Development and application of high-resolution X-ray ptychographyusing total-reflection focusing mirrors

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Coherent diffractive imaging (CDI) is a lensless imaging technique based on the iterative phasing of diffraction amplitudes. Ptychography is a method of CDI that applies translational diversity, in which a sample is scanned across a coherent X-ray probe, the coherent diffraction pattern is observed at each beam position, and then images of both the sample and probe are reconstructed using iterative phase retrieval calculation. So far, we have developed high-resolution hard X-ray ptychography using total-reflection Kirkpatrick–Baez (KB) mirrors with elliptic shapes as the X-ray focusing device at SPring-8 [1] and have applied it to the structural visualization of various specimens in biology and materials science [2,3]. X-ray ptychography using multiple energies including the absorption edge of a specific element, which is often referred to as X-ray spectro-ptychography, enables us to visualize the chemical state of nanostructures buried within thick samples. Total-reflection mirror optics is convenient in multiple-energy hard X-ray experiments owing to its achromatic property. Recently, we have demonstrated the visualization of the cerium density and valence in micrometer-size platinum-supported cerium-zirconium oxide three-way catalyst particles at better than 50 nm resolution by hard X-ray spectro-ptychography [4]. A crucial issue towards achieving better spatial resolution is to improve the positional stability of the focused X-ray beam at each illumination. Advanced KB (AKB) mirrors consist of mirrors with elliptic and hyperbolic shapes, which can produce a more stable focusing beam since it is almost free from coma aberration [5]. Very recently, we have installed AKB mirrors in our X-ray ptychography apparatus. In my presentation, I also intend to report the experimental results of X-ray ptychography using the AKB mirrors.

References

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