Production, control and application of discharge plasma using a gas jet in the atmosphere or in a vacuum

Project Leader
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1. Objective

This project is aimed at:

Generating discharge plasma with a gas jet in air or in a vacuum, and controling reaction processes in plasma to develop new applications in the fields of materials science, medicine, biology and agriculture. We have succeeded in operating localized gas discharge for production of a micro-plasma in the vacuum chamber of an SEM (scanning electron microscope) [1-3], and also in operating core-shell structured stable APPJ (atmospheric pressure plasma jet) with laminar flow [4]. The novel techniques of plasma production in a controlled gas jet will enable the development of innovative applications of plasma.

2. Project Outline

To that end, the project will consist of the following phases:

(a) Development of a gas nozzle for stable operation of a gas jet in a vacuum and in atmospheric air
(b) Development of an electrical power source and an electrode system for stable electrical gas discharge
(c) Investigation of plasma properties and analysis of chemical reaction processes in the plasma
(d) Pioneering of novel applications

3. Expected Performance

In this project, the successful candidate would be expected to:

(a) Work independently when planning, preparing and carrying out the experiments
(b) Report research progress at weekly laboratory meeting
(c) Provide supervision for master course and undergraduate students in the laboratory
(d) Perform routine work for the maintenance of experimental apparatus

4. Required Skills and Knowledge

The successful candidate for this project will have the following knowledge and skills:

(a) Basic understanding of physics, chemistry, electromagnetics, electronics and electrical engineering
(b) Principles of gas discharge and plasma science, vacuum systems and engineering
(c) Handling of high-voltage and high-frequency power supplies, electronic measurement instruments
(c) Operation of material analysis equipment such as SEM, EDS, XRD, Raman, FT-IR, XPS, and so on.

References

1) Khanit Matra, Yusuke Mizobuchi, Hiroshi Furuta, Akimitsu Hatta: "Local sputter etching by micro plasma jet in SEM", Vacuum 87 (2013) pp.132-135., http://dx.doi.org/j.vacuum.2012.03.011
2) K Matra, H Furuta and A Hatta: "Current-Voltage Characteristics of DC Discharge in Micro Gas Jet Injected into Vacuum Environment", J. Phys.: Conf. Ser. 441(2013) 012021. doi: 10.1088/1742-6596/441/1/012021
3) Khanit Matra, Hiroshi Furuta and Akimitsu Hatta: "DC Microplasma Jet for Local a:C-H Deposition Operated in SEM Chamber", Micromachines 8(7) (2017) 211. doi: 10.3390/mi8070211

4) Kotaro Ogawa, Hideki Yajima, Jun-Seok Oh, Hiroshi Furuta, and Akimitsu Hatta: "Effects of sheath gas flow on He atmospheric pressure plasma jet", Appl. Phys. Express 12 (2019) 036001. https://doi.org/10.7567/1882-0786/aafde9.

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