IN SITU- MEASUREMENTS OF GRAIN BOUNDARY MOTION IN ZINC

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

Introduction

A recently designed and fabricated high magnetic field polarization microscopy probe provides the opportunity to measure continuously the position and shape of a moving grain boundary in magnetically anisotropic materials. The approach utilizes the anisotropy of reflectivity of visible light for orientation contrast to determine the boundary location. Since the driving force for boundary migration is induced by a magnetic field and does not depend on boundary properties, the method provides an opportunity to investigate the motion of a planar grain boundary with well defined structure.

Results

The probe consists of an incident light polarizing microscope with a CCD camera aligned in field direction over a sample chamber. While a high magnetic field is applied, the sample temperature is increased stepwise in an inert gas atmosphere. Several microscope settings are remote controlled either by stepper motors or manually. In addition to the experimental setup used in previous sessions, the probe was equipped with Ag-based nano-particle Codexx® polarization filters that ensure enhanced contrast and further improve the *in situ*-visibility of migrating grain boundaries.
During annealing of high purity Zn-monocrystals (99,999%) in a magnetic field individual grain boundaries were induced in situ [1]. For this, one of the monocrystal surfaces was deformed by a single macro Vickers hardness indentation. A successive annealing treatment resulted in a local recrystallization of the deformed volume only. Then a magnetic field was applied parallel to the principal axis of this monocrystal. Due to the magnetic anisotropy of Zn, a driving force acted on all grain boundaries between the host matrix and those new grains whose principal axis was not parallel to the field. However, usually only one boundary, whose product of mobility and driving force is maximal, swept the sample.

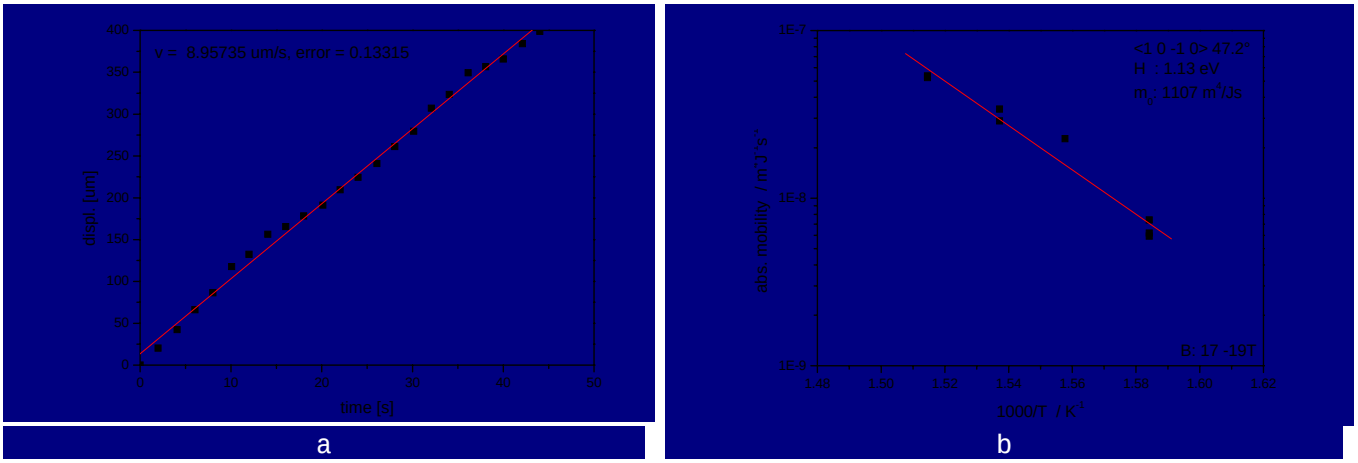

Fig. 1. Migration of a 47.2° $<10\bar{1}0>$ grain boundary in zinc. (a) Displacement vs. time at 370°C and (b) temperature dependence of the boundary mobility. The measured activation enthalpy of boundary motion amounts to 1.13 eV.

Figure 1 depicts first results of measurement of grain boundary migration in zinc utilizing the novel high magnetic field microscopy probe. The boundary was observed to move in steady-state for a constant temperature (Fig. 1a). Therefore the velocity for each temperature could be calculated. Since the magnetic driving force can be determined accurately, the measurement of boundary motion under a constant magnetic driving force allows to determine the absolute value of grain boundary mobility, the dependence of grain boundary mobility on temperature (Fig. 1b) and on the specific grain boundary character.

References

[1] Konijnenberg, P.J., *et al*., Mater. Sci Forum, 467-470, 763-770 (2004).