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Does field emission from 'real' surfaces affect the high-pressure air breakdown in electric power equipment?

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Field emission from cold cathodes, with electric field enhanced by roughness of (micro-protrusions on) the cathode surface, may play a role in breakdown of the high-pressure air under conditions relevant to electric power equipment. Two examples are considered in this contribution. The first one concerns the breakdown in conditions of the experiment [1]: a concentric cylinder discharge in synthetic air in the pressure range 5-100 bar, with an interelectrode gap of 5 mm and the outer cylinder diameter of 190 mm. Numerical modelling was performed by means of the numerical model of low-current discharges in air [2]. At pressures up to 10 bar, both the experimental breakdown voltage and the computed discharge inception voltage, computed without account of the field emission, grow linearly with the pressure and are close to each other. For higher pressures, the experimental breakdown voltage saturates which is actually a well-known effect, while the computed voltage continues to grow linearly. This striking difference between the modelling and the experiment was removed by introducing in the numerical model the effect of field emission with account of amplification of electric field due to roughness of (micro-protrusions on) the cathode surface. The electron emission current was determined by means of the code [3], based on the straightforward evaluation of the Murphy-Good formalism, protrusions were taken into account by means of a field enhancement factor β introduced on the entire cathode surface. With β =50, which is standard in the literature and corresponds to protrusions with aspect ratio of 10, the computed discharge inception voltage indeed reveals a saturation in the dependence of the breakdown voltage with pressure, similar to the one observed in the experiment [1].

Another example considered in this contribution concerns the effect of field emission during the ignition of an arc at separation of contacts of low-voltage contactors or circuit breakers. Note that this topic is related to the effect of field emission in breakdown in micrometer gaps, which is currently under an intensive investigation; e.g., [4] and references therein.

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[1] M. Seeger, P. Stoller, and A. Garyfallos, IEEE Trans. Diel. Elect. Insulation 24, 1582, 2017.

[2] N. G. C. Ferreira, D. F. N. Santos, P. G. C. Almeida, G. V. Naidis, and M. S. Benilov, J. Phys. D: Appl. Phys. 52, 355206, 2019.

[3] M. S. Benilov and L. G. Benilova, J. Appl. Phys. 114, 063307, 2013.

[4] S. D. Dynako, A. M. Darr, and A. L. Garner, IEEE J. Elect. Dev. Soc. 7, 650, 2019.

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