Mo L X-rays Relative Yield Ion Energy Dependence

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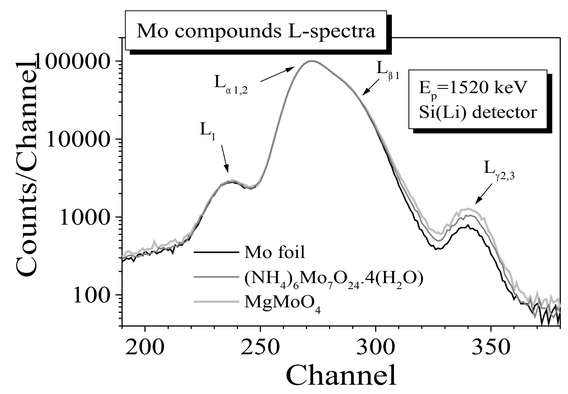
Abstract

In the present work, Mo L_{α}, $L_{\beta 3,4}$ and $L_{\beta 2,15}$-spectra were obtained using the high resolution Johansson type crystal spectrometer at the Micro Analytical Center of the Josef Stefan Institute at Ljubljana, and Mo, $MgMoO_4$ and $(NH_4)_6Mo_7O_{24}.4(H_2O)$ L-spectra were obtained using a Si(Li) detector of ITN at Lisbon, and several proton beam energies between 0.4 and 1.5 MeV (which correspond to reduced velocities values between 0.7 and 1.4). Spectra deconvolution, whenever required, used a Bayesian Inference process to reduce errors due to spectra fitting. In the case of the Mo foil and the $MgMoO_4$ samples, ultra pure material were used to avoid any possible target contamination. In the case of $(NH_4)_6Mo_7O_{24}.4(H_2O)$ this was not possible so P.A. material was used. In this communication observed $L_{\beta 2,15}/L_{\alpha 1}$ and $L_{\beta 2,15}/L_{\beta 3,4}$ ratio variability presented but unexplained in a previous work [2] will be discussed based on new evidence and comparison of data relative to different chemical species. Other Mo intensity ratio variation patterns will also be presented and discussed.

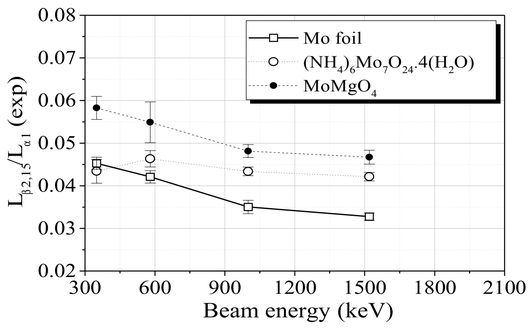
Materials and Methods

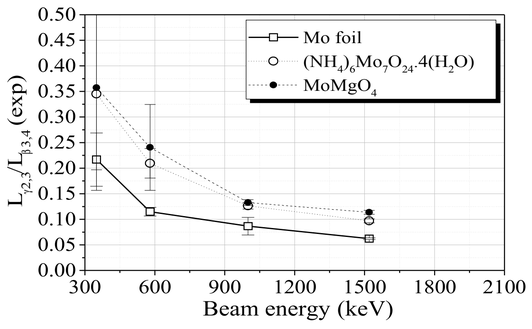
- Mo compounds: Mo foil, $MgMoO_4$ and $(NH_4)_6Mo_7O_{24}.4(H_2O)$
- Intensity ratio $L_{\beta 2,15}/L_{\beta 3,4}$ for High resolution detector and for Si(Li) detector
- $L_{\alpha 1,2}$ spectra for a pure Mo foil using high resolution
- Intensity ratios $L_{\gamma 2,3}/L_{\beta 3,4}$, $L_{\gamma 1}/L_{\beta 1}$ and $L_{\beta 2,15}/L_{\alpha 1}$ corresponding to L3, L2 and L1 sub-shell, respectively.
- Fitting process using the DT2 code

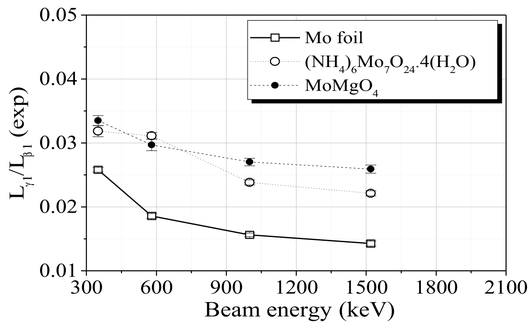


Mo L X-ray spectra colected with Si(Li)

Intensity ratios for L3,L2 and L1 sub-shell transitions

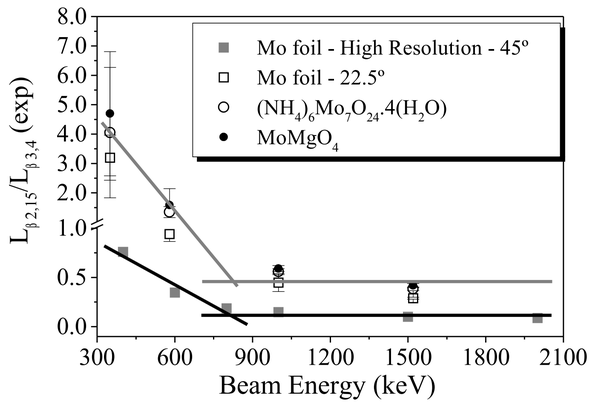






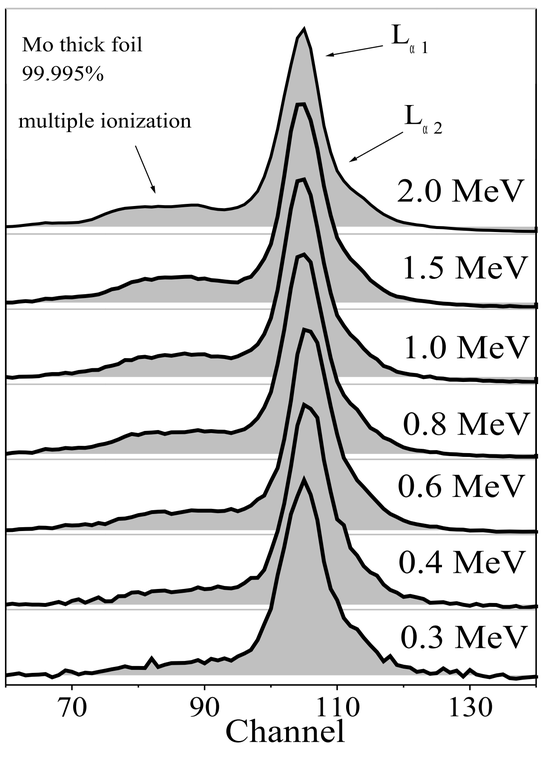
The dependence of intensity ratios with incident ion beam energy, already observed in the L1 sub-shell [2], were also observed for L2 and L3 sub-shell.
The values of the ratio do not always decrease with the increasing of the ion beam energy, as would be expected from the variation of autoabsorption.

$L_{\beta 2,15}/L_{\beta 3,4}$ Intensity ratio Si(Li) and High resolution



The curve obtained for high resolution when compared with the curve for Si(Li) detector reflects the differences in the incident angle.
This intensity ratio change its behavior of the ratio near to 900keV, confirming the results seen with high resolution spectrometry and discussed in a previous work

Multiple ionization structure grows with increase of ion beam energy.
This contribution of multiple-ionization appears to became constant above an ion beam energy 1000 keV.



Conclusions

It was shown that the intensity ratio $L_{\beta 2,15}/L_{\beta 3,4}$, obtained using high resolution and the Si(Li) detector for a pure Mo 1mm thick foil lead to the same curve type. Furthermore, this intensity ratio presents a point, where there is a change in behavior of the ratio, already seen in previous work.
The $L_{\alpha 1,2}$ spectra collected using high resolution shows that the multiple ionization structure grows with the increase of ion beam energy up to an energy identical to the crossing slopes energy for the line ratios variations. Above this ion beam energy the multiple ionization structure remains essencialy constant. We are thus lead to conclude that multiconfiguration effects are behind this course effect reported here and also in previous works [1,2].

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