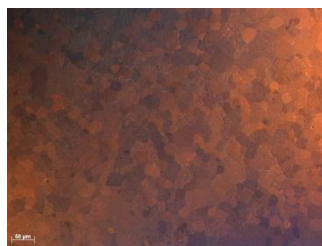


Figure 2. Structure of initial sample ZZ13 observed by light microscope Zeiss Axio Imager ZM1.

## Inverse pole figures

The intensity ratios  $p_{hkl,q}$  were calculated by Mueller formula for (100), (002), (101), (102), (110), (103), (112) and (201) reflections for directions  $q = \text{TD, ND, RD}$ , see Tab. 2.

**Table 2.** Calculated inverse pole figures of ZZ samples.

Sample	ZZ13	ZZ14	ZZ19	ZZ16	ZZ17
P002, TD	1.3	1.9	1.8	2.1	2.3
P002, ND	2.8	2.7	2.6	2.8	3.1
P002, RD	0.1	0.1	0.1	0	0
P100, TD	1.0	0.7	0.5	0.6	0.5
P100, ND	0.4	0.5	0.4	0.5	0.4
P100, RD	2.6	3.2	4.3	3.8	4.0
P110, TD	0.8	0.8	0.7	0.7	0.9
P110, ND	0.21	0.3	0.2	0.4	0.4
P110, RD	3.1	2.6	2.8	2.2	1.9

## Discussion and Conclusions

Our results can be summarized as follows:

- Samples prefer orientation of planes (100) and (110) perpendicular to rolling direction.
- Basal planes are oriented perpendicular to normal direction.
- The texture increases with deformation.

Zirconium based alloys are used in nuclear technology, and our results are consistent with data published by the other authors [3].

## References

1. H. Hsun, *Texture of metals*, Technical report, United States Steel Corporation Research Laboratory, 1974
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3. A. V. Nikulina, *Zirconium Alloys in Nuclear Power Engineering*, Metal Science and Heat Treatment, 46, 2004, pp. 458 – 462.

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