MAGNETICALLY DRIVEN SELECTIVE GRAIN GROWTH

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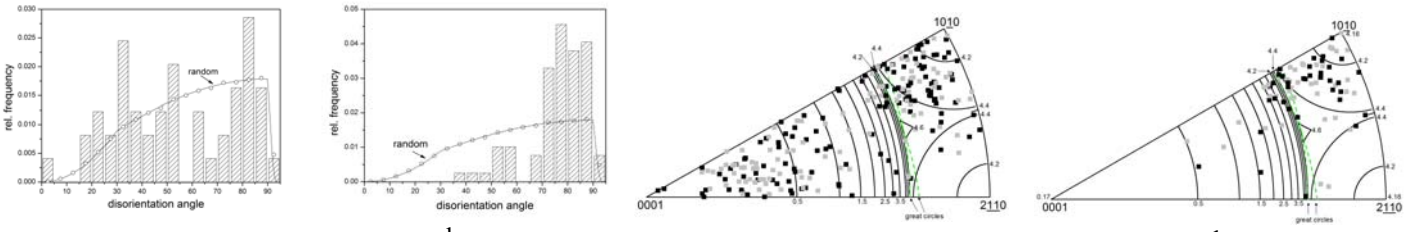
Introduction

At suitably high field strengths and temperatures even the microstructure evolution of non-ferromagnetic anisotropic metals is affected by magnetic annealing [1]. During this process the non-uniformity and anisotropy of the boundary mobility plays an important role. Selective grain growth during magnetic annealing yields a valuable insight into these parameters.

Experimental and Results

Large single crystals (2x4x15mm^3, Zn 99.99+%) are locally deformed by a Vickers hardness indentation along either <2$\underline{1}\underline{1}$0> or <10$\underline{1}\underline{0}$>. Annealing at about 673K in a high purity inert gas atmosphere initiated a local recrystallization which resulted in a set of new local orientations. SEM-EBSD analysis revealed that at the sample surface all grains invariantly border with the host matrix. Rodrigues-Frank parameters of boundaries between these grains and the single crystalline host matrix are plotted separately; disorientation angles in Fig. 1a and disorientation axes in Fig.1c. Both figures show a clear deviation from a random distribution (resp. indicated by a MacKenzie distribution and contour lines).

A subsequent addition of a high magnetic field (Keck magnet) for several minutes (in similarly pretreated samples), directed along the extraordinary axis of the host matrix, resulted in a magnetic driving force on the new grains depending on the misalignment angle of their extraordinary axes. Frequently this resulted in selective growth of a single grain into the single crystalline host matrix. Orientations of these grains were determined by Laue X-ray backscatter diffraction. Apparently these grains can be distinguished from their competitors by their combination of driving force and boundary mobility. Boundaries of these prevailing grains are plotted correspondingly in Fig.1b and d.



a b c d

Fig. 1 Disorientation angle and axis distribution before (a,c) and after (b,d) magnetic annealing.

Discussion

Clearly, after magnetic annealing a large part of the angle distribution as available before magnetic annealing is suppressed. The axis distribution behaves similarly. Before magnetic annealing two clusters can be recognized around <0001> and <10$\underline{1}\underline{0}$> of which only the latter is maintained after magnetic annealing. The angle distribution becomes less random whereas the axis distribution becomes more random, seen along the symmetry line <0001>-<10$\underline{1}\underline{0}$>. Due to the sample geometry boundary normals point in <0001> of the host matrix. Consequently selectively grown grain boundaries have a strong asymmetric <10$\underline{1}\underline{0}$> tilt component. However, previous research revealed that symmetric <10$\underline{1}\underline{0}$> 86±3° tilt boundaries tend to be quite immobile under similar conditions. Further research is needed.

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References

[1] Molodov D.A. *et al.*, Acta Mat., **52**, 4377-4388 (2004).