CURRENT CONTROLLED PLASMA-ON-A-CHIP FOR ATMOSPHERIC PLASMA GENERATION

Hyunho Park, Junyoung Jeong and Youngmin Kim
School of Electrical Engineering
Hong Ik University
Seoul, Korea

We present plasma-on-a-chip operated in a current controlled bias scheme for atmospheric plasma generation. The plasma-on-a-chip includes an array of microelectrodes and vertically formed micro gaps between anode and cathode, ranging from 5 μm to 10 μm[1]. Use of a few micron gap enables atmospheric plasma generation at a low voltage (~250 V). To enhance stability of the glow discharge, in this work a current controlled bias scheme is suggested using a current mirror circuit. Compared to voltage controlled bias scheme, the current controlled scheme may improve stability of the glow discharge by suppressing excessive current flow occurred during the glow discharge, which may be caused by electrode-sputtering induced gap narrowing or elevated temperature. Also, the current controlled discharge will be desirable for emission spectroscopy of mixed gases where breakdown voltages for the gases are different.

In this work, the discharge current flowing through the anode and cathode was precisely controlled by a predetermined reference current in the current mirror circuit. Temporal current-voltage characteristics during plasma generation were measured, providing insight of electrical behavior of the device, such as conduction current and displacement current in the pulsed mode. The discharge current could vary from 10 mA to 20 mA when the reference gate voltage was adjusted. Measurement of the discharge current revealed the current controlled bias was able to suppress an arc transition during the glow discharge and to maintain the predetermined discharge current, resulting in significant improvement in stability and reliability of the atmospheric plasma. The plasma was also diagnosed by optical emission spectroscopy based on diatomic N_2 molecule. Electron and gas temperatures of the atmospheric plasma were estimated to be 2550 °K and 1000 °K, respectively. In summary, we have demonstrated improved stability and reliability of atmospheric plasma generated on plasma-on a chip by utilizing a current controlled bias scheme. The work suggests that a compact reliable plasma source, which is usable for portable applications, can be realized using the plasma-on-a-chip.

1. S. Han and Y. Kim, “Self-Aligned Micro Triode for plasma generation at atmospheric pressure”, Journal of Vacuum Science and Technology B, Jan. 2007, pp. 286-288.

* This work was supported by the Korea Science and Engineering Foundation (KOSEF) grant funded by the Korea government(MEST) (No. 2009-0078875).