ABSTRACT

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Experimental Investigation of Plastically Deformed Al-Alloy Samples
Using High Energy Synchrotron Radiation

In the present work experimental investigations of the texture and strain state were carried out on plastically deformed samples, made from non-age hardenable, single phase Al-alloy AlMg3 and from the two phase PM-alloy AlSi25Cu4Mg1. The samples were deformed uniaxially (in tension and compression), biaxially (torsion of tubular samples), and triaxially (free end solid torsion).

Well-established, non-destructive, diffraction techniques, based on the use of high energy synchrotron radiation, were applied for the observation of the residual strain state in the uni- and biaxially deformed samples. For the investigations of the solid torsion samples, which show a strong deformation gradient in the bulk, a novel, non-destructive, strain and texture scanning technique was successfully developed and applied. It allowed unprecedented dynamic in-situ observation with high spatial resolution of the texture and strain state within the sample. The technique combines, for the first time, a microfocussed high energy synchrotron beam (as available at the beamline ID11 at the ESRF), a newly developed conical slit system, and a large area detector for fast data acquisition. Novel data analysis techniques were applied and a complete data analysis software package was developed. In addition to the techniques based on x-ray diffraction, investigations of the deformation microstructure were carried out by applying microscopical techniques (optical microscopy, TEM).

The results for the crystallite microstrain analyses show in some cases much larger values for the triaxial deformation (not previously studied) than in the case of uniaxial deformed samples, proving that, in general, the crystallite microstrains cannot be neglected for deformations of higher dimensionality. The investigation of intergranular strains in the solid torsion samples showed that the 220 direction exhibits often the opposite sign to the strains observed for the other reflections. This is particularly the case for the axial strain component. The observation of the so-called Swift effect (i.e. the length change of plastically deformed torsion samples) was correlated with the results of the hkl specific crystallite microstrains and the local, radially dependent texture evolution. For the first time, the radially and deformation dependent texture evolution within the sample was investigated and showed clearly the development and partial rotation of ideal torsion texture orientations. From the investigations of the microstructure, three typical types of deformation microstructure could be identified.