Abstract of a Miniature Auxiliary X-ray Diffraction Setup for a Synchrotron Beamline End Station

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This research presents the development and application of a miniature auxiliary X-ray diffraction (XRD) setup designed to be used in synchrotron beamline experiments. The primary focus is on the integration of the Advacam Minipix hybrid pixel detector into the ID20 beamline at the European Synchrotron Radiation Facility (ESRF). The objective was to create a compact, efficient XRD system that maintains high resolution and sensitivity while addressing the spatial and operational constraints of synchrotron environments. This approach allows for material studies under extreme conditions, such as high temperatures or pressures, within the same experimental configuration.

The study began with the preparation of tungsten trioxide (WO_3) and alumina (Al_2O_3) pellets. Calibration of the setup was performed using cerium dioxide (CeO_2) as a reference material, enabling precise determination of parameters such as sample-to-detector distance and angular resolution. The experiments compared data acquired using the Minipix detector with that of the Pilatus detector, a widely used standard in synchrotron facilities. Both detectors were evaluated based on key performance metrics, including diffraction peak sharpness, angular resolution, and sensitivity to temperature-induced structural changes. Measurements were conducted at photon energies near the tungsten L_3 absorption edge and across a range of temperatures from room temperature up to 600°C.

These results demonstrate that the Minipix detector, despite its smaller size, provides adequate resolution and accuracy for many XRD applications, particularly in constrained environments. The compact design facilitates integration into existing beamlines without significant modifications, making it highly adaptable for diverse experimental setups. While the Pilatus detector showed better performance in peak sharpness and resolution due to its larger pixel size and area, the Minipix detector effectively captured thermal expansion and phase transitions in the WO_3-Al_2O_3 samples. These observations validate the detector's suitability for monitoring structural changes in real time, a critical requirement for in situ studies. The study also provided recommendations for future improvements. For example, the integration of advanced image processing algorithms and optimized detector alignment could further enhance the system's performance.

Thus, the Minipix-based miniature XRD setup offers a promising solution for advanced structural characterization in environments where traditional systems are impractical. Its balance between portability, functionality, and reliability positions it as a valuable tool for synchrotron facilities, enabling high-quality diffraction studies under diverse experimental conditions. This work emphasizes the growing importance of compact and efficient technologies in the pursuit of material science research.