Investigation on Extended Phenomenon of DBD under High Temperature and Demonstration of Large-area Nitriding

Naoto Kanda*, Ryuta Ichiki, Keiju Kawanobe, Kosuke Tachibana,
Takashi Furuki, and Seiji Kanazawa

Oita University, Japan
*Corresponding author e-mail: ryu-ichiki@oita-u.ac.jp

Dielectric barrier discharge (DBD) is currently applied in various fields because it can generate non-thermal plasma under the atmospheric pressure. We applied this non-thermal plasma of DBD to metal nitriding treatment performed under high temperature of ca. 500°C.

As a result of high temperature, we found that DBD exhibits an extension phenomenon in which the plasma spreads beyond the existing range of the spot electrode under high temperature as shown in Fig.1.

Moreover, the extension phenomenon is applied to metal nitriding treatment. The surface of the downside electrode (JIS SKD61, 15 x 15 x 5mm^3) is treated by the extended DBD plasma, where the operating gas is N_2/H_2 mixture (4.0 slm; H_2 10%) and the treatment temperature is 550°C. As a result, we succeeded in large-area nitriding treatment by extended DBD for the first time as shown in Fig.2. The cause of non-uniformity of the layer thickness is under investigation.

Next, we focused on the creeping discharge. In order to generate the DBD plasma locally, we tried to suppress creeping discharge because the plasma and creeping discharge occured simultaneously. For this reason, we performed an experiment in which the spot electrode was covered with ceramic bulk (10 x10 x 10 mm^3) to prevent the extension of the creeping discharge. As a result, we succeeded in suppressing the creeping discharge. However, we could not localize the plasma. This result indicates the possibility that the extension of the creeping discharge and that of the DBD plasma are not strongly related

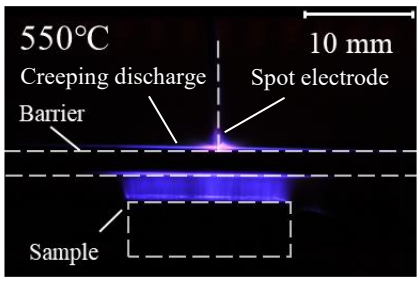

Fig.1 Extension of DBD under high temperture.

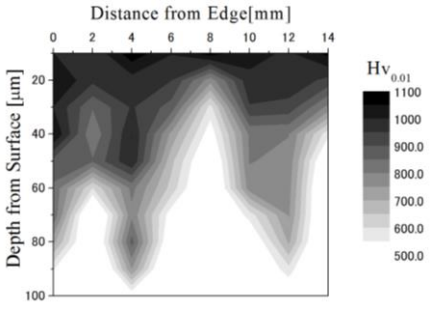

Fig.2 Hardness profile of sample cross section.