A NOVEL HIGH MAGNETIC FIELD POLARIZATION MICROSCOPY PROBE

P.J. Konijnenberg, D.A. Molodov and G. Gottstein (RWTH-Aachen University, Institute of Physical Metallurgy and Metal Physics)

Introduction

Results acquired with a novel space-resolving high magnetic field polarization microscopy probe are presented. With this high field probe (Fig. 1) it is possible track the evolution of position and shape of a grain boundary at the surface of magnetically anisotropic crystalline matter. This is of particular interest because it is known from experiments that magnetic annealing of even non-ferromagnetics can result in a magnetically affected texture evolution [1]. Two major advantages in this approach to measure the kinetics of individual boundaries are a constant, adjustable and accurately known driving force and the possibility to study plane grain boundaries with a uniform and well defined boundary structure.

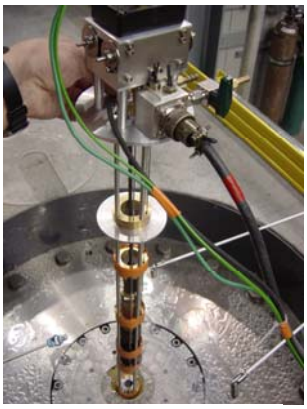

Fig. 1. High field probe being lowered in the Keck magnet.

Experimental and Results

The probe consists of an incident light polarizing microscope with CCD camera which is aligned in field direction over a sample chamber. It is designed to fit inside the Keck magnet with a bore hole diameter of 52 mm. While a high magnetic field is applied, the sample temperature is elevated step wise in an inert gas atmosphere. The sample temperature is derived from a calibration curve and constant within ±1 K. Several microscope settings were remote controlled either by stepper motor or hand.

The sample consists of a rectangular in-situ generated Zn bicrystal (hexagonal crystal structure) (2x4x15 mm^3). The first grain's c-axis is aligned with the field within a few degrees, whereas the c-axis of the second in-situ generated grain shows a high angle (near 90°) with regard to the field. Due to a crystallographic anisotropic susceptibility, the first grain's free energy density becomes larger than that of the second grain. This driving force results in the first grain being consumed, whenever the mobility of the grain boundary is sufficiently thermally activated during annealing of the sample. The boundary is tracked by polarization microscopy.

The activation energy of plane boundaries was derived from measuring the boundary velocity at several constant temperatures. To derive the driving force the bicrystal misorientation was measured by Laue X-ray diffraction afterwards. With a known driving force and a measured velocity the boundary mobility (m = v /p) was derived and plotted in an Arrhenius plot.

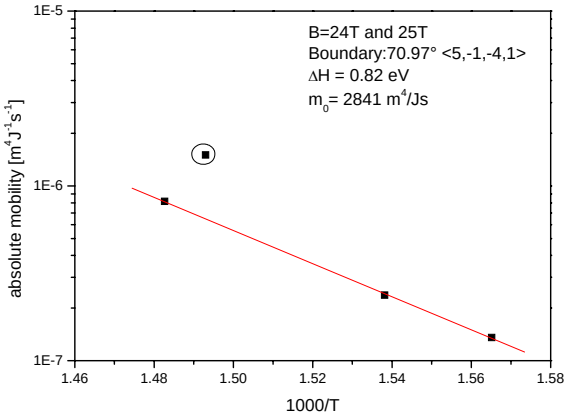

Fig. 2. Arrhenius plot of mobilities vs. temperature.

As shown in Fig.2, the derived absolute mobilities of an approx. 71° <5141> boundary are shown versus the inverse temperature. It shows an activation enthalpy of about 0.82 eV. This value is in agreement with literature values for capillary (curved) driven grain boundaries. However, an improved orientation contrast, currently being developed, will enable a better verification that the boundary velocity was constant and not impeded by any defects.

Acknowledgements

Financial support from the Deutsche Forschungsgemeinschaft (MO 848/4), as well as Dr. Scott T. Hannah's support, are gratefully acknowledged.

References

[1] Molodov, D.A., *et al.*, Mat. Lett., **59**, 3209-3213 (2005).