Diffraction line and texture variations in Ti-2.5Cu during in situ tensile loading

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In Ti-2.5Cu, {11.2} twins are suppressed by adding the alloying element Cu. This is due to the finely dispersed second phase (Ti₂Cu) [1]. However, the role of Cu to change the activation mode in Ti-2.5Cu during tension is still less understood. The present study aimed for the investigation on diffraction line and texture variations during uniaxial tension at ambient temperature. A universal testing machine (UTM) [2], by which specimen can be loaded up to 20 kN, was installed at Hasylab at DESY. The loading axis was parallel to the rolling direction. The beam line with the UTM set-up is shown in Fig. 1. Monochromatic incident beam has a size of 1 x 1 mm² and a wavelength of 0.1262 Å. The distance between the specimen and the area detector was 1166 mm. The stress–strain curve from the in situ measurement is illustrated in Fig. 2.

![UTM with specimen](image1.png)

**Fig. 1:** Beam line set-up with UTM

![Engineering stress-strain curve](image2.png)

**Fig. 2:** Engineering stress-strain curve

The shaded circles in Fig. 2 indicate some examples of the cake taken parallel and perpendicular to the loading direction. The intensity distributions of prismatic (10.0) and basal (00.2) planes, as 2 examples, show that the intensity of (10.0) increased with increasing the plastic strain parallel to loading direction (LD), while it decreased perpendicular to LD (see Fig. 3). The opposed results of (00.2) were obtained. Furthermore, it was found no basal planes perpendicular to LD in the elastic zone (up to elastic strain of 3.66% and stress of 500 MPa). It was also observed that the FWHM of both planes markedly increased in LD rather than that perpendicular to LD (Fig. 4) as a result of Poisson’s ratio of 0.33 for alpha Ti. In addition, the peak position of (10.0) significantly decreased in LD (Fig. 5). In contrast, it was observed no significant change in the peak position of (00.2) in LD, while it slightly increased perpendicular to LD. This can be explained by grains rotation during tensile testing as described by the orientation distribution function (ODF). It should be pointed out that Debye–Scherrer rings show relatively coarse grains up to stress of 500 MPa (Fig. 2) leading to scattered values which are more pronounced in the elastic zone. The ODF on the initial and the broken (at strain of 34.6% and stress of 510 MPa) tensile specimens are illustrated in Fig 6a and Fig. 6c, respectively. Obviously, the initial texture was changed from {00.1} <11.0> component to stronger {00.1} <10.0> component (indicated by shaded squares). Furthermore, it was observed that relatively weaker {11.0} <10.0> component was activated (indicated by opened circles Fig 6c). The activation of {11.0} <10.0> component is caused by little increase of {11.2} twins due to a greater reduction along the c-axis. Therefore, suppression of {11.2} twins by the second phase Ti₂Cu was overcome by higher reduction (43%). Furthermore, the ODF at ultimate tensile stress (UTS = 595 MPa at uniform strain of 23.5%) shows a combination of weaker initial texture (indicated by crosses in Fig. 6b) and relatively stronger texture of broken specimen.
Fig. 3: Variation of (10.0) and (00.2) intensities during tensile loading

Fig. 4: Variation of FWHM of (10.0) and (00.2) during tensile loading

Fig. 5: Variation of peak position of (10.0) and (00.2) during tensile loading

Fig. 6: ODF sections showing texture variation during tensile loading

References: