ESRF	**Experiment title:** Orientation dependent stored energy in cold–rolled ultra high purity iron	**Experiment number**: HS-1170
Beamline: BM-16	**Date of experiment**: from: 31.05.00 to: 04.06.00	**Date of report**: 25.08.00
Shifts: 12	**Local contact(s)**: Eric Dooryhee	*Received at ESRF:*

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Report:

During cold work of a metal, a small fraction of the energy of deformation is stored in the crystal in the form of the elastic energy associated with the strain field of the generated dislocations. Grains with different orientations experience during deformation different amounts of plastic slip and consequently different amounts of stored energy. Usually the final dislocation structure of a cold worked metal is heterogeneous and the total stored energy can be approximated by the sum of three terms. 1) W_s the self–energy of dislocations, 2) W_{het} the interaction energy associated with the long–range stress fields in cellular dislocation structures and 3) W_{mean} the elastic energy associated with the mean stresses due to the heterogeneity at the level of individual grains. The aim of the experiment done at BM16 was to explore the stored energy corresponding to these mean stresses. The investigated material was a cold–rolled ultra high purity iron sample, which has two typical fibre–texture components, the soft {001}<110> α–fibre and the hard {111}<211> γ – fibre. The ratio of the hardness measured in the γ and α grains is of about 1.8 [1], which means that the cold–rolled sample is a proper system for the investigation of the desired mean strains. The position of the Bragg–peaks corresponding to the different texture components were measured with high angular resolution and compared to the position of the corresponding peaks measured on an annealed powder sample. Four texture components {(100)<110>, (211)<110>, (111)<110> and (111)<211>} were investigated using two

appropriate Bragg reflections. The relative change of the lattice spacing as obtained from different reflections and different texture components is shown in Fig. 1 as a function of sample reduction. It can be observed that the α texture components present very large negative mean strains, which are almost independent of the direction of the diffraction vector related to the sample coordinate system. The γ fibre presents means strains, which are small in the rolling and transverse direction (the γ_2 –211 and γ_1 –211 reflections), and are comparable to those of the α fibre for other directions. The picture of mean strains is incomplete. In order to determine the mean strain tensor and the related stored energy, four more directions for each texture component should be investigated.

The W_{het} part of the stored energy associated to the self-energy of the dislocations can be determined from the form of the Bragg peaks [1]. Unfortunately working at 25 keV the high background made not possible to apply the method for the UHP iron. Preliminary investigations made on an aluminium alloy have shown (see Fig. 2) that using a beam energy of 18 keV the background level of the peaks recorded at ESRF is similar to that measured in the lab with 6.9 keV. The peaks measured in transmission at ESRF contain much more information about the investigated sample, and this is visible on the different shape of the peaks. Evaluation of the broader peak (broadening, which is observable just at intensities below 2 x 10^{-2}) gives a higher value of the dislocation density parameter, which is approximately 2 times the value obtained from the peak measured in the lab. This difference between the peaks measured in transmission and in backreflection should be investigated in the future, since getting the right values of the dislocation density and other data related to the dislocation structure are indispensable for the development of appropriate theories of plastic deformation.

[1] A. Borbély, J. H. Driver and T. Ungár, Acta mater. **48**, (2000) 2005 – 2016.

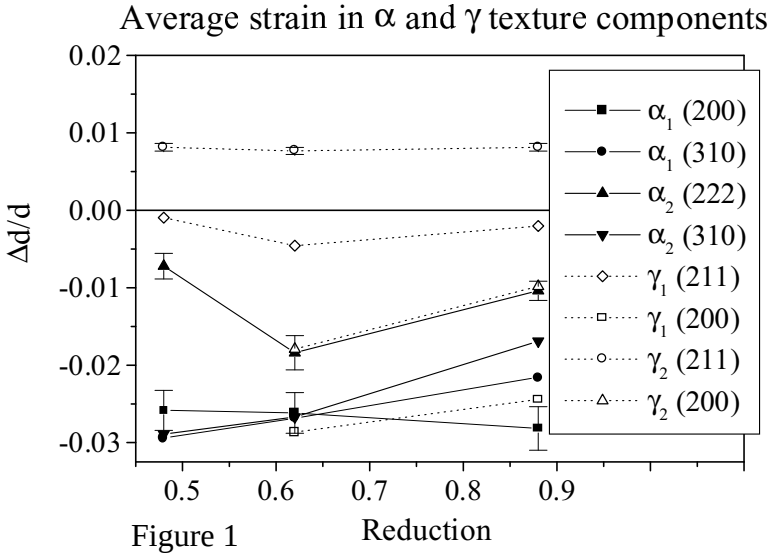

Figure 1

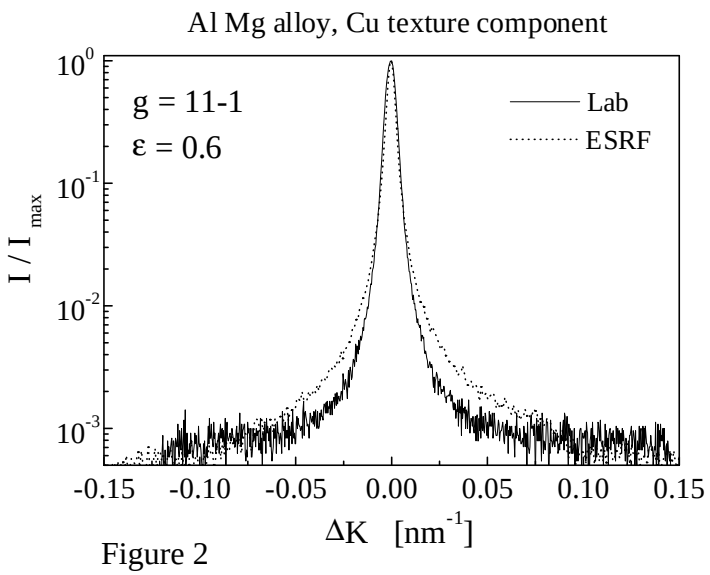

Figure 2