BAKING PROCEDURE OF THE ACCELERATOR TUBE BY MEANS OF LOW VOLTAGE ARC DISCHARGE

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Experiences on the high-voltage electroststic accelerator indicate that the baking treatment is very important to obtain a stable operation of the accelerator tube at the highest working voltage. For this reason, for example, NEC tubes of the pelletron include a heating element in every tube units, which can be used during the high-voltage generation. This provision is an indispensable part of this special type of tube for its remarkable performance.

Recently in the tandem accelerator laboratory of this university a new effective method of initial baking is developed by means of gaseous discharge. The accelerator tubes used here are ceramic ones fabricated by a metal bonding technique, eliminating organic material from the inside. Originally baking was performed by using electric mantle heaters, so the procedure was very tedious and troublesome. This procedure involved hard heating of the tube flanges, which often caused leakage trouble of the metal gaskets. In the new method a dense plasma is produced along a long path of the accelerator tube with an oxide cathode at one end of the tube and an anode at the opposite end. The electrodes in the tube exposed to the plasma are easily heated to high temperature of several hundreds degrees in centigrade. The flanges are heated only weakly. Since the inside high temperature is well insulated from the surrounding by the ceramic insulator, this baking procedure can be carried out with the tube as completely equipped with such accessories as annular spark gaps and dividing resistors.

The effect of this discharge treatment is not only degassing by heat but includes some degree of conditioning by ion- and electron-bombardment of the surface of metal electrodes and ceramic insulators. One of anticipated dangerous events of this treatment is the contamination of the insulator surface by sputtering. To avoid this it is necessary to use a discharge gas of the lightest elements, like hydrogen or helium, and further, as a more important thing, to produce a plasma of low electron temperature. Plasma of the latter property can be produced by using an oxide cathode ("low voltage arc").

We searched the way of producing the arc discharge most suitable for the above requirements by using actual tube units of the tandem. In the case of H_2 gas preferable pressure was found to be about 0.1 Torr, with which the average voltage gradient along the tube is about 40~50 volts per unit tube (25cm long), independently of the magnitude of the arc current. Therefore, with the arc current of 10 to 20 A heating power of several hundreds to one kilo watts can be easily supplied to each tube unit. The temperature of demountable electrodes rises quickly (in a few minites) to an equilibium temperature of more than one hundred degrees and then gradually up to several hundreds degrees (in about one hour). A small step of potential is formed in diaphragm positions at the ends and middle of the unit tube, due to higher plasma impedance at these portions. These diaphragms are easily red-heated by receiving more heat. The location of the oxide cathode requires special precausion. It should be set close to the entrance of the tube. Otherwise a large potential fall is generated at the entrance portion and serious sputtering occurs from every points of the electrode surface in this portion due to the effect similar to the hollow cathode phenomena, contaminating ceramic insulators.

The effect of the discharge baking was investigated by using 1MV electrostatic test generator. It was found that the effect is apparent and remarkable. Microdischarges accompanying X-ray bursts due to the ion-exchange sputtering*, which usually started from the voltage of 300KV or less per unit tube when it was not treated, were found to disappear with a moderated discharge treatment and did not appear up to the highest working voltage of 500KV (corresponding to 10MV of the terminal voltage). Frequency of local spark discharges, which are considered due to the flashover along the ceramic insulator surface in the individual insulator sections decreased drastically and then 500KV could be attained per unit tube in a short time with quite few breakdowns.

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* The electrode arrangement in the present tandem accelerator tube of this laboratory is designed so that the ion exhange sputtering process is confined within the domain of one unit tube by placing diaphragms of concave shape at the flange portions.