Development of the Thomson scattering measurement system for cascade arc device with indirectly heated hollow cathode

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We have developed a Thomson scattering measurement system for the cascade arc discharge device designed for the plasma window (PW) application study. PW is a plasma application technique that separates a high-pressure (10-100 kPa) and vacuum (~1 Pa) environment using plasma [1,2]. The plasma inside the channel of the PW heats the neutral gas to reduce the flow conductance. The flow inside the channel is considerably suppressed due to the decrease in the conductance, resulting in the high-pressure difference between the gas inlet and outlet of the PW. These features enable the PW to transmit the soft-X rays, electron, and ion beams into the atmospheric pressure side without drastic beam attenuation/scattering. Since the plasma thermal energy is the essential parameter for the pressure separation capability of PW, we installed the Thomson scattering measurement system to observe the electron density and temperature within the anode and cathode of the PW. A schematic diagram of the cascade arc device (PW) and the Thomson scattering measurement system is shown in Figure **1**. Frequency-doubled Nd:YAG laser (532 nm, 200 mJ, 8 ns) was employed for the probe laser. The scattered light was fed to the triple grating spectrometer. The notch filter between the first and second grating eliminated the stray light, realizing a sufficiently high signal-to-noise ratio. The Thomson scattering measurement system successfully obtained the electron density and temperature of the cascade arc plasma at 2 cm downstream from the tip of the cathode. We will discuss the detail of the measurement system and the analysis result on the obtained data.

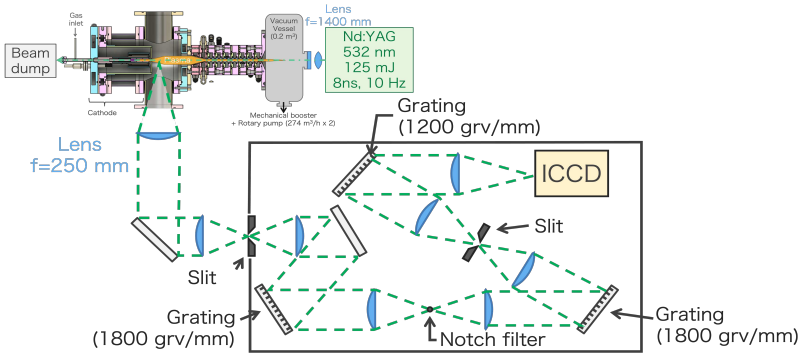

Figure 1 Schematic diagram of the cascade arc device and the Thomson scattering measurement system with a triple grating spectrometer.

[1] K. Yamasaki, *et al.*, RSI **93**(5) (2022) [2] K. Yamasaki, *et al.*, JJAP **62** (2023)

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