Experimental test of models for ideal grain growth in a single-phase polycrystal

Because numerous materials properties depend on the size and distribution of crystallites (grains) in a polycrystalline material, scientists have devoted considerable effort to understanding the physics of the so-called grain growth process that occurs during sample processing. Until recently, such studies could be carried out only in a statistical sense, as experimental methods for measuring the sizes and shapes of grains always led to destruction of the sample! With the new technique of 3D x-ray diffraction (3DXRD) microscopy, however, we are now able to track the migration of individual grain boundaries nondestructively in a sample containing hundreds or even thousands of grains. As shown in Fig. 1, we used this technique to study grain growth in a cylindrical sample of Al-1 wt% Mg, but because of its strong texture this specimen failed to manifest the desired “ideal” growth process.

In a new project (the scope of which can be tailored to a Bachelor’s or Master’s thesis), we propose overcoming this limitation by exploiting the semisolid regime of the Al-Cu phase diagram to obtain a nearly texture-free Al specimen containing a small amount (2.5 wt%) of Cu. Then we will travel with the sample to the SPring-8 synchrotron facility in Japan, where we will use 3DXRD microscopy to map out the internal microstructure as it changes during grain growth. If successful, this project will constitute the first-ever experimental validation of computational models for “ideal” grain growth at the individual grain boundary level!

![3DXRD microscopy investigation of an Al-1 wt% Mg sample. In 3D reconstructions of the (left) initial state and (middle) the same sample after annealing for 90 min at 400°C, the grain colors are indexed to the corresponding lattice orientation. (right) Strong peaks are observed in a (111) pole figure of the initial state, indicating the presence of preferred grain orientations (i.e. texture) in the sample.](image)

**Fig.1:** 3DXRD microscopy investigation of an Al-1 wt% Mg sample. In 3D reconstructions of the (left) initial state and (middle) the same sample after annealing for 90 min at 400°C, the grain colors are indexed to the corresponding lattice orientation. (right) Strong peaks are observed in a (111) pole figure of the initial state, indicating the presence of preferred grain orientations (i.e. texture) in the sample.

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