In-situ study of the cyclic deformation behaviour of the magnesium base wrought alloy AZ31 by means of high energy synchrotron diffraction

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With regard to the processing of structural lightweight components there exists an increasing demand for the application of Mg-base wrought alloys, which are basically highly textured due to the cold forming process. By this means the flexibility for the design of the components is higher and apart of that the strength of the material state can be partially tailored to the operational demands.

However, magnesium has a poor deformability at room temperature due to the fact that only a limited number of glide planes are activated. Furthermore twinning can occur for loading the hexagonal magnesium unit cells in compression parallel to the basal planes or in tension normal to the basal planes. After twinning has occurred it has been shown that the twins can recover during cyclic loading when reversing the loading direction.

Although the focus of recent research activities on light metals is on the investigation of the texture evolution and the mechanical behaviour of Mg-base alloys during processing and in service, there still exist a lack of understanding of the mechanical-technological characteristics of magnesium wrought alloys, e.g. the knowledge about the deformability or the cyclic deformation behaviour with respect to the initial crystallo-graphic texture of the material state.

In the present research project the deformation behaviour during cyclic loading of the highly textured hot rolled magnesium wrought alloy AZ31 has been investigated in-situ using energy dispersive diffraction for high energy synchrotron radiation in transmission mode on bars subjected to purely elastic as well as elasto-plastic 4-point-bending. Loading or residual stress distributions were determined for one load cycle including loading, load release and load reversion. The experiments were carried out at the EDDI-Beamline at Bessy II, Berlin using a white beam up to energies of 150 KeV.

The results obtained for the multitude of reflexions being recorded simultaneously in one single diffraction spectrum clearly indicate the highly elastic isotropic behaviour of the textured alloy. For elasto-plastically bended bars a strong plastic anisotropy was observed leading to a distinct shift of the neutral fibre of the bars. Reverse loading causes a shift of the neutral fibre almost symmetrically in the opposite direction of the bar which can be attributed to the reversibility of the twinning. Twinning and the untwinning process can clearly be observed on basis of the diffraction results by local changes of the texture caused by the elasto-plastic loading.

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