Soft X-Ray Spectro-Microscopy and Spectro-Scattering for Life Science Research

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Scanning Transmission X-ray Microscopy: STXM is a mainstream of Soft X-ray Spectromicroscopy techniques due to that versatility since it is a photon-in & photon-out technique, which allow us to have some freedom of the sample specimen environments, like under magnetic field or wet condition. STXM utilizes the NEXAFS: Near Edge X-ray Absorption Fine Structure as the image contrast mechanism. When we study the soft materials ex. polymers, which consist of Carbon, Nitrogen, and Oxygen as a main element, through the NEXAFS spectral features we can obtain the chemical bonding/functional group information about the samples. Combined with the focused soft x-ray beam, about several tens of nanometer, we can achieve the chemical component mapping of the samples. If we look at the phase-separated polymer blend, we can speciate each domain with such high spatial resolution. Figure 1 shows an example of the chemical component map; blend of PS: Polystyrene, PMMA: Polymethylmethacrylate, and PVC: Polyvinylchloride mixed with nano-clays. The thin-section sample was prepared by a ultramicrotome (~100 nm thick).

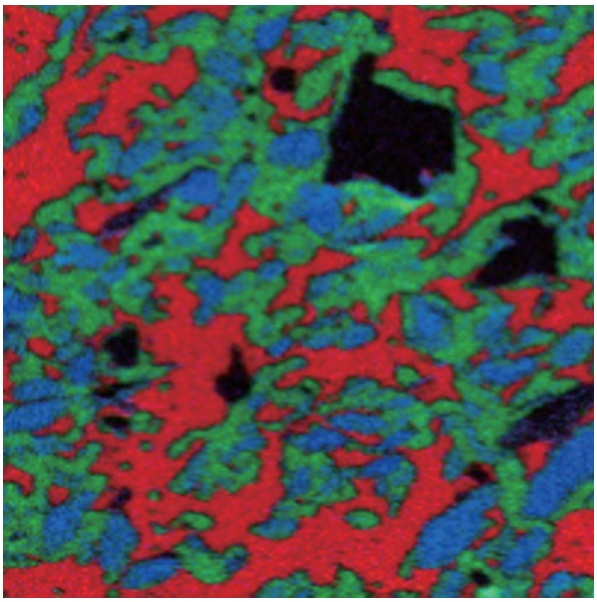

Figure 1. STXM chemical component map of the Polymer-Nano Clay Blend. R:PS, G: PMMA, B: PVC. The image size is 20 µm by 20 µm.

Before joined the IMS, at the Diamond Light Source in the UK, I had worked with my collaborators to study many environmental science cases to understand the interaction between minerals and organics including bacteria with using STXM in the Soft and Tender X-ray regimes.[2,3]

Since January 2023 I have been responsible to operate the BL4U STXM beamline at the UVSOR to maintain the user program including the industrial research, especially for the soft materials research like the radiation sensitive rubbery materials, which is difficult to study by the electron microscopy.

Another important mission is to plan the future UVSOR project,[1] which will be under the Research Center for Autonomous Functions by Tailor-made Photon Science. Toward the new approach using the combination of the low energy range photon from infrared to soft/tender x-rays, currently I am working with many scientists in the Life Science field to start the feasibility/trial studies using STXM and other soft x-ray techniques such as RSoXS: Resonant Soft X-ray Scattering, counterpart of STXM in reciprocal space. Figure 2 illustrates my concept to study the soft materials including biological samples using the three types of x-ray technique based on the NEXAFS spectroscopy.

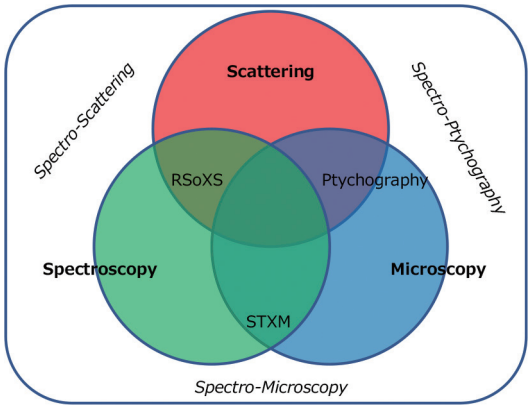

Figure 2. Concept of the NEXAFS based submicron chemical speciation methods.

References

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