Current status and future perspective of high-resolution X-ray microscope at Photon Factory

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Photon Factory (PF) has long provided brilliant X-ray light to a large number of researchers in various fields since the first beam in 1982. Synchrotron x rays are emitted over a wide range of energies and a wavelength can be selected with a monochromator. Spectral imaging, i.e., imaging with changing wavelength, enables us to map the amount, valence, and coordination number of elements in a sample. Therefore, the spectral imaging with an X-ray microscope at the synchrotron radiation facility has been widely used in geochemistry. PF provides some beamlines equipped with an X-ray microscopy system with various resolutions. In particular, the resolution of X-ray microscopy with a Fresnel zone plate (FZP) reaches several tens of nm and many researchers have used the system for chemical analyses.
X-ray microscopy with an FZP can be categorized into two main groups. The first one is the microscopy using an FZP as the collecting lens. Scanning transmission X-ray microscopy (STXM) is an archetypal method, in which the transmitted X-ray intensity is measured while scanning a sample by the beam with a size of several tens of nm focused by an FZP. This method corresponds to high-resolution X-ray absorption fine-structure (XAFS) imaging, which makes it possible to map the functional group of carbons and the valence state of transition metal ions. At PF, the beamline BL-19 always equipped with an STXM system was constructed in 2018 and has been open for users since May 2019. The second one is the microscopy with an FZP as the objective lens. This is full-field microscopy and is appropriate to obtain 3D images with computed tomography. Also, it is easy to switch the mode from the absorption-contrast imaging to other imaging such as refraction- and phase-contrast imaging. At PF, the beamline AR-NW2A makes it possible to conduct 3D mapping of valence state, and the development of the new zooming microscopy is in progress, in which the magnification and imaging modes are controllable.
In the presentation, the X-ray microscopy at PF and its future perspective will be introduced together with some applications.

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