ISSRNS 2010: Abstracts / Synchrotron Radiation in Natural Science Vol. 9, No. 1 – 2 (2010)

LIFETIME BROADENING-FREE L_3 X-RAY ABSORPTION SPECTRUM OF Xe MEASURED BY X-RAY RESONANT INEASLTIC SCATTERING

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Keywords: high-resolution spectroscopy, x-ray resonant inelastic scattering, beamline

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The one of the most useful tools for studying the density of unoccupied electronic states of an atom is the x-ray absorption near edge structure (XANES) technique. However, in many cases the resolution of the XANES spectroscopy is limited by the natural broadening originating from the lifetime of atomic states. The x-ray resonant inelastic scattering (RIXS) represents an alternative technique to probe both occupied and unoccupied electronic states of an atom. The RIXS is a photon-in photon-out second order process and therefore is characterized by low scattering probabilities. However, the energy widths of the RIXS spectra depend only on the experimental resolution and not on the natural width of the initial core-hole state. For this reason, the RIXS spectroscopy reveal much more details and features that could not be observed by means x-ray absorption spectroscopy [1,2].

Nowadays, the third generation synchrotron light source combined with modern focusing type crystal spectrometer exhibits sufficient experimental energy resolution and efficiency needed to record high quality RIXS spectra well below the absorption edge thus yielding the possibility to extract the absorption spectrum with the subnatural line width resolution. For this work, a Johansson type crystal spectrometer of J. Stefan Institute was coupled to the ID26 beamline of the ESRF synchrotron. We have recorded the L_3-$N_{4,5}$ RIXS spectrum of Xe well below the L_3 absorption edge (4770 eV) with relatively small statistical uncertainty. The overall energy resolution was ~1 eV which is below the width given by the Xe L3 hole lifetime (2.82 eV). The data analysis based on the Kramers-Heisenberg approach was employed to deduce the Xe L_3 absorption edge with the subnatural energy resolution from the measured RIXS spectrum. Energy positions and relative emission rates *f0* if for $[2p_{3/2}]$nl inner-hole excited states are extracted and compared to the calculated values.

References

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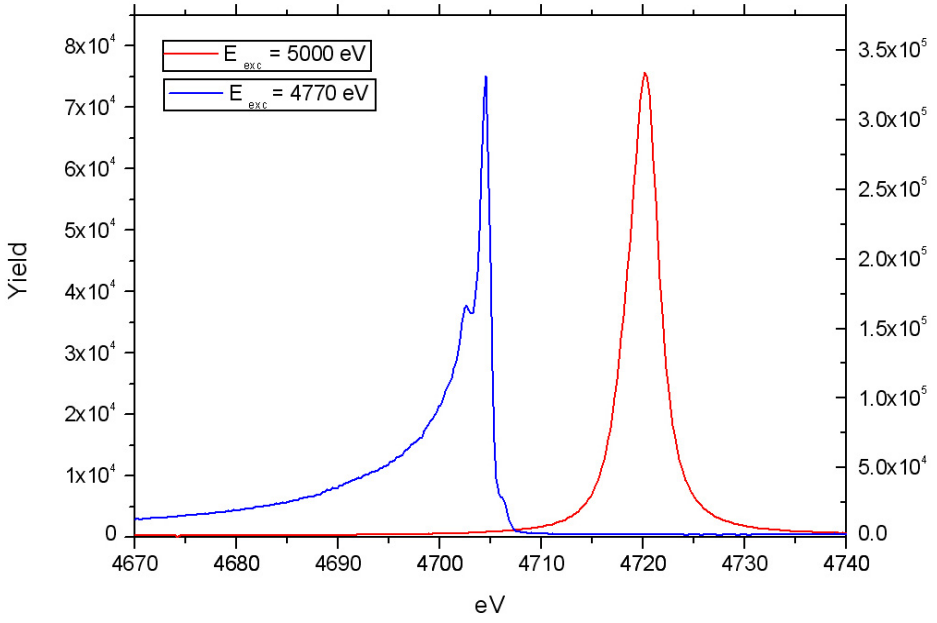

Figure 1. High resolution Xe L_3-$N_{4,5}$ x-ray emission line excited above (5000 eV) and below (4770 eV) the L_3 absorption edge.