In-situ neutron diffraction study under compressive stress combined with AE measurement of extruded AZ31 alloy

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Recently, magnesium alloys are attracted attention in the view point of reduction of environmental load for such as carbon dioxide generated by automobiles, airplanes, etc., because their specific density is most light among practical metals. But, the formability of magnesium alloys is not enough at room temperature, therefore their applications are limited. Poor formability arises from their crystal structure. Magnesium alloys are h.c.p metals of which the single crystal exhibits strong anisotropy for applied stresses, because the dominant slip system is only the basal $\langle a \rangle$ slip system which contributes only two independent slips. Therefore, the von Mises criterion for homogeneous formability with arbitrary shape, which requires five independent slips, is not satisfied. The basal $\langle a \rangle$ slip does not contribute to the strain along the c-axis direction. Therefore, the deformation twin is the dominant deformation mechanism, which can contribute to the strain along the c-axis direction, for external stresses at room temperature for magnesium alloys. Although, there are many literatures about the deformation twin of magnesium alloys, the detailed mechanism is unclear. This is due to the difficulty for microscopic *in-situ* measurements under stresses. We performed *in-situ* neutron diffraction measurements under compressive stress combined with AE (Acoustic Emission) measurements which is sensitive for microscopic dynamical motion, to reveal the deformation mechanism of magnesium alloys, using TAKUMI, BL19 at MLF, J-PARC. Commercial extruded AZ31 alloy with the c-axis being perpendicular to the extrusion direction, which is a typical magnesium alloy, was used, and compressive stress with parallel to the extruded direction was loaded. The stress and strain curve showed the nonlinearity from far below the macroscopic yield stress. From the stress starting this nonlinear behavior, AE signals were detected and the AE energy distribution showed the logarithmic behavior until macroscopic yield stress. This means that slip occurred at that stress, namely the plastic deformation started, and the slip size is scale free. The formation of the $\{10\bar{1}2\}\langle 10\bar{1}1 \rangle$ deformation twin at the stress around the macroscopic yield point was revealed by neutron diffraction and the AE energy distribution showed a peak which corresponding to the deformation twin.