

A High-Resolution 2p→3d Photoexcitation Spectrum of Atomic Mn

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1 Introduction

The 2p→3d photoexcitation of free 3d transition metal atoms from Sc to Cu has received much interest not only for recognizing electron correlation in atoms but also for understanding solid-state effects in various kinds of materials including these atoms. Photoabsorption and photoelectron studies reported up to 2006 have been reviewed by Martins *et al* [1]. However, charge separated photoion-yield study has been reported only for Sc atom. In the present study, photoabsorption spectrum of free Mn atoms in the same spectral region was measured using total photoion-yield method with an energy resolution higher than in the previous measurement [2]. In addition, the ion time-of-flight (TOF) spectrum was measured in list mode, which allows to make three-dimensional plot of the TOF spectrum. By analyzing these spectra, we can consider the decay processes from the 2p→3d excited states to final production of multiply-charged ions.

2 Experiment

Our experiment was carried out at the undulator beamline BL-2C [3] in Photon Factory. An ion TOF spectrometer combined with a metallic oven of electron bombardment type was used. The monochromatized synchrotron radiation beam intersects the Mn-atom beam from the oven at right angles. Mn ions produced in the interaction section were pushed into the TOF tube with periodic positive pulses and measured by a multichannel plate and a subsequent electronics. With this apparatus, three types of measurement can be made: total photoion yield spectrum, TOF mass spectrum at a given photon energy, and TOF spectrum in the list mode.

3 Results and Discussion

The present total photoion-yield spectrum shown in Fig.1, which is almost the same as the photoabsorption spectrum, is compared with the spectrum calculated tentatively using GRASP92 and REOS codes. Further calculations are under way to obtain more satisfactory agreement. Figure 2 shows TOF spectrum measured in the list mode. From this spectrum, charge-separated photoion-yield spectra and charge state distribution were obtained as a function of photon energy. It was found that from M^+ to Mn^{6+} ions are formed from the 2p→3d excited states. Auger cascade processes from these excited states to final ion production are under consideration by referring to an energy-level diagram calculated using GRASP92 code.

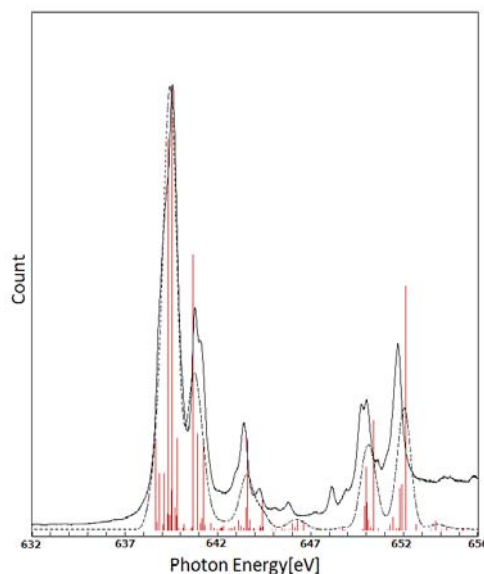


Figure 1. Total photoion-yield spectrum. Also shown is a tentative theoretical spectrum (dotted curve) convoluted from oscillator strengths (red vertical lines) calculated using GRASP92 and REOS codes.

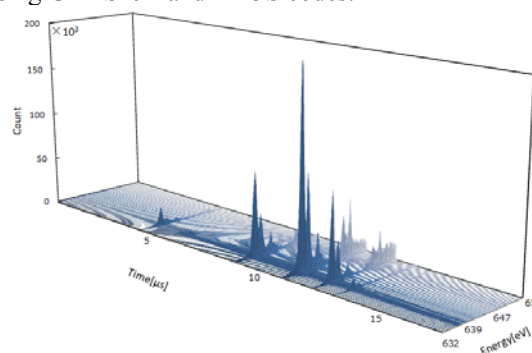


Figure 2. Ion TOF spectrum measured in the list mode. From Mn^+ ion (at 4.6 μs) to Mn^{6+} ions (at 13.7 μs) are observed, with Mn^{3+} ions being strongest.

References

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