Electronic states analysis of Li metal by photoelectron spectroscopy

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Li ion battery has been used in our life. Li compounds occurred from discharge product of Li-ion battery or Li-air battery. Extensive measurements have revealed a chemical property of Li compounds. In addition, it is reported that Li_2O_2 changes to Li_2O by electron or soft x-ray irradiation (1, 2). From this result, it is possible to change the Li compounds on the Li metal surface by utilizing electron beam. Because of high activity of Li metal, its surface reacts with some contaminations like O, C and N in air. We think that Li metal changes to other Li compounds like Li_2O_2. With electron irradiation, we tried to measure the electronic state of modified Li metal by photoelectron spectroscopy (PES).

The PES measurement was carried out at the linearly polarized soft x-ray beamline BL-7 of SR center, Ritsumeikan University. The measurements were performed at room temperature and ultrahigh vacuum of ~ 10^{-7} Pa. The energy resolution was set to ~ 200 meV. We have used photon energy of 45 eV and 140 eV by photoelectron spectroscopy. The sample is Lithium metal plate from Aldrich. This sample was not exposed in air. The energy of electron beam was set to 1500 eV. The diameter of electron beam was set to ~ 1 mm.

The PES results before and after the electron irradiation are shown in Fig. 1. After the electron irradiation, contamination peaks appeared around 25 eV [Fig. 1(a)]. This method could not remove contaminations. As for the Li 1*s* core-level spectra, the Li 1*s* peak was divided to two peaks after the electron irradiation. The peak positions were 56 eV and 54.9 eV [Fig. 1(b)]. The binding energy of this lower binding energy side peak was lower than that of other Li compounds. Moreover, Fermi edge occurred after the electron irradiation [Fig. 1(c),(d)]. We think that this Fermi edge was related to the lower binding energy side peak. Therefore, the Li compound formed after the electron irradiation was metallic. However, we think that this Fermi edge is not because of Li metal. Because, the contamination peaks appeared around 25 eV. Since the compound produced by the discharge process in Li-O system, i.e., Li_3O_4 has metallic property (3), we think that this compound was produced by the electron irradiation with the residual gas.

We tried to measure the electronic state of Li metal by electron irradiation. The Fermi edge occurred by electron irradiation and Li 1*s* peak was divided to two peaks, maybe due to the formation of a metallic Li compound.

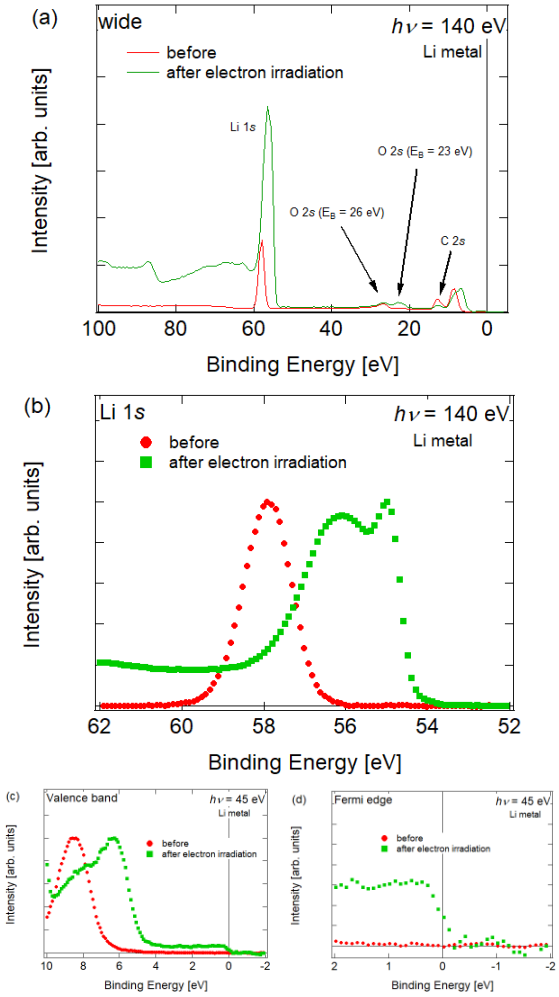

Fig. 1 (a)Wide spectra and (b)Li 1s core-level spectra and (c)valence band spectra (d) near Fermi edge spectra of Li before and after electron irradiation.

References

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