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Fundamental Study on Conditioning of a Vacuum Gap with Low Breakdown Energy

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Conditioning experiment of a commercial vacuum interrupter was carried out with a gap distance of 1˜3 mm. Energy of the vacuum arc following a breakdown has been controlled to be as low as several hundred mJ with a 100 kΩ current-limiting resistor. Breakdown voltage and field emission current was measured during the conditioning process. The Murphy-Good plot was employed to further study change of field enhancement factor β and the field emission area Ae. The conditioning process was proceeded if no higher breakdown voltage was observed during the last 100 breakdowns. Results showed that at 1 mm gap distance, breakdown voltage increased smoothly as β decreased. The local breakdown electric field βU/d remained almost constant. However it was out of expectation that the maximum field emission current before each breakdown increased from several mA to over 100 mA during the conditioning process. At gap distance of 2˜3 mm, the conditioning process consists of two stages. The first stage was the same as the case with gap distance of 1 mm, with breakdown voltage increased and β decreased smoothly. But when β decreased to a certain value, the conditioning process turned into the second stage, with abnormal field emission current increase sometimes observed before breakdown. A microparticle approaching the cathode surface could be responsible for the current increase. β usually gets higher after such a breakdown. Then during the next few shots, with no abnormal field emission current rise before breakdown, β decreases again till the certain value, and a breakdown with abnormal field emission current shows again. This process loops throughout the second stage, with breakdown voltage fluctuated around a certain value, which is often called “saturation”. Results in this paper could be partially explained by a model proposed by Chatternton’s.

Topic

Applications

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