HIGH-RESOLUTION SOFT X-RAY MEASUREMENTS IN 2.3keV/u $^{15}N^{7+}$ IONS TRANSMITTED THROUGH A MICROCAPILLARY

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When a slow highly charged ion approaches a solid surface, it resonantly captures electrons from the solid valence band into an excited state of the ion. X-rays emitted from 2.3keV/u $^{15}N^{7+}$ ions transmitted through a thin Ni microcapillary target were measured with a high-resolution soft X-ray spectrometer[1, 2)]. The target was $\sim$1mm^2 in area with a thickness of $\sim$1 μm and had a multitude of straight holes $\sim$200nm in diameter[1)]. The spectrometer consists of an entrance slit, a concave grating and a back-illuminated CCD[2)]. The energy resolution and the energy accuracy were 3.1eV (FWHM) at 500eV and 0.5eV at 500eV, respectively. The time window was 37ps for a slit width of 25 μm and 2.3 keV/u ions. The present experiment was performed using 14.5GHz Caprice-type electron cyclotron resonance (ECR) ion source at RIKEN[3)].

X-ray spectra were observed at the downstream surface of the target (T=0ns), 0.35mm downstream (T=0.52ns), and 2.75mm downstream (T=4.10ns). Figure 1 shows the spectrum with four peaks at the target immediately downstream. Five peaks were observed, at 625.1 $\pm$ 0.7eV, 593.0 $\pm$ 0.7eV, 500.3 $\pm$ 0.5eV, 430.5 $\pm$ 0.4eV, and 425.8 $\pm$ 0.4eV. According to reference data, the five peaks are attributed to core electronic transitions of H-like[4)] 4p $^2P_{3/2}$ $\rightarrow$ 1s $^2S_{1/2}$ (625.3eV), 3p $^2P_{3/2}$ $\rightarrow$ 1s $^2S_{1/2}$ (592.9eV), 2p $^2P_{3/2,\ 1/2}$ $\rightarrow$ 1s $^2S_{1/2}$ (500.3eV, 500.2eV), He-like[5)] 1s2p $^1P_1$ $\rightarrow$ 1s^2 $^1S_0$ (430.7eV), and 1s2p $^3P_1$ $\rightarrow$ 1s^2 $^1S_0$ (426.3eV). The observed transitions with their core configurations are summarized in Table 1.

Figure 2 shows the X-ray intensities for transitions from 2p $^2P_{3/2,\ 1/2}$, 1s2p $^1P_1$, and $^3P_1$ states as a function of the time after the ion leaves the microcapillary target. This result provides information on the decay process related to outer shells.

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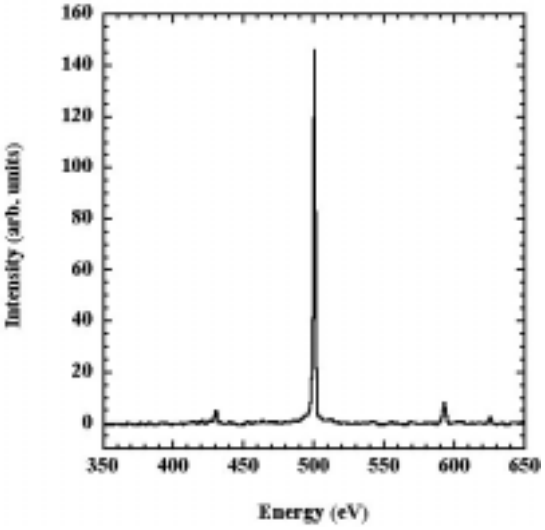

Fig. 1. Spectrum of *K* X-rays measured with the spectrometer immediately downstream of the target (*T*=0ns), for 2.3keV/u $^{15}N^{7+}$ ions transmitted through a Ni microcapillary. The spectrum has four peaks, at 625.1 ± 0.7eV, 593.0 ± 0.7eV, 500.3±0.5eV, and 430.5±0.4eV.

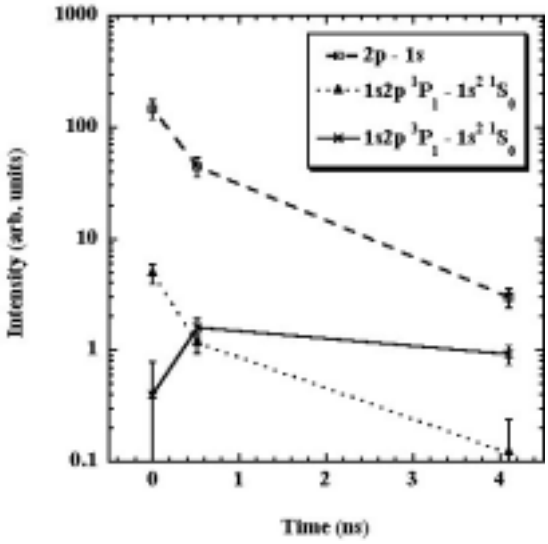

Fig. 2. X-ray decays of the 2p $^2P_{3/2, 1/2}$, 1s2p $^1P_1$, and $^3P_1$. The error bars, except for the ^3P first and ^1P last points, are mainly due to the beam stability

Table 1. Electronic core configurations.

Experiment	Ref. data	Core configuration	Term
625.1±0.7eV	625.3eV[4)]	4p → 1s	$^2P_{3/2}$ → $^2S_{1/2}$
593.0±0.7eV	592.9eV[4)]	3p → 1s	$^2P_{3/2}$ → $^2S_{1/2}$
500.3±0.5eV	500.3eV[4)] 500.2eV[4)]	2p → 1s	$^2P_{3/2}$ → $^2S_{1/2}$ $^2P_{1/2}$ → $^2S_{1/2}$
430.5±0.4eV	430.7eV[5)]	1s2p → $1s^2$	$^1P_1$ → $^1S_0$
425.8±0.4eV	426.3eV[5)]	1s2p → $1s^2$	$^3P_1$ → $^1S_0$

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