X-RAY DIFFRACTION

D6 PHASER – Benchtop Texture Analysis

Application Report 41

In addition to its atomic structure, the macroscopic morphology of a material significantly contributes to its properties. One of these properties is the degree of orientation of the crystallites which make up the sample. When the crystallites are strongly aligned, mechanical and electrical properties can be amplified. But at the same time, this alignment can ease fracture propagation leading to premature failure. The correct orientation, or texture, in a sample is essential in engineering it for a particular application.

As X-ray diffraction is sensitive to a material's atomic structure, it can be used to measure its degree of orientation. A perfect powder exhibits a completely random, or isotropic, texture. Most metal samples exhibit some degree of orientation due to mechanical deformation during processing. Coatings can exhibit exceptionally high degrees of orientation, even to the point of being a perfect single crystal.

To measure texture, a system capable of tilting the sample relative to the bisecting "Bragg" condition, when the incident and diffracted angle are equal, is required. In addition, the sample must then be rotated with intensity being collected as a function of rotation angle. This is accomplished in the D6 PHASER with the universal stage and phi rotation module. This stage can accommodate samples mounted in standard 51 mm holders or samples mounted in standard metallographic polishing mounts. In this application report, we present the results from a measurement collected on a piece of aluminum.

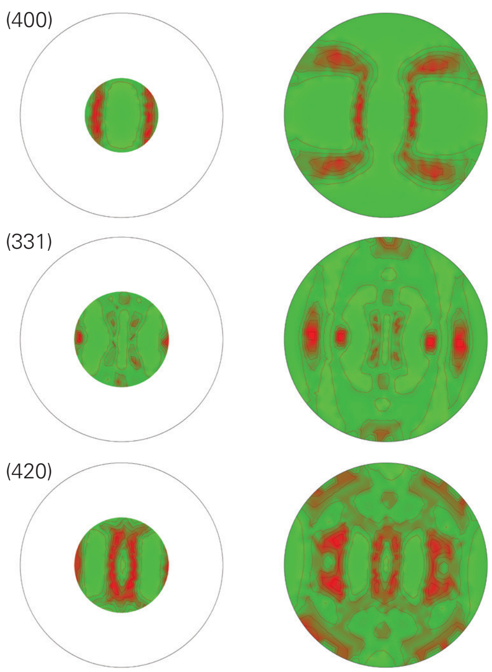

Figure 1
As measured and recalculated (400), (331) and (420) pole figures for the Al sample

Figure 2
Universal stage equipped with phi attachment

Measurement planning was carried out in the WIZARD. Using the graphic user interface, a series of phi scans were carried out for 3 Al reflections; 400, 331 and 420. The 3 pole figures were collected in approximately 30 minutes.

The data was then imported into DIFFRAC.TEXTURE where the phi scans were converted into pole figures, shown in Figure 1. This process occurs automatically using metadata from the measurements. Corrections for absorption related to the iso-inclination method are applied automatically. Auto-Indexing of the pole figures was carried out using the included materials database.

Fitting of the pole figures was accomplished with the component method. In this case, a single elliptical component with a monoclinic process symmetry was employed. Figure 1 shows the resulting recalculated pole figures. By having access to all 3 pole figures and using crystallographic symmetry, the peripheral areas are filled in. Figure 3 shows the resulting recalculated pole figures for the RD, TD and ND directions. A strong [111] texture is observed in rolling direction, with a [101] to [112] fiber observed in the normal direction and [111] to [101] fiber in the transverse direction.For a more comprehensive picture, the orientation distribution function, ODF, is shown in Figure 4.

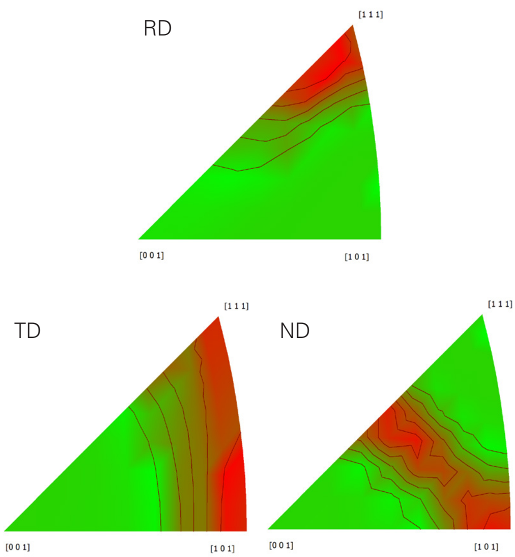

Figure 3
Inverse pole figures for the Al sample

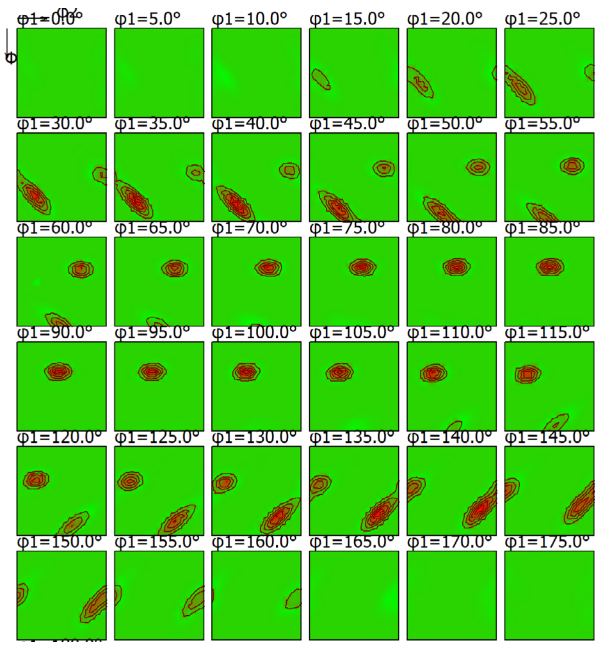

Figure 4
Orientation Distribution Function (ODF) for the Al sample

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