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Thermal Plasma Generation for Innovative Materials Processing

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Thermal plasmas are expected to be utilized for a number of innovative industrial applications such as decomposition of harmful materials, recovery of useful materials from wastes, and synthesis of high-quality and high-performance nanoparticles. The advantages of thermal plasmas including high enthalpy to enhance reaction kinetics, high chemical reactivity, and oxidation or reduction atmospheres in accordance with required chemical reactions are beneficial for innovative processing.

The experimental and modeling efforts on thermal plasma characteristics has been devoted to industrial application. However, the thermal plasma characteristics remain to be explored in spite of these efforts. The arc fluctuation phenomena are one of the most considerable issues, because it determines the processing performance in thermal plasmas. The objective of the talk is to investigate the physical and chemical phenomena in thermal plasma processing for industrial application.

A multiphase AC arc (MPA) as shown in **Fig. 1** is one of the most attractive thermal plasmas due to its advantages such as large plasma volume with low gas velocity, which are favorable for material processing [1,2]. Other advantages compared with other thermal plasmas include high energy efficiency and low cost. The most important phenomena to be explored are the arc stability, the temporal and spatial characteristics of the arc discharge.

Fluctuated temperature field of the MPA were successfully visualized by a high-speed camera. **Figure 2** of the MPA temperature fluctuation with top and side view is useful for industrial application. These temperature distributions were measured from Ar I at 675 and 795 nm.

Water plasma system has been scaled up into a mobile system in a vehicle with direct-current generator as shown in **Fig. 3**. This innovative in-vehicle plasma has great advantage to reduce the risk and cost caused by the transportation of harmful wastes [3]. Recent studies have revealed the arc fluctuation and temperature field of the water plasma by high-speed visualization. The observation of arc fluctuation and the measurement of the arc temperature were conducted by employing the high-speed camera system. Water as plasma source was introduced from cathode nozzle to discharge area. The copper or iron as anode material rotates to reduce anode erosion.

A high-speed camera with an appropriate band-pass filter system was used to visualize the arc fluctuation and the temperature field. The wavelengths of the filters were 656 nm and 486 nm for H_α and H_β, respectively. Highest temperature was over than 15,000 K. These results revealed that the arc temperature of in-vehicle water plasma was sufficiently high to decompose any organic and inorganic compounds.

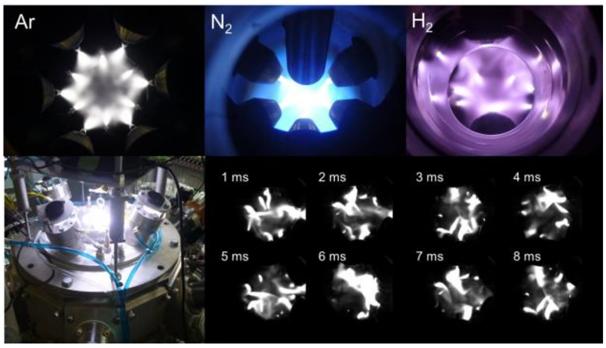

Fig. 1 Schematic image of multiphase AC arc.

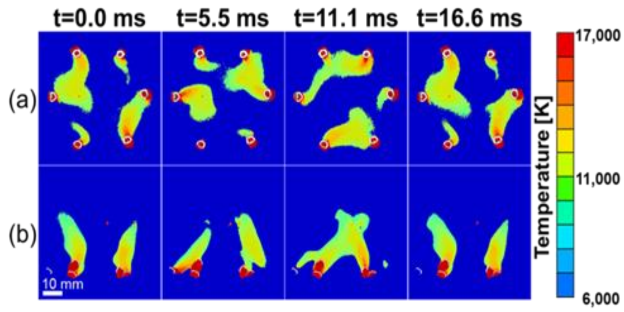

Fig. 2 Temperature distributions measured (a) from the top and (b) from the side during one AC cycle of 60Hz and 120 A.

Fig. 3 Plasma Truck with water plasma system.

References

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