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The investigation of propylene carbonate based nano-fluids as an energy storage medium for pulsed power sources

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Propylene carbonate (PC) is a promising dielectric for the compact pulsed power sources because of its large permittivity, high dielectric strength and broad operating temperature range. By adding nano-particle suspensions homogeneously to the dielectric liquid, the insulating properties of the dielectric liquid can largely be enhanced in the electrical engineering application. In this paper, the breakdown properties of PC based nano-fluids containing only 2 ppm TiO2 nano-particles is experimentally studied and the result of more than 60% higher impulse breakdown voltage than that of base liquid is presented. It is found that the resistance of the test gap containing nano-fluids increases by a factor when the test gap is subjected to high amplitude voltage before the development of electrical breakdown, greatly differing from the invariable resistance in the pure PC case. Moreover, compared with pure PC, the streamers in nano-fluids are more complex branched. It implies that the charge carriers in nano-fluids can be effectively captured and scattered by nano-particles, which is verified by means of thermally stimulated current method.
Based on these experimental results and theoretical analysis mentioned above, a nano-fluids-dielectric helical pulse forming line accelerator is developed, which has a 0.4-m diameter, a 1.2-m length, and a 7-Ω wave impedance. It can steadily operate at a 500-kV output voltage and a pulse width of 70 ns with better operation stabilities and 2.5 times higher output power than that of pure PC. These efforts set a good foundation for the development of a compact pulsed power generator with a new kind of high energy storage medium, and the results show an appealing application of PC based nano-fluids for the future.

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