§25. X-ray Spectrum Emitted from Argon Periodically Puffed Plasma in LHD

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X-ray emissions from medium-Z argon puffed plasma has been measured with an assembly of x-ray pulse-height analyzer (PHA) in Large Helical Device (LHD)[1]. The assembly is equipped with three detectors to measure x-ray spectra with three vertical chords of 300 mm intervals[1]. As an x-ray detector, a 5-mm-thick-solid-state-lithium-drift-silicon sensor cooled by liquid nitrogen has been used with the PHA. The PHA has 1024 ch for x-ray energy. The PHA also has 2048 frames. The frame rate is 200 Hz. Then, 2048 spectra are continuously measured in an accumulation time of 10.24 s.

The argon gas has been puffed into LHD plasma to investigate the argon behavior. In this article, rapidly reported the first experimental results on x-ray spectrum measurement for periodic argon gas puffing in LHD.

In the present experiment, the electron temperature at the plasma center is more than 3.0 keV. The puffing has been carried out, while the electron density and temperature have been approximately constant.

Figure 1 shows a measured spectrum. Respective line is an x-ray emission from each impurity. The argon K_α line appears at an energy of E = 3.2 keV. Below the energy, the x-rays are fully absorbed with a beryllium filter. Continuum is another x-ray emission due to electrons. In the present experiment the continuum is rather comparable with the lines. Then, the continuum is taken into account in the estimation of the respective line intensity.

Figure 2 shows the time-evolution of the argon K_α intensity. In the present research, three times of argon puffs have been carried out in each shot. The time intervals between the puffs are equal to 0.5 s. The respective pulse length is 5.94 ms. It seems that the argon response against respective puff is identical, since the experimental result approximately reflect only the phase shift of the respective puff. Then, it is suggested from the first puff that the argon exponentially decays in a time of 0.5 s.

In the present research the time response of argon is also being investigated at another density case.

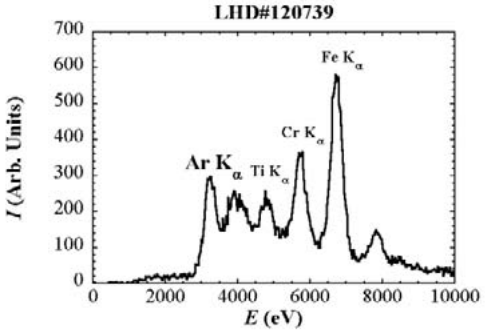

FIG.1. X-ray spectra measured with the PHA in which x-ray sensor sees the plasma center. The spectra are fully integrated in the accumulation time. The horizontal and vertical axes represent the x-ray energy and the intensity reduced with a 1-mm-thick-beryllium filter, respectively. The lines are emitted from argon, titanium, chromium, and iron, respectively. The transition metals come from the vacuum wall of LHD as intrinsic impurities. Continuum is the emission due to electrons.

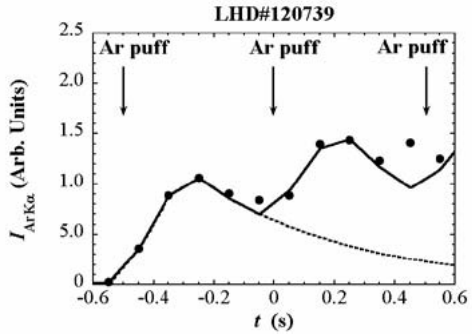

FIG.2. Time-evolution of the argon K_α intensity obtained at an electron density of $n_e = 1.5\times10^{19}$ m^{-3}. The horizontal and vertical axes represent the relative time and the intensity, respectively. The gas puffs are periodically carried out at times of t = -0.5, 0.0, and +0.5, respectively. Filled circles, broken, and solid lines represent the experimental results from the periodic puff, an assumed intensity for the first puff, the intensity summed over the three assumptions, respectively. The three assumptions are the same except for phase shifts of ±0.0 s, +0.5 s, and +1.0 s. Before secondary puff, the experimental results and the assumed intensity are approximately identical.

1) Muto, S., *et al.* : Rev.Sci.Instrum.**72**(2001),pp.1206-9.