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Study of Nanosecond Electrical Breakdown in Perfluorinated Liquids at 140 kV

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Perfluorinated delectric liquids are perspective for using in high-voltage devices because of their chemical stability under electrical discharges. For applications like liquid spark gaps, velocity of breakdown is an important parameter. In this work the results of measurement of velocity of anode-initiated electrical breakdown at 140 kV in perfluorinated liquids of different chemical classes are presented. Experimental setup [1] comprised nanosecond generator, breakdown cell, voltage divider, and digital oscilloscope. Generator impedance is 50 Ω, stored energy 0.8 J, voltage under no-load 140 kV. Pulse duration is 8 ns under the load-matched conditions, rise time less than 0.5 ns. Point-to-plane configuration of electrodes with positive point was used. It has been shown that perfluorinated ethers have close values of breakdown velocity in wide range of gaps and demonstrate relatively low jitter in gaps for which time to breakdown (up to 30 ns) is comparable to pulse duration. Velocities of breakdown in these liquids are $5 \cdot 10^6 - 1.3 \cdot 10^7$ cm/s for gaps up to 2 mm, which is 3–8 times larger than in transformer oil under the same conditions [2]. Differential velocity of breakdown front propagation for all tested liquids substantially decreases in gaps wider than 1.5–2 mm being about $2 \div 3 \cdot 10^6$ cm/s. Time to breakdown in wider gaps grows linearly up to 6 mm. As soon as differential velocity of breakdown remains nearly constant for wide gap range, it might be considered as an electrophysical characteristic of the dielectric liquid under these pulsed conditions.

[1] I. F. Punanov, V. D. Kulikov, R. V. Emlin, and S. O. Cholakh, "Resistance of a pulsed electrical breakdown channel in ionic crystals," *Technical Physics*, vol. 59, no. 4, pp. 503–507, Apr. 2014.

[2] I. F. Punanov, R. V. Emlin, P. A. Morozov, and S. O. Cholakh, "Investigation of breakdown in porous ceramics initiated by nanosecond pulses," *Russian Physics Journal*, vol. 55, no. 2, pp. 191–194, Jul. 2012.

Primary author: PUNANOV, Ivan (Institute of Electrophysics UB RAS)

Co-authors: MOROZOV, Pavel (Institute of Electrophysics UB RAS); EMLIN, Rafail (Institute of Electrophysics UB RAS); CHOLAKH, Seif (Ural Federal University)

Presenter: PUNANOV, Ivan (Institute of Electrophysics UB RAS)

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