Development of unipolar charged nanoparticle generation via corona *in situ* generating spark discharger

Seung Ryul Noh[1, 2], Dae Seong Kim[2], Sei Jin Park[2] and Mansoo Choi[1, 2]

[1]School of Mechanical and Aerospace Engineering, Seoul National University, Seoul, 151-744, Republic of Korea

[2]Global Frontier Center for Multiscale Energy System, Seoul National University, Seoul, 151-744, Republic of Korea

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Presenting author email: ambiboy5@snu.ac.kr

Charged nanoparticles are widely used for building-blocks in electrostatic patterning (You *et al*, 2010; Ha *et al*, 2014). Spark discharge is a proper method which generate charged sub 10 nm nanoparticles easily. In a spark discharge nanoparticle generation, plasma developed by electrical breakdown of carrier gas between two electrodes vaporizes electrode material. And then, nanoparticles generated from the spark discharge chamber with surrounding ions and charges acquire charges by diffusion charging. However, bipolar charging of nanoparticles has a lower yield of charged particles than unipolar charging (Adachi *et al*, 1985)

In this study, we devised a new spark discharge scheme to increase the production of positively charged particles by using the electrodes themselves of spark discharger as the supplies of positive ions *in situ*. To this end, as shown in Figure 1, we invented a new spark control circuit to maintain the voltage of electrode with the value above the corona discharge voltage always excepting the moment of spark discharge.

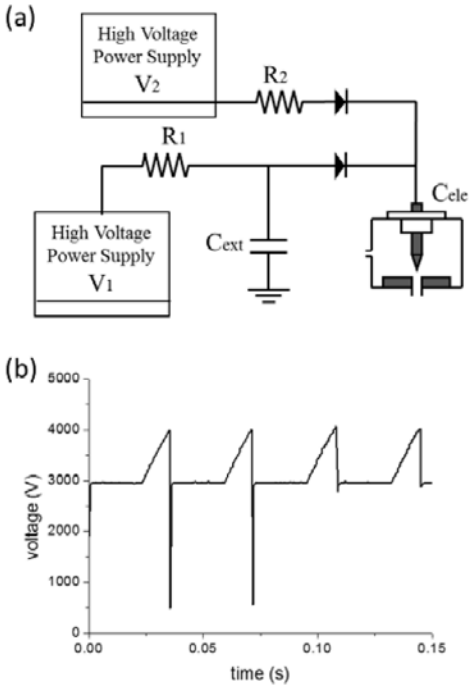

Figure 1. (a) Spark discharger scheme for unipolar charged particle generation, (b) voltage profile measured from the anode of spark discharger by using new type external circuit.

We confirmed the 1.8-fold increase of the amount of positively charged particles generated from the spark discharger when using the pin-to-plate type electrodes and the new circuit. And the amount of the negatively charged particles was reduced by half due to the increase of positive ion generation. For investigating the effects of electrode geometry, we conducted the comparative study on generation of positively charged particles between rod-to-plate and wire-in-hole type electrodes.

Finally, we studied the effects of flow rate that confirmed the positively charged particles increased by positive ion generation.

The new spark discharge scheme in this study is the simple method to increase the positively charge particle production which can be utilized in the electrostatic aerosol lithography as a building block.

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