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Voltage Maintaining Performance of High Energy Density Capacitor

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The high energy density (HED) capacitor is the energy storage component in capacitive pulsed power systems. There is an obvious voltage decay phenomena when the capacitor is disconnected with the charge source, and the higher the energy density is, the faster the voltage decay. And the voltage maintaining performance (VMP) of capacitor is of special interests especially in the occasion that has high requirement of output energy efficiency. For the HED capacitor made of metallized films, there are three factors influencing the VMP: self-healing, dielectric leakage and polarization. In order to investigate the effect of above factors on VMP of HED capacitor, the experiments and analyses of self-healing characteristics, dielectric leakage in stable status and slow polarization are carried out. For a 3kV/1.4MJ/mˆ3 HED capacitor, the self-healing is responsible for less than 12.5% of the whole voltage decay. And the dielectric leakage contributes for 32.5% with the fact that the conductivity is in the range of 3×10ˆ-16 S/m-1.5×10ˆ-15 S/m.The voltage decay is mainly caused by the slow polarization. Then a VMP simulation considering no self-healing process established by using Debye theory, and different working parameters such as charging rate, holding time are studied by using the VMP simulation. When the charging rate is 100 V/s, 300 V/s and 3000 V/s, the voltage decay in 1 minutes is 5.2%, 5.5% and 5.75% respectively, and when the holding time is 0 s, 10 s, 100 s and 1000 s, the percentage of 1min voltage drop of capacitor is 5.2%, 4.75%, 3.25% and 2% respectively. The results based on the space charge reveal the facts that faster charging rate or shorter holding time result in faster voltage decay. And, with the consideration of the energy output efficiency and voltage withstand characteristics of dielectric, the charging time and holding time will be compromise values.

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