Influence of the UV wavelengths on photoemission-induced atmospheric pressure DC gas discharge

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In our previous work, photoemission-induced atmospheric pressure gas discharge was stably generated by back-illuminating a gold photocathode with an excimer lamp (λ: 172 nm) [1]. The previous study also reported the utilization of an excimer lamp for assisting low-pressure plasma generation [2]. However, the application of this lamp is rather challenging due to zone-producing. In this study, less hazardous UV light with wavelengths of 207 nm and 222 nm were employed for back-irradiating the photocathode. Gas discharge generation was performed using an experimental setup shown in Figure 1. A 9 nm gold thin film deposited on the quartz glass as a photocathode, then argon and air were employed as discharge gas.

Figure 2 shows the I-V characteristic of photoemission-induced gas discharge using 172 nm, 207 nm, and 222 nm UV lights for argon and air. A stable and continuous gas discharge was achieved using all the UV sources. As the voltage increase, the current increases then it seems nearly saturated and followed by an exponential increment. However, different UV wavelengths and types of gas discharge resulted in different current values. The almost saturated current value, so-described as photocurrent I_0, for 207 nm and 222 nm was lower compared to 172 nm for both argon and air. In the case of argon, the current for 222 nm was higher than 207 nm. On the other hand, the current for 222 nm and 207 nm was almost similar in air. This result suggests that the value of I_0 is not only affected by the emitted electron from the photocathode but also ozone generation and molecular excitation by UV light in the space of the discharge cell.

In a comparison of gas discharge (Figure 2 (a) and (b)), to obtain a similar value of current, it required higher voltage in air rather than in argon for all wavelengths of UV light. It might be due to low-energy electrons in air have a high probability of becoming attached to oxygen. Thus, it can hinder their acceleration and ionization process.

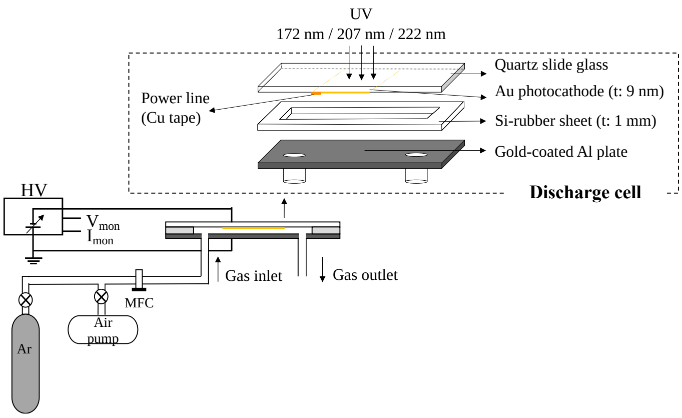

Figure 1. Experimental setup of photoemission-induced atmospheric gas discharge

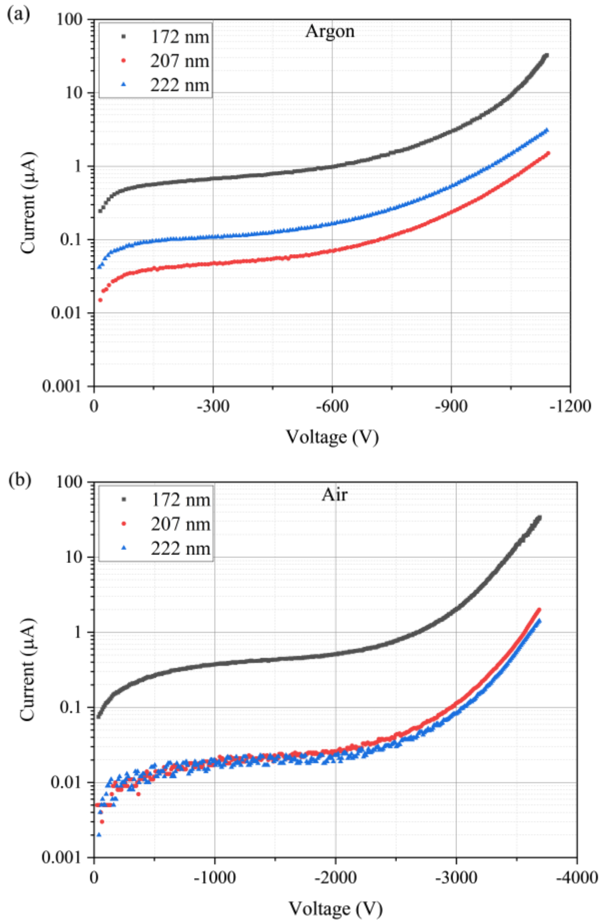

Figure 2. I-V characteristic of photoemission-induced gas discharge in different wavelengths of UV light for (a) argon (b) air

References:

[1] S. W. Fitriani, H. Yajima, and A. Hatta, Appl. Phys. Express, **15**, 116001 (2022).

[2] Y. Ohtomo, S. Ogawa, and Y. Takakuwa, Surf, Interfaces Anal. **44**, 670 (2012).