4 semester PhD Project Report

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ELTE TTK, Fizika Doktori Iskola, Anyagtudomány és Szilárdtestfizika PhD Program
Témavezető: Prof. Dr. Sidor Jurij, ELTE IK Savaria Műszaki Intézet

PhD Topic: Investigation of recrystallization phenomena in face-centered-cubic polycrystalline systems

Subjects Registered

Courses	Remark / Grade
Solid State Theory I. EA	Excellent/ 5
Technology of Materials (intensive course)	Grades yet not published

Other Academic Activities:

Took part in teaching activity at Faculty of informatics, Savaria Institute of Technology, ELTE	Subject – Structure of Materials III (Theory + Practice)	Syllabus completed on time. Final exams on going
Co-supervised Bsc thesis	Investigation of recrystallization phenomena in Al alloys. Student: Samar Mani	On going

Research activities:

It is well established that, the driving force for recrystallization, offered by dislocation density ρ in the material that produces stored energy E . Hence it is very important to have idea of dislocation density for the material under consideration. From the value of ρ it is possible analyze the recrystallization kinetics for the material using JMAK equation.

In reference with the work done in previous semester dislocation density has been calculated for 5%,15%,21% 29%, 40% and 49% deformed Al1050 material. The samples are symmetrically cold rolled.

The dislocation density of the material is been evaluated using Vicker's indenter under the consideration of indentation size effect. As well as calculated value of dislocation density is compared with values obtained from XRD experiment.

Under the ongoing work of present semester distribution of dislocation density through the thickness of the material is evaluated. As well EBSD experiments are conducted for the samples under consideration. Some of the experimental results are presented below.

1. **Dislocation density throughout the thickness of rolled material.**
   Indents are made on from the sub-surface to the midhalf plane of the samples through the thickness in three layers. Method used to calculate GND and SSD (Statistically stored dislocations), as well total dislocation density is mentioned in semester-3 report.
   The data below represented is for 21% Al1050

Table1: GND, SSD and total dislocation density from surface to core of the material.

	Distance from the surface (m)	ρ, $1/m^2$	GND, $1/m^2$	SSD, $1/m^2$
layer1	2.60E-04	1.19E+15	2.27E+14	9.65E+14
layer2	5.20E-04	8.74E+14	2.29E+14	6.45E+14
layer3	7.80E-04	1.62E+15	2.82E+14	1.34E+15

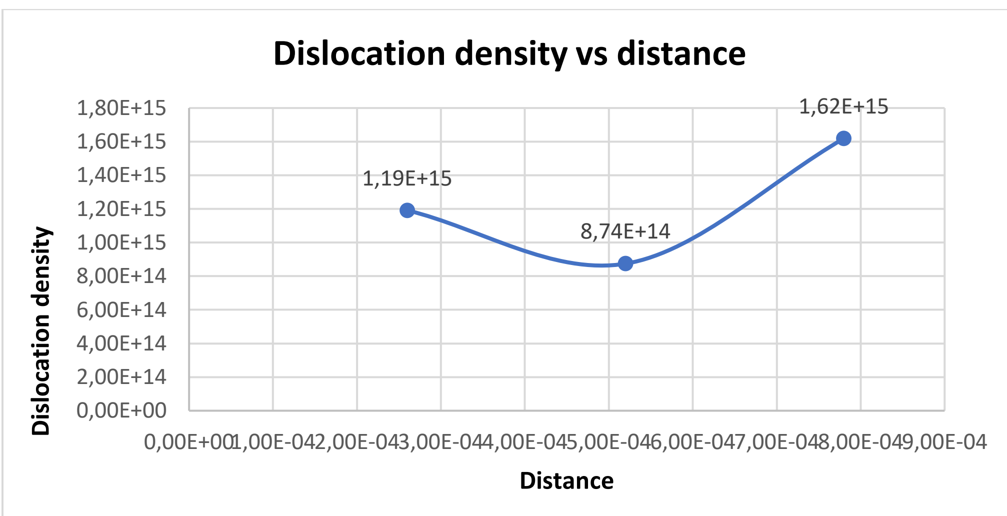
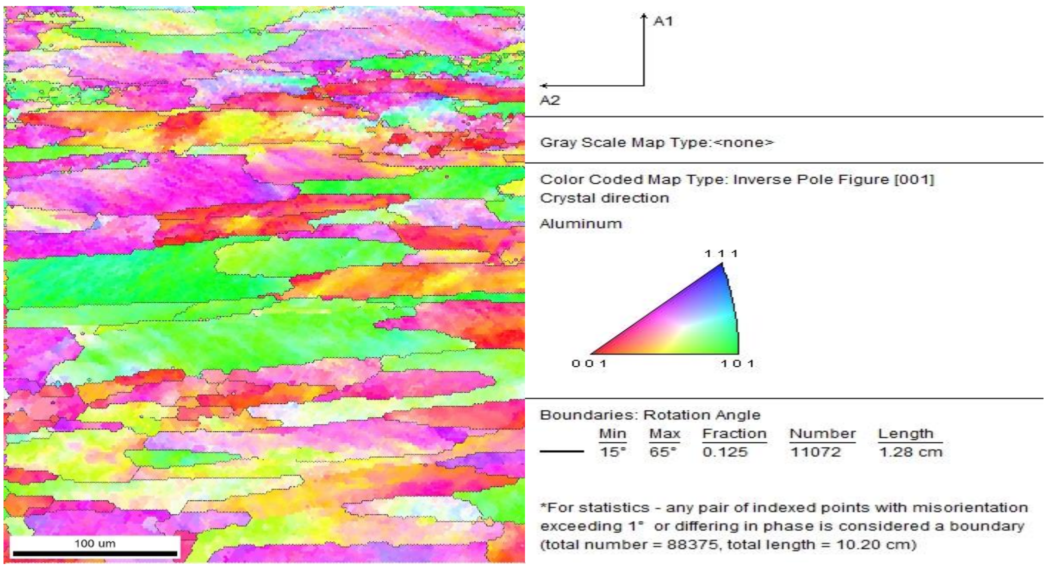


Fig. 1. Distribution of total dislocation density with distance from subsurface towards the mid-thickness plane.

From the above table 1 and Fig (1) it is clear that overall distribution of dislocation density is inhomogeneous across the thickness of the material. Although it is reported that the trend of DL vs distance directly depends on the level of deformation as observed for other samples. The observed distribution is a direct consequence of deformation flow across the thickness of rolled material.

2. **Electron Backscatter Diffraction (EBSD)**

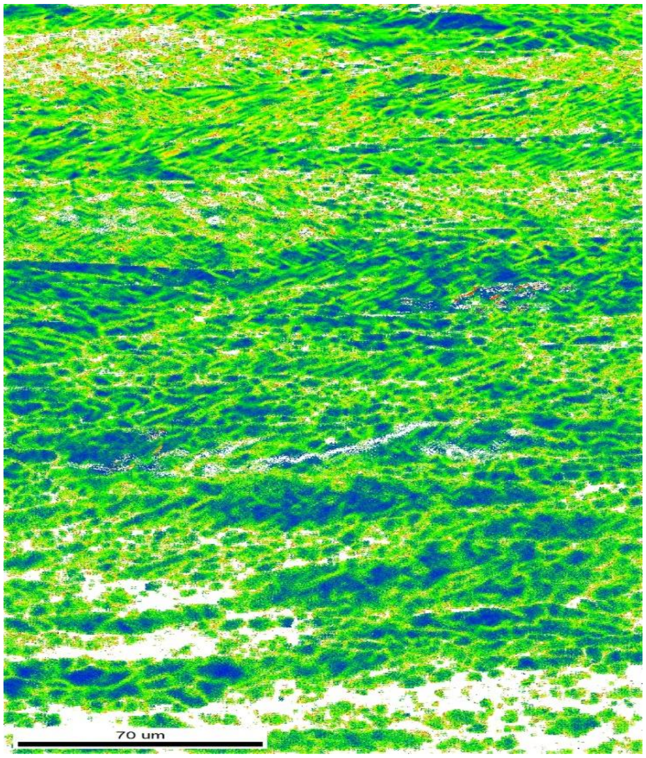
EBSD experiments are conducted for the samples for visualizing orientation contrast and misorientation, texture trends and grain boundary types as well as to calculate the geometrically necessary dislocation density (GND) independently. Experiments performed on the TD plane.



Fig(2) : Inverse pole figure for 49% deformed symmetrically cold rolled Al1050

From the above IPF map it can observed that, the high angle grain boundaries are aligned towards rolling direction. On the other hand deformation bands inside the grain is around Transverse direction. As the measurements are taken in such a way that the top of the map is the mid-half plane of the sample and bottom is a surface. It is interesting to visualise that if we consider the map in terms of layers just as indentation technique we can conclude that characteristic of the grains varies through out the layers.

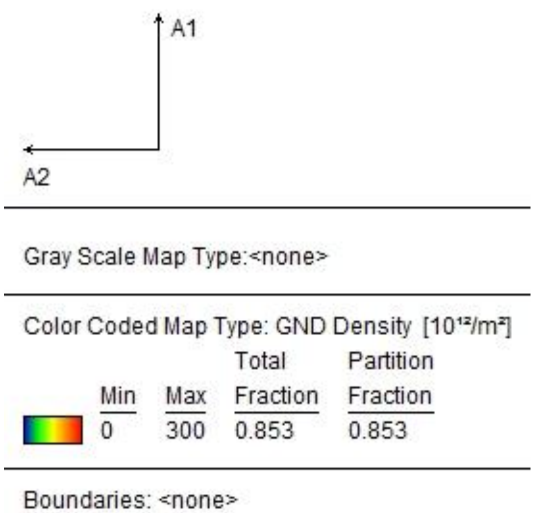
The geometry of the deformed grains is dependent on the amount of deformation and the applied strain mode, hence it varies from sample to sample.

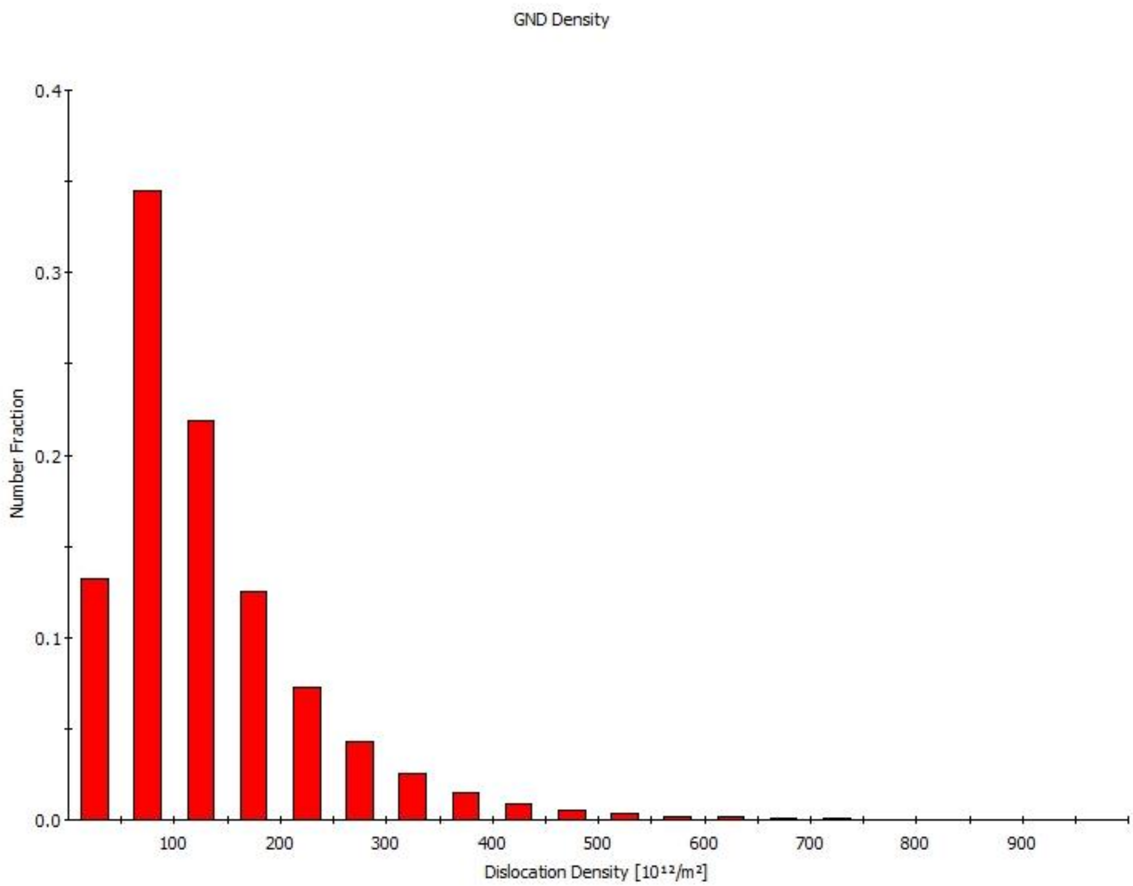


Since, area under consideration is from mid-half plane or core of the material to surface the following observations are made:

We can see that the GND density is mostly about $3*10^{14}$ m^{-2}. Highest GND density can be seen at the core of the material that decreases gradually throughout the thickness. From the map it is cross verified that distribution of GND is inhomogeneous across the thickness of the material. As well as we can estimate the local GND density with a better accuracy. The white points in graph stands for non-indexed points.

Fig(3): Representation of GND in 49% deformed symmetrically cold rolled Al1050





Fig(4): GND vs Number of fraction for the same sample as above

From the above graph we can see the distribution of dislocation density with distance. Whereas with consideration of Fig(2) we can conclude that the average disloacation density saturates around $3*10^{14}$ m^{-2}