

# Capacitor Discharge Test System

## PK-CPR1701

$\delta^+$  PolyK  $\delta^-$

This test system was inspired by the publication of Zhang et al "A Dielectric Polymer with High Electric Energy Density and Fast Discharge Speed". *Science* 313, 334 (2006)

### Functions

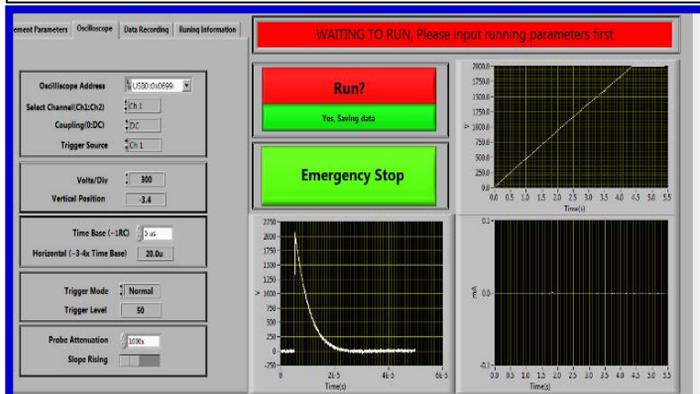
- This unique test setup can be used to evaluate the discharging performance (speed and energy density) of new dielectric materials (100 pF) or packaged capacitors (100  $\mu$ F) under high voltage.
- **Polarization loop test provides incorrect energy density for capacitor application:** the energy of the sample is discharged to power supply in a linear function (1-100 ms) and it significantly over estimate the energy density! In practical application, the discharging usually in nanosecond to millisecond and the discharge is RC exponential decay!
- It controls a high voltage power supply to charge the specimen to a pre-set voltage  $\rightarrow$  disconnect the charged sample from the power supply  $\rightarrow$  connect the charged sample to a load resistor (user selectable) with a HV MOSFET switch.
- The voltage across the load is recorded with an oscilloscope through a HV probe. Data are then transferred to the host computer, and discharged energy density is calculated automatically.
- Two Operation Modes:
  - Manual: the user control the charging relay and the discharging switch by pushing the buttons.
  - Auto: computer control everything and save test results.



### Capability

1. Voltage: 10-15 kV (relay and switch)
2. Sample capacitance: < 100 pF to > 100  $\mu$ F
3. Discharge peak current: \* < 10 A to > 5,000 A
4. Discharging load: <1  $\Omega$  to > 100 M  $\Omega$
5. Discharging speed: high voltage MOSFET switch, rise time < 10 ns.
6. Accuracy of charging current, voltage, and energy is determined by the capability of the power supply & sample capacitance.
7. Temperature of capacitor and ambient may be recorded during lifetime test [Option].
8. Evaluate the capacitor discharge speed from 100 ns to > 1 ms.
9. Perform automatic lifetime test and save a summary file with energy density.
10. System components: test control system, high voltage power supply, oscilloscope, non-inductive high voltage resistors, HV probe, laptop

\* Certain models are subject to Export Control regulation.



### LabView Control Program: Auto Mode

- Test controlled by the PK CapControl® LabView
- Set test voltage, charging current or voltage ramp rate, number of test cycles, data storage locations
- Control the HV amplifier, switch, and oscilloscope
- Automatically perform charge-discharge cycle lifetime test and save original charge/discharge data (voltage vs. time). A summary file is generated to save all the charge cycle, charging time, energy density, etc.

### Recent Publications with this test system:

Wang et al "Sandwich-structured polymer nanocomposites with high energy density and great charge-discharge efficiency at elevated temperatures" *Proceedings of the National Academy of Sciences*, 2016; DOI: 10.1073/pnas.1603792113  
<http://www.pnas.org/content/113/36/9995.abstract>

### Contact Information

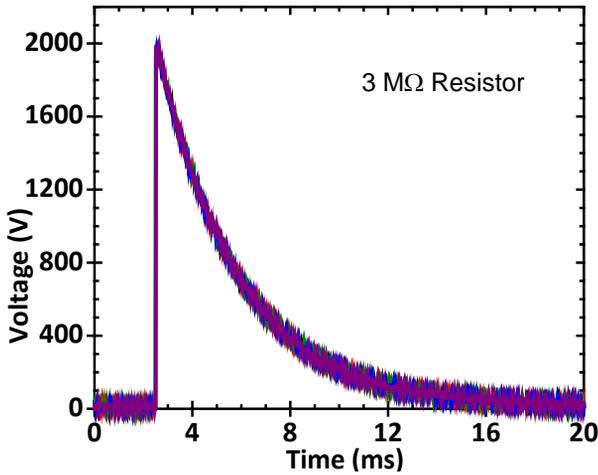
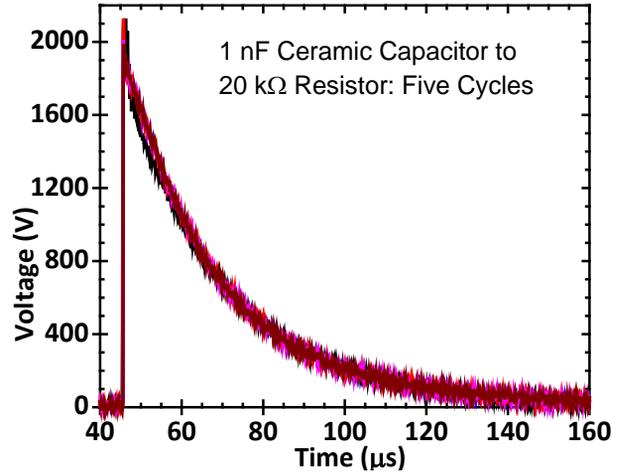
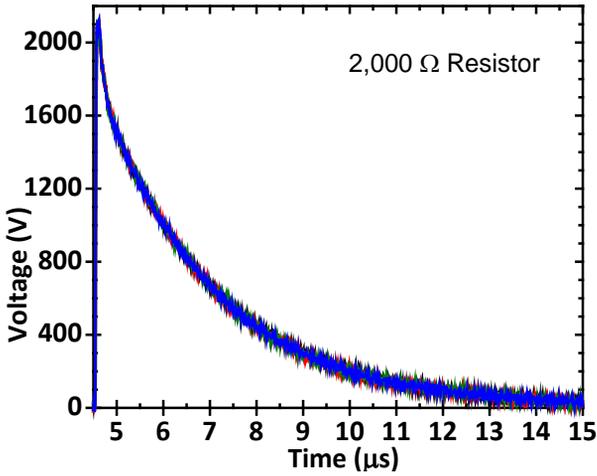
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# Example Test Results

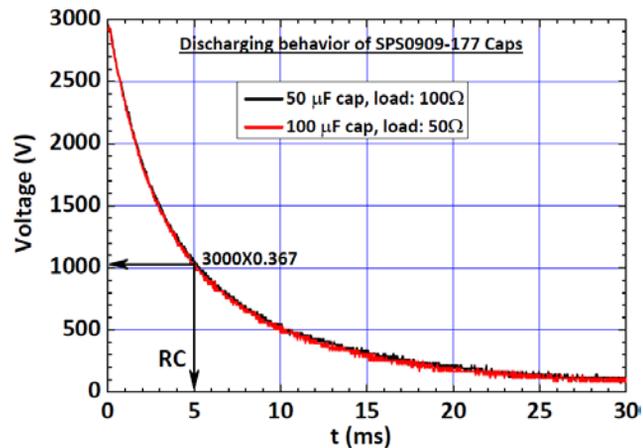
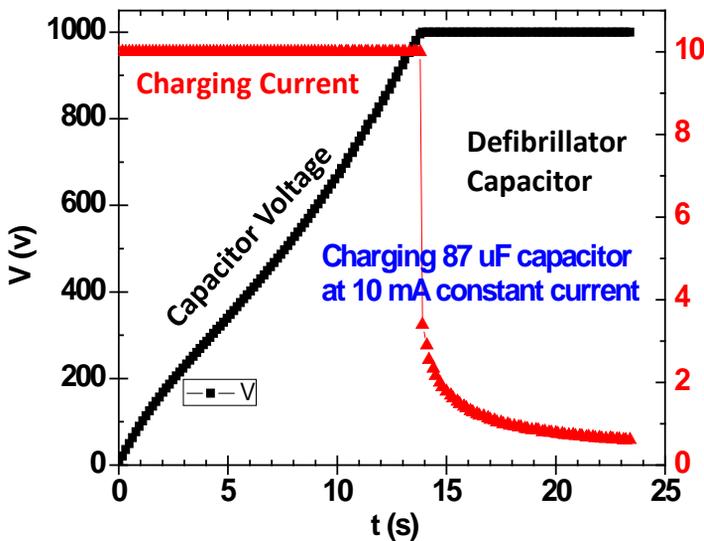
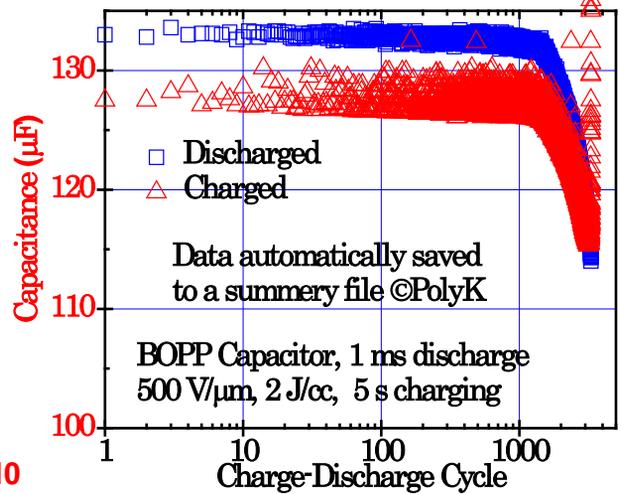
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### Discharge Speed Test: 1 nF Ceramic Capacitor



### Lifetime Test of BOPP Capacitors



The capability to record charging current and voltage and the stability of the current are determined by the HV power supply or amplifier.

#### Contact Information

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