A Study of Spark Discharger for Stability Control in High Frequency Region

Seung Ryul Noh[1, 2], Dongjoon lee[1, 2], Sei Jin Park[2], Dae Seong Kim[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

Spark discharge is a simple and energy efficient method for generating charged nanoparticles in gas phase media. Nanoparticles generated by spark discharge have been used in various applications because of their noble electric, catalytic and optical properties (Sung *et al*, 2014; Messing *et al, 2010*). As utilities of nanoparticle are increasing, the necessity of scaling up the production rate is emerging important issue. A recent research (Pfeiffer et al) has increase production rate by using switchable electronic component for stability control of spark discharge up to frequency of 20 kHz.

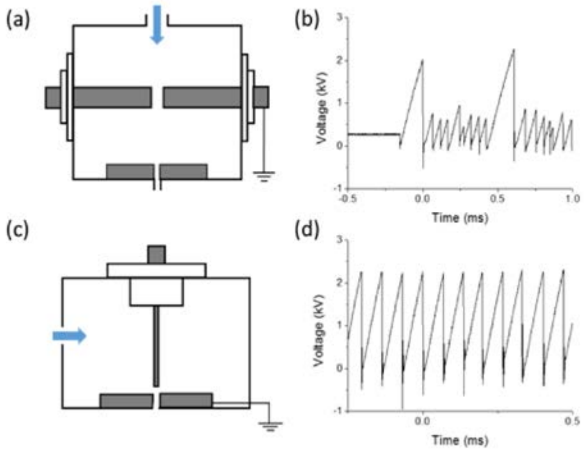

Figure 1. (a) Rod-to-rod electrode type spark discharger scheme, (b) voltage profile with unstable state measured from rod-to-rod electrode type spark discharger, (c) Wire-to-plate electrode type spark discharger scheme and (d) voltage profile with stable state measured from wire-to-plate electrode type spark discharger

In this study, we conducted comparative study between the wire-to-plate electrode type and the rod-to rod spark discharger for understanding the effect of electrode geometry on stability of spark discharge.

As shown in Figure 1, with using the rod-to-rod type electrode configuration, the spark discharge voltage dropped to the voltage below the desired break down voltage of the spark discharger (unstable state) over the spark frequency of 1.1 kHz. On the other hand, the spark discharge voltage was maintained the desired break down voltage (stable state) of the spark discharger with the wire-to-plate electrode configuration over the spark frequency of 10 kHz.

In wire-to-plate electrode type spark discharger, the carrier gas velocity in vicinity of spark discharge is much faster than that in rod-to-rod electrode type spark discharger. In addition, we confirmed the stable state of spark discharge with wire-to-plate electrode type spark discharger changed to unstable state by decreasing the carrier gas flow rate. Therefore, we identified that the carrier gas velocity in vicinity of spark discharge was main factor for maintaining stable condition of spark discharger over the frequency of 10 kHz.

Moreover, we investigated the effect of electric field near the spark discharge zone on the stability of spark discharge. To this end, we measured the spark stability of the wire-to-rod type electrode. Its carrier gas velocity field has a similarity to that of rod-to-rod type electrode but stronger electric field intensity due to wire electrode. Then, we confirmed that wire-to-plate type electrode could maintain the stable state over the frequency which exhibited unstable state in the rod-to-rod type electrode.

Finally, we measured the mass production rate of the spark discharger which exhibited proportional growth to the frequency increment while stable state of spark discharge was maintaining. However, the mass production rate fell out drastically when the spark discharge became unstable state.

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