LB-01

A Newly Developed Grating and Soft X-ray Spectrometer for Electron Probe Microanalyser and Transmission Electron Microscope - An Acquisition of the Li K Emission Spectrum with High-energy Resolution and Detection of Light Elements -

H. Takahashi*, N. Handa*, T. Murano*, M. Terauchi**, M. Koike***, T. Kawachi***, T. Imazono***, N. Hasegawa***, M. Koeda****, T. Nagano****, H. Sasai****, Y. Oue****, Z. Yonezawa**** and S. Kuramoto****

* EO Peripheral Component BU, JEOL Ltd., 1-2 Musashino, 3-chome, Akishima, Tokyo 196-8558, Japan.
Institute for Multidisciplinary Research for Advanced Materials, Tohoku University, Sendai 980-8577, Japan. * Japan Atomic Energy Agency 8-1 Umemidai, Kizu 619-0215, Japan. ****Optical Components BU Device Department, SHIMADZU Corp., 1, Nishinokyo-Kuwabaracho, Nakagyo-ku, Kyoto 604-8511, Japan.

Soft X-ray spectroscopy with high-energy resolution gives useful information of the chemical bonding states in compounds[1)]. Terauchi et al. recently reported a high-energy resolution of 0.2eV in the Al-L emission spectrum using the previously developed soft X-ray Emission spectrometer (SXES) with a transmission electron microscope[2)]. This spectrometer can design to detect the energy from 60 to 1200 eV. In order to progress this result, we had attempted to enhance the detection energy range. Especially to detect the Li-K emission spectrum, we are developing a spectrometer with newly designed aberration corrected gratings. The newly developed grating JS50XL can cover the X-ray energy range from 50 to 200 eV with high energy resolution. It actually means to detect emission lines of Li-K (54eV), Al-L (74eV), Si-L (100eV), B-K (180eV), higher order lines of C-K (279eV), N-K (392eV), O-K (525eV) and so on (Fig. 1). This SXES can be equipped not only with TEM, but also with EPMA. Fig. 2 shows external views of TEM JEM2010 and EPMA JXA-8100 equipped with the SXESs.

Moreover, we found out that attached EPMA with SXES has another strong feature that the X-ray intensity is in directly proportional to probe current. This feature is very useful for the trace element analysis. In the case of Li-K, Be-K and B-K emissions, the detection limits have been evaluated to be a few tens of ppm. For example trace boron analysis is expected to evaluate the newly developed materials quantitatively. This developed spectrometer is hopeful to observe chemical bonding state and trace element analysis in many kinds of fields. In this presentation we report the results for fundamental and actual samples.

This development is conducting as one project of Collaborative Development of Innovative Seeds (Practicability verification stage) by Japan Science and Technology Agency.

Reference

1) D. J. Fabian (editor) ; Soft X-ray Band Spectra and the Electronic Structure of Metals and Materials (Academic Press 1968)
2) M.Terauchi, M.Koike, K.Fukushima and A.Kimura *J. Electron Microscopy*, **59**, 252 (2010).

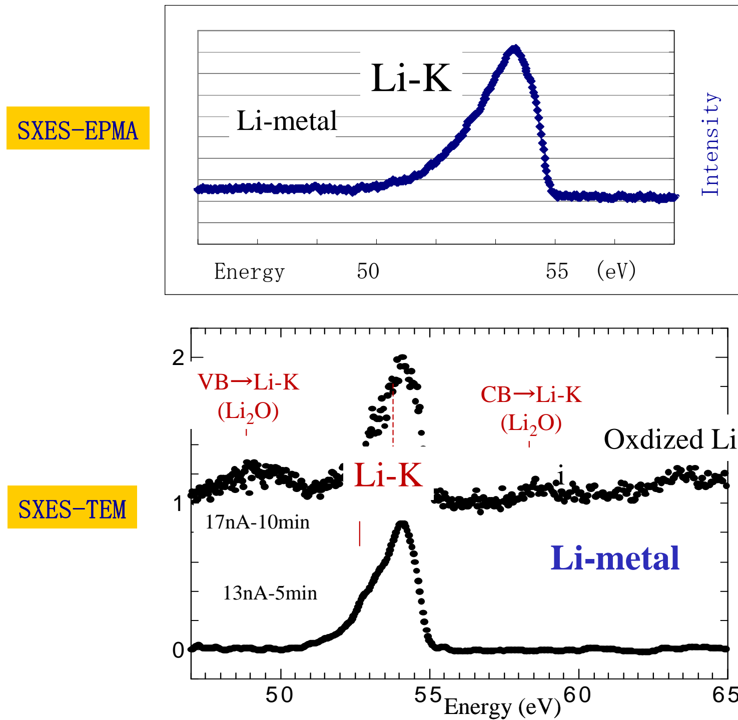

Fig. 1. Li-K emission spectra obtained by the developed soft X-ray spectrometers attached to EPMA and TEM.

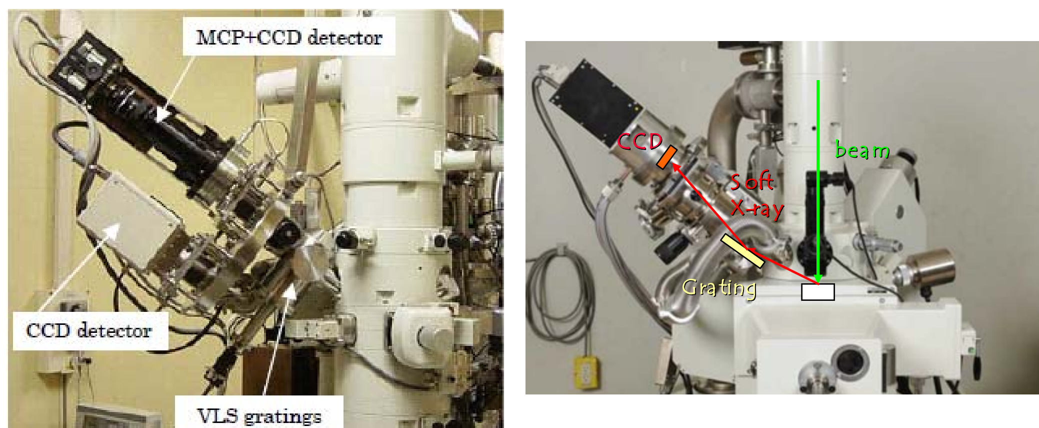

Fig. 2. An external view of SXES-TEM (JEM-2010) and SXES-EPMA (JXA-8200).