NEW X-RAY DIFFRACTION STATION AT NIST-BOULDER

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The Materials Reliability Division at NIST-Boulder has assembled a new multi-functional x-ray system. In recent years, we have studied different scientific and engineering problems. We needed the ability to work on development of microstructural characterization procedures of materials and methodology in x-ray diffraction, to test and apply these procedures to variety of materials, and solve practical problems that involve both structural and functional materials. All these applications often require very different experiment geometries, x-ray wavelengths, and detection techniques. Instead of acquiring several new diffractometers, we opted for a cost-effective solution; to design an instrument that is versatile enough for different uses and that goes beyond a common commercially available x-ray diffraction apparatus.

The new x-ray system comprises Cu-target and W-target microfocus x-ray sources, both collimating-polycapillary and focusing-monocapillary optics, an adjustable system of incident-beam and diffracted-beam slits, a kappa-geometry four-circle goniometer, a 2-D x-ray imager, and solid-state and proportional detectors. The apparatus is of a modular design, which allows for a quick change of diffraction optics, x-ray source, and geometry, depending on a particular application. Either quasiparallel or customary divergent Bragg-Brentano geometry can be utilized. The former is achieved by a collimating polycapillary optic. If high resolution is required, an incident-beam four-bounce Bartels monochromator and a flat analyzer crystal in the diffracted beam can be used. Specimen positioning can be achieved with better than 0.5 μm repeatability using an x-y-z stage. A focusing, tapered monocapillary is used for microdiffraction measurements and will be utilized for microfluorescence measurements in the future. The instrument is used for both energy-dispersive and angle-dispersive data collection. The 2-D x-ray imager is used for real-time Laue diffraction, strain and texture determination, and imaging. The W-target x-ray source is used for studies of bulk properties or subsurface layers in thick coatings, and for determination of local crystal ordering where measurements up to a high value of the wavevector Q are required. We will give several examples on recent science and engineering applications.