Soft X-Ray Absorption Spectroscopy for Observing Chemical Processes in Solution

Department of Photo-Molecular Science
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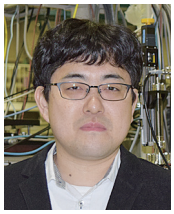

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Soft X-ray absorption spectroscopy (XAS) observes local structures of liquids with different light elements. We have developed liquid cells and devices with precise absorbance control and observed several chemical processes in solution by using *operando* XAS.[1)] In this year, we have developed an ultrathin liquid cell for XAS of liquids in the low-energy region below 200 eV.

1. Development of the Ultrathin Liquid Cell for XAS in the Low-Energy Region

XAS below 200 eV is important for chemical research since it includes K-edges of Li and B and L-edges of Si, P, S, and Cl. Recently, we have established soft X-ray transmission argon gas window that is effective from 60 to 240 eV.[2)] From soft X-ray transmission calculations, soft X-rays below 200 eV can transmit argon gas with the optical length of 2.6 mm. As shown in Figure 1, we have developed the ultrathin liquid cell that realize the 2.6 mm optical length of argon gas. XAS spectra of 2 M LiCl aqueous solution at Li K-edge and Cl L-edge were successfully obtained by using this liquid cell.

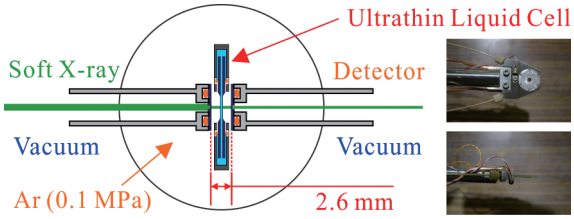

Figure 1. The schematic and photographs of the ultrathin liquid cell for XAS measurements of liquids in the low-energy region.

References

1) M. Nagasaka and N. Kosugi, *Chem. Lett.* **50**, 956–964 (2021).
2) M. Nagasaka, *J. Synchrotron Radiat.* **27**, 959–962 (2020).

Distribution of Biological Molecules in a Cell Nucleus Analyzed by 3-Dimensional Spectro-Microscopy

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Scanning transmission X-ray microscopy (STXM) is a promising tool to analyze 2-dimensional chemical state of a sample with high spatial resolution around 30 nm. We have been developing computer tomography (CT) for STXM to perform 3-dimensional spectro-microscopy.[1,2)] An isolated cell nucleus of a HeLa S3 cell was used as a sample. 50 datasets of 2-dimensional X-ray absorption spectra (2D XAS) of the sample around O K-edge was acquired with rotating the sample 3.6° each (180° rotation in total). 3D XAS of the cell nucleus is reconstructed from 50 datasets of 2D XAS. Distributions of DNA (red) and protein (green) are obtained by fitting reference spectra to the 3D XAS by single value decomposition algorithm (Figure 1). In cross sectional images, nucleoli and network structure of protein around them can be distinguished clearly. A goal of this research is to elucidate chemical and morphological change of biological molecules through a process of apoptosis.

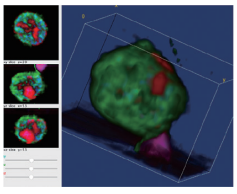

Figure 1. 3-dimensional distributions of DNA (red) and protein (green) in a HeLa S3 cell nucleus. Left panels are cross sectional images and a right panel is volume rendering image.

References

1) T. Ohigashi, A. Ito, K. Shinohara, S. Toné, Y. Inagaki, H. Yuzawa and N. Kosugi, *Microsc. Microanal.* **24**, 400–401 (2018).
2) T. Ohigashi, Y. Inagaki, A. Ito, K. Shinohara and N. Kosugi, *J. Phys.: Conf. Ser.* **849**, 012044 (2017).