4Cp08

高速度測定システムを用いた多相交流アークの温度特性測定
Investigation of Temperature Characteristics in Multiphase AC Arc by High-speed Visualization

大熊 崇文[1,2], 丸山 大貴[1], 田中 学[1], 永井 久雄[2], 小岩崎 剛[2], 渡辺 隆行[1]
Takafumi Okuma[1,2], Hiroki Maruyama[1], Manabu Tanaka[1], Hisao Nagai[2], Takeshi Koiwasaki[2], and Takayuki Watanabe[1]

[1]九州大学, [2]パナソニック株式会社
[1]Kyushu University, [2]Panasonic Corporation

1. Introduction

A multiphase AC arc is expected to be a promising heat source for mass producing functional materials because it possesses many advantages such as high energy efficiency, large plasma volume, easy to scale-up, and low equipment cost. Characteristics of thermal plasmas such as temperature distribution and arc behavior must be investigated to realize thermal plasma system as industrial technology. Recent studies on multiphase AC arc have revealed the characteristics of multiphase AC arc, such as arc fluctuation, arc temperature [1], and electrode phenomena [2], utilizing high-speed visualization. The purpose of this study is to clarify the influence of the electrode arrangement and phase number of AC arc generation on the temperature characteristics. The obtained results gives design requirements of the system for practical application.

2. Experiment

The schematic diagram of multiphase AC arc generator with measurement system and plane view of electrode arrangement are shown in Fig. 1. Arc is generated between the electrodes by supplied AC power with different phases. The arc behavior and temperature were investigated by the observation system consisting of a high-speed video camera and band-pass filters. The temperature was conducted by Boltzmann plot method.

Two different phase-number conditions of AC voltage were compared. The waveform of the voltage is shown in Fig. 2 for 12-phase and double-6-phase AC arc generations. The applied voltage of 12-phase AC arc has AC phase shifted of 30 deg to the adjacent electrode. The double-6-phase AC arc was generated by the same phase voltage to the adjacent electrodes. The working pressure of arc was set at 101 kPa of Ar gas and the current for each electrode was fixed at 150 A.

3. Results and Discussion

The arc existence probabilities are shown in Fig. 3. The existence probability was defined as the ratio of the time during which the arc existed to total time period of AC cycle. Therefore, the value of unity means that the arc always exists. The arc exists relatively uniformly, and the arc always exists in the center region at 12-phase AC arc. In contrast, the arc exists at a high probability in the outer circumference and hardly exists in the center region at double-6-phase AC arc. This is due to the difference in the interaction between adjacent arcs. In the double-6-phase AC arc, each electrode is adjacent to an electrode with a mechanical angle difference of 30 deg and an AC phase difference of 60 deg. Therefore, the arc generation is susceptible to adjacent arc since the voltage difference between adjacent electrodes is larger than 12-phase AC arc. The 12-phase AC arc with a relatively uniform arc region are suitable to realize a reliable plasma process.

References

[1] T. Okuma, et al., J. Fluid Sci. Technol., **13**(4) 18-00119 (2018).
[2] T. Hashizume, et al., Jpn. J. Appl. Phys. **56,** 056101 (2017).

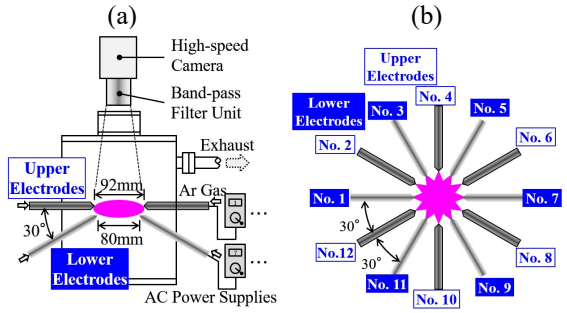

Fig. 1. (a) Schematic diagram of the multiphase AC arc generator with measurement system and (b) plane view of electrode arrangement.

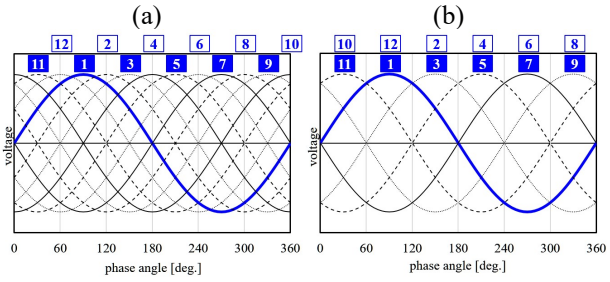

Fig. 2. Voltage waveform to each electrode in (a) 12-phase AC arc and (b) double-6-phase AC arc.

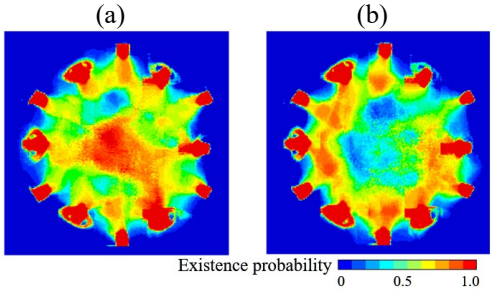

Fig. 3. Arc existence probabilities in (a) 12-phase AC arc and (b) double-6-phase AC arc.