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EDS of Lithium Materials from 0.5 to 30 keV

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This paper will present state of the art results of EDS and EELS of Lithium based materials acquired with the SU-9000 dedicated STEM that has EELS capabilities and the Extreme EDS system from Oxford Scientific that can detect the K_α line of Lithium [1]. Lithium can be detected with EELS in this microscope [2] but this is not the focus of this paper that will concentrate on EDS of Lithium. The SU-9000 has a resolution of 0,22 nm in bright field STEM without aberration correctors and it allows lattice imaging.

Figure 1 shows an EDS spectra of the Li K_α line acquired at 1 keV for a LiCl specimen after 1s, 20 s and 30 s of acquisition time. Initially, no X-Rays of Li are emitted because the L electron is bounded to Cl that is the element with the second highest electronegativity. Because of electron beam heating, Cl evaporates, and the amount of Cl intensity is decreased at 20 s. At 30 s, there is no more Cl. Therefore, Li becomes metallic. Then, the intensity of Li K_α line is finally observed. More data on several compounds will be presented.

Figure 2 shows the percentage of X-Ray generated by the Auger Electrons the K_α line of Lithium in LiCl and Li_3N for a 100 nm thin foil as a function of accelerating voltage simulated by the Monte Carlo method. The details of the Monte Carlo simulations of X-Ray generated by Auger electrons are given by Gauvin [3]. For Li_3N, the x-ray for Li is generated by the 0.38 keV KLL Auger electron of N and for LiCl, Li x-rays are generated by the 2.25 keV KLL Auger electron of Cl. Since the ionization energy of the K shell is around 0.055 keV (in fact is varies from materials to materials because of solid state effects), the Auger electrons has enough energy to generate an amount of X-Ray in the 0.5 to 3 % range. The emitted percentage is smaller because of x-ray absorption. Since Li based cathode materials can have several elements, fraction of emitted x-rays around 5 to 10 % from Auger electrons is likely and detailed Monte Carlo simulations of compounds will be presented to investigate this, as well as the effect of Fast Secondary electrons (FSE)on X-Ray emission [3]. Clearly, the effect of Auger electrons becomes negligeable at low beam energy as well as for the FSE [3].

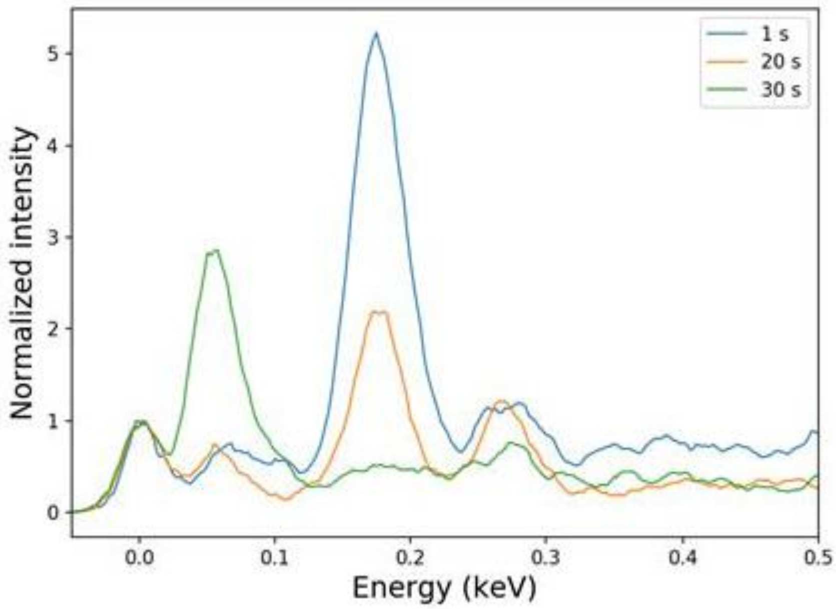

Figure 1. EDS spectra of Li acquired at 1 keV for a LiCl specimen after 1s, 20 s and 30 s of acquisition time. The Li Ka line is at 0.055 keV and the L lines of Cl are at 0.185 keV.

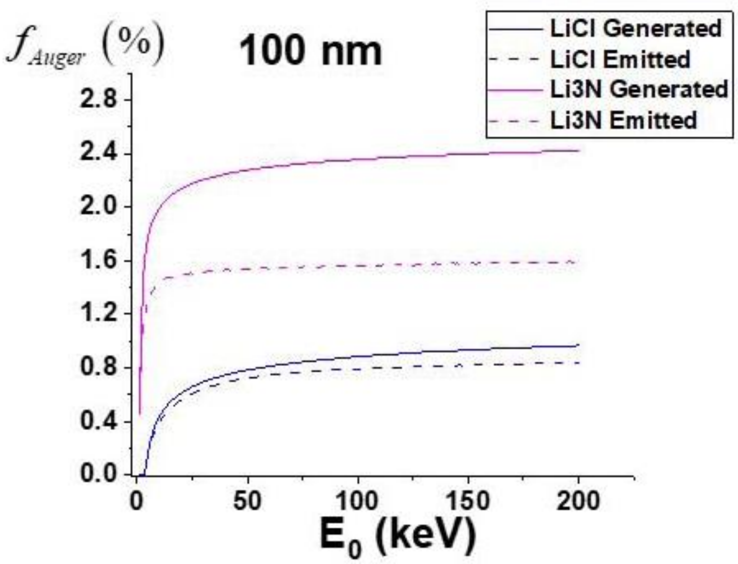

Figure 2. Percentage of X-Ray generated by the Auger Electrons the Kα line of Lithium in LiCl and Li3N for a 100 nm thin foil as a function of accelerating voltage. For Li3N, the x-ray for Li is generated by the 0.38 keV KLL Auger electron of N and for LiCl, Li x-rays are generated by the 2.25 keV KLL Auger electron of Cl.

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