

## NOVEL X-RAY DIFFRACTION TECHNIQUE FOR STRAIN MEASUREMENTS USING AREA DETECTOR\*

Yong S. Chu, Derrick C. Mancini, Francesco de Carlo,  
Jonathan D. Almer, and Dean R. Haeffner.  
Advanced Photon Source, Argonne National Laboratory, IL.

Despite the readily available small x-ray beams ( $\sim 10\ \mu\text{m}$  with a pinhole or sub-micron with focusing optics) at synchrotron facilities, three-dimensional mapping of bulk strain with a spatial resolution commensurate to the beam size remains a challenging task. The greatest challenge is that most diffractometers have a “sphere of confusion” of about  $50\ \mu\text{m}$ , and a spatial resolution better than the sphere of confusion is hard to achieve without resorting to complicated correction methods. When the beam size approaches the average crystal grain size in the polycrystalline sample, a good powder diffraction pattern is difficult to obtain, and two or more circles of the diffractometer must be used to meet the diffracting conditions for the individual grains. Consequently, the measurements from most polycrystalline samples suffer from displacement errors due to rotations of the diffractometer circles.

In order to reduce the sphere of confusion, we propose to make strain measurements by varying the energy of the incident beam, which is possible using synchrotron radiation and a double-crystal monochromator. The advantage of this method is that only one sample rotation, in general, is needed to meet the diffracting condition. Consequently, the displacement error caused by the sample rotation can be easily kept below  $1\ \mu\text{m}$ , using a commercial rotary stage. In addition, the detection of the diffracted beam is carried out using an area detector mounted on two precision linear translation stages. The linear motions for detector offer two distinct advantages over the rotational motion adopted in the diffractometer. First, the translation motions are much easier to monitor and to correct, and consequently do not increase the sphere of confusion. Second, the diffracted beam can be tracked back to the diffracting crystal grain, to improve the spatial resolution and to increase the sensitivity of the strain measurements. The use of the area detector is crucial to obtain the tractability and the high-throughput data acquisition.

We present the results from initial experiments on single crystal Beryllium and polycrystalline aluminum samples and discuss data analysis methods. Our technique is ideally suited for the samples with relatively large crystal grain sizes ( $> 20\ \mu\text{m}$ ) which exhibit tractable diffracted pattern. The discussion will include the comparison of our technique with the conventional techniques, pointing out its unique advantages as well as its current limitations.

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