

Experimental Investigation of Energy Losses in Reverse Switching Dynistors

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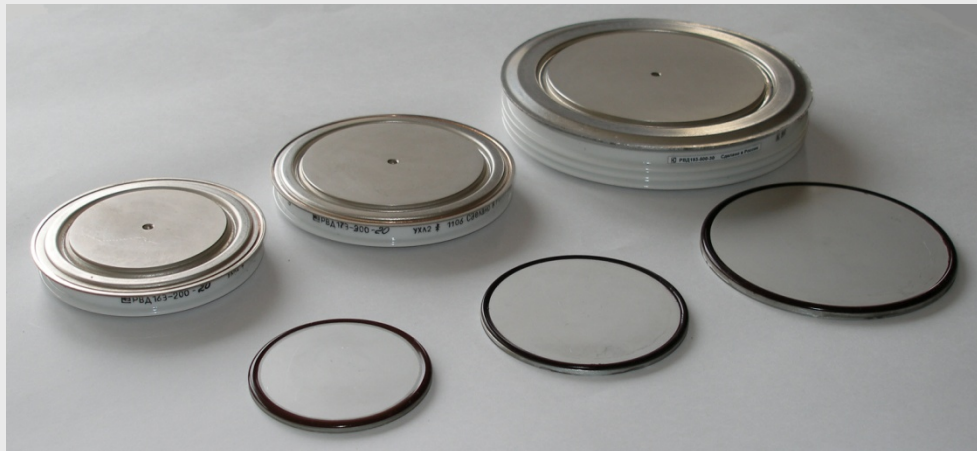
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- Conclusion

Introduction

- Large capacitive energy storage systems (>100MJ) are widely implemented in the pulsed power system.
- Flashlamp-pumped Glass Lasers, laser initiated inertial fusion, electromagnetic launch, electromagnetic propulsion.
- Precise, reliable, robust and long lifetime
- High current, high di/dt, millisecond pulse durations, transferring high Coulombs

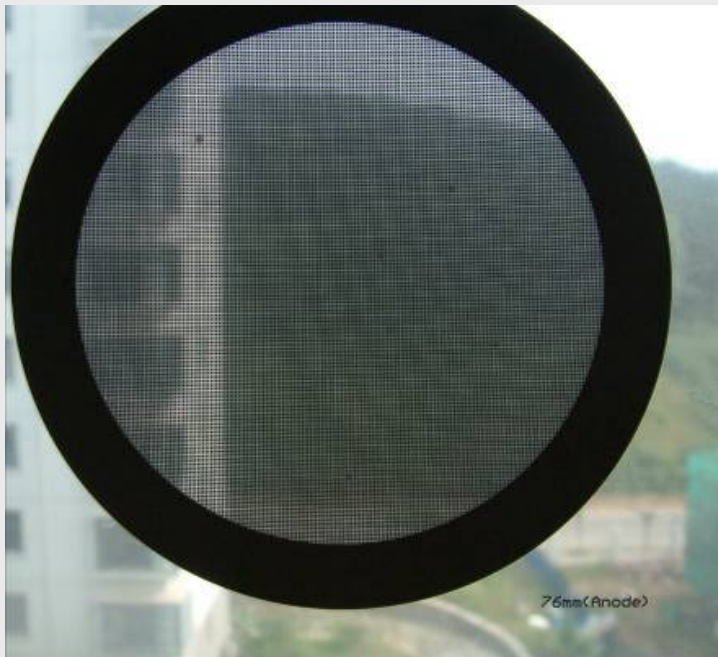
Introduction

Diameter of the semiconductor structure	Max blocking voltage, U_{DRM}	Max peak current, I_{TM}	Current rise rate, dI/dt_{crit}
40 mm	3000 V	55 kA	30 kA/ μs
56 mm	3000 V	80 kA	30 kA/ μs
76 mm	2200 V	300 kA	30 kA/ μs
100 mm	2200 V	500 kA	30 kA/ μs

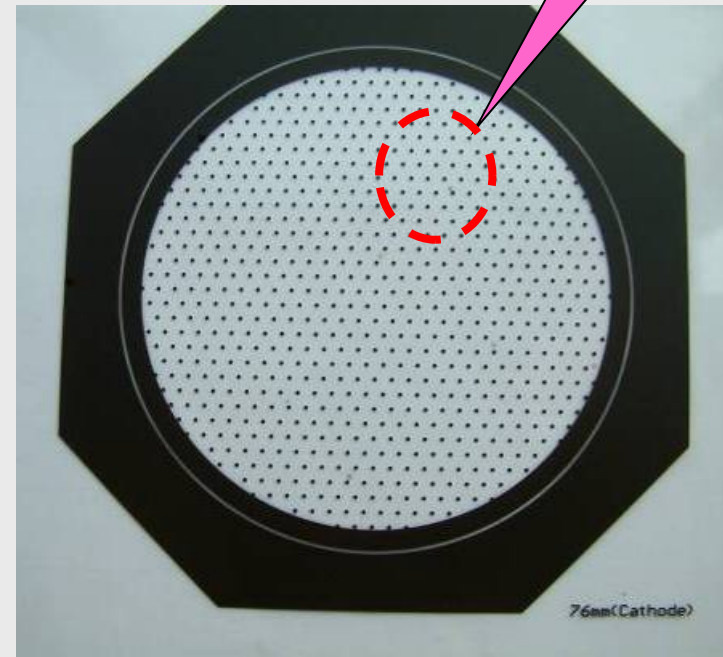


40mm, 56mm and 76mm RSD semiconductor structures and packed devices.

RSD Operating principle

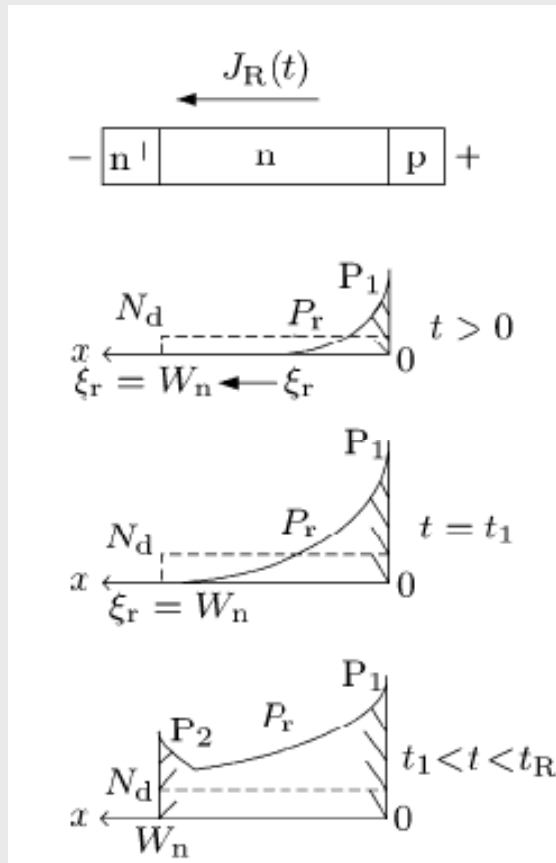


anode

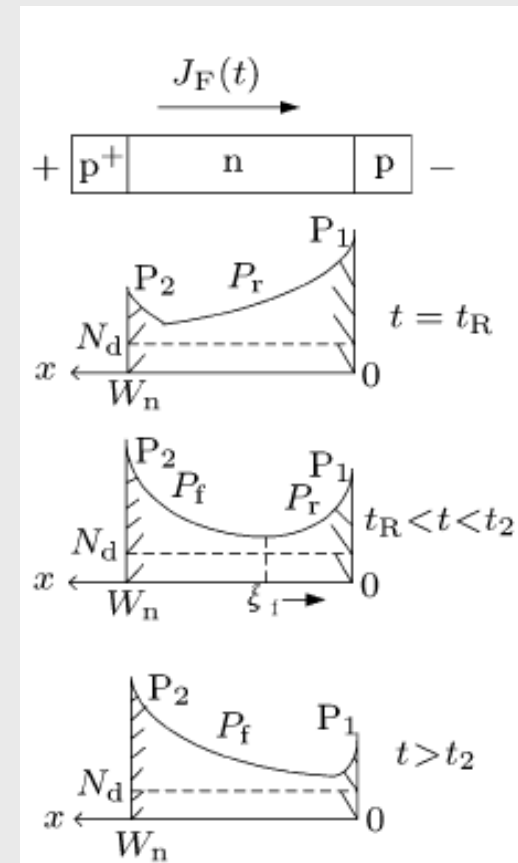


cathode

Calculation of energy losses in RSD



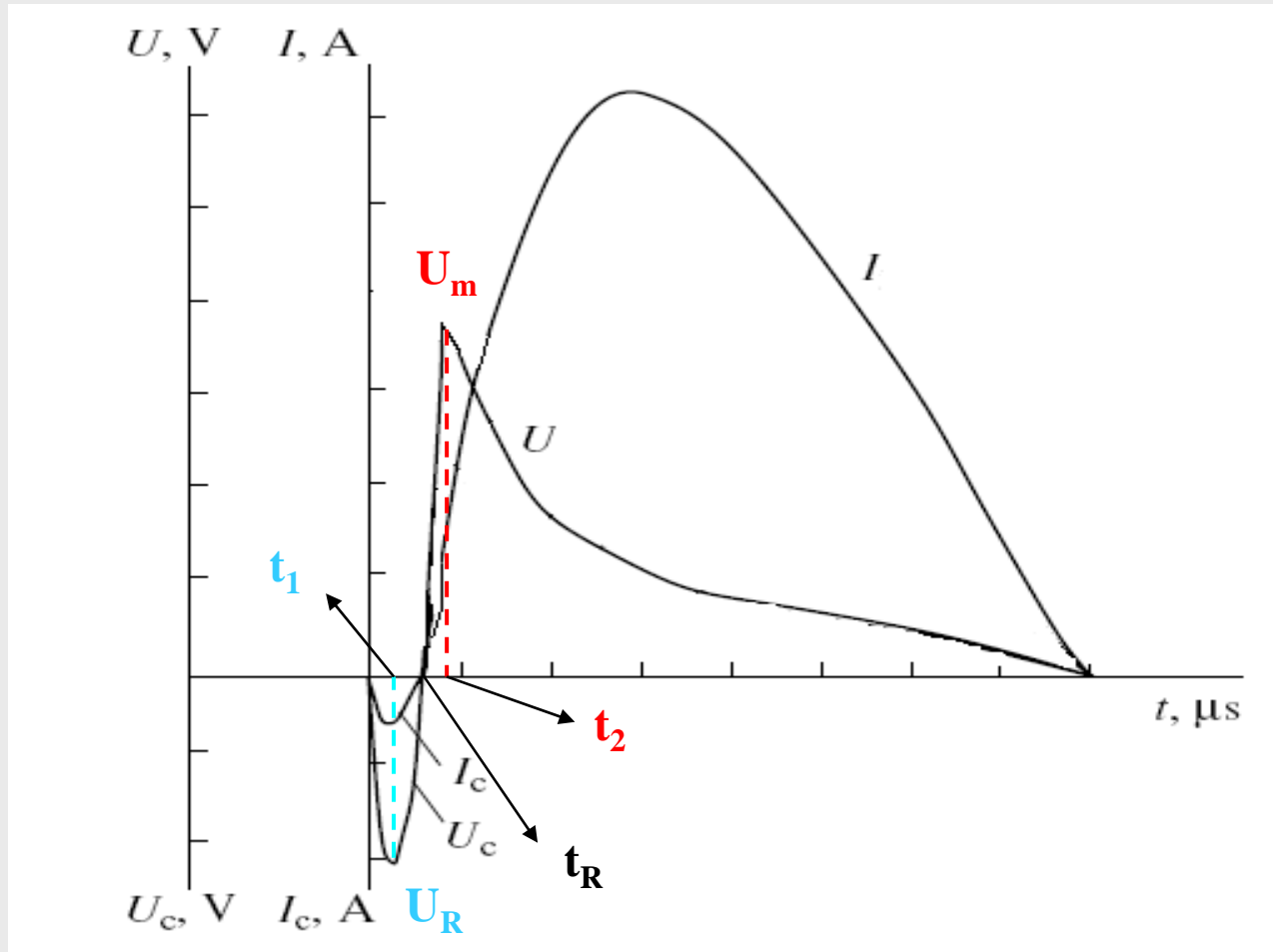
Trigger process



Switching process

Plasma distribution in RSD operating process

Calculation of energy losses in RSD



Typical voltage drop and current

Calculation of energy losses in RSD

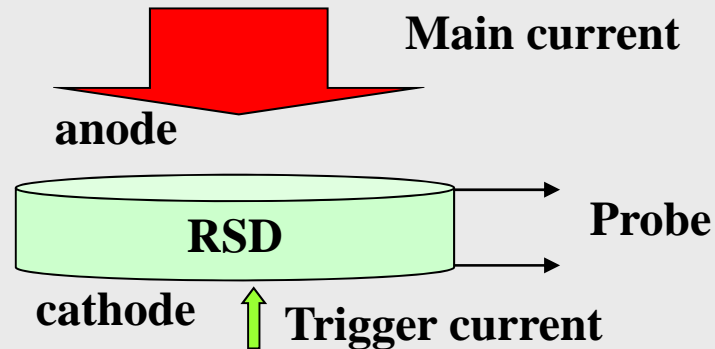
$$U_{\text{RSD}}(0 < t \leq t_1) = \frac{J_{\text{R}} W_n^2}{\mu_p} [(BQ_N)^{-1} - \frac{1}{3} Q(t)(BQ_n)^{-2}] + U_{\text{BREAK}}^{\text{E}}$$

$$U_{\text{RSD}}(t > t_1) = \frac{2}{3} \frac{J_{\text{R}} W_n^2}{\mu_p \sqrt{BQ_n Q(t)}}$$

$$U_{\text{RSD}}(t_R < t \leq t_2) = \frac{2}{3} \frac{J_{\text{F}}(t) W_n^2}{\mu_p \sqrt{BQ_n Q_{\text{R}}(t)}}$$

$$U_{\text{RSD}}(t > t_2) = \frac{2}{3} \frac{J_{\text{F}}(t) W_n^2}{\mu_p \sqrt{BQ_n Q_{\text{F}}(t)}}$$

Results and Discussion

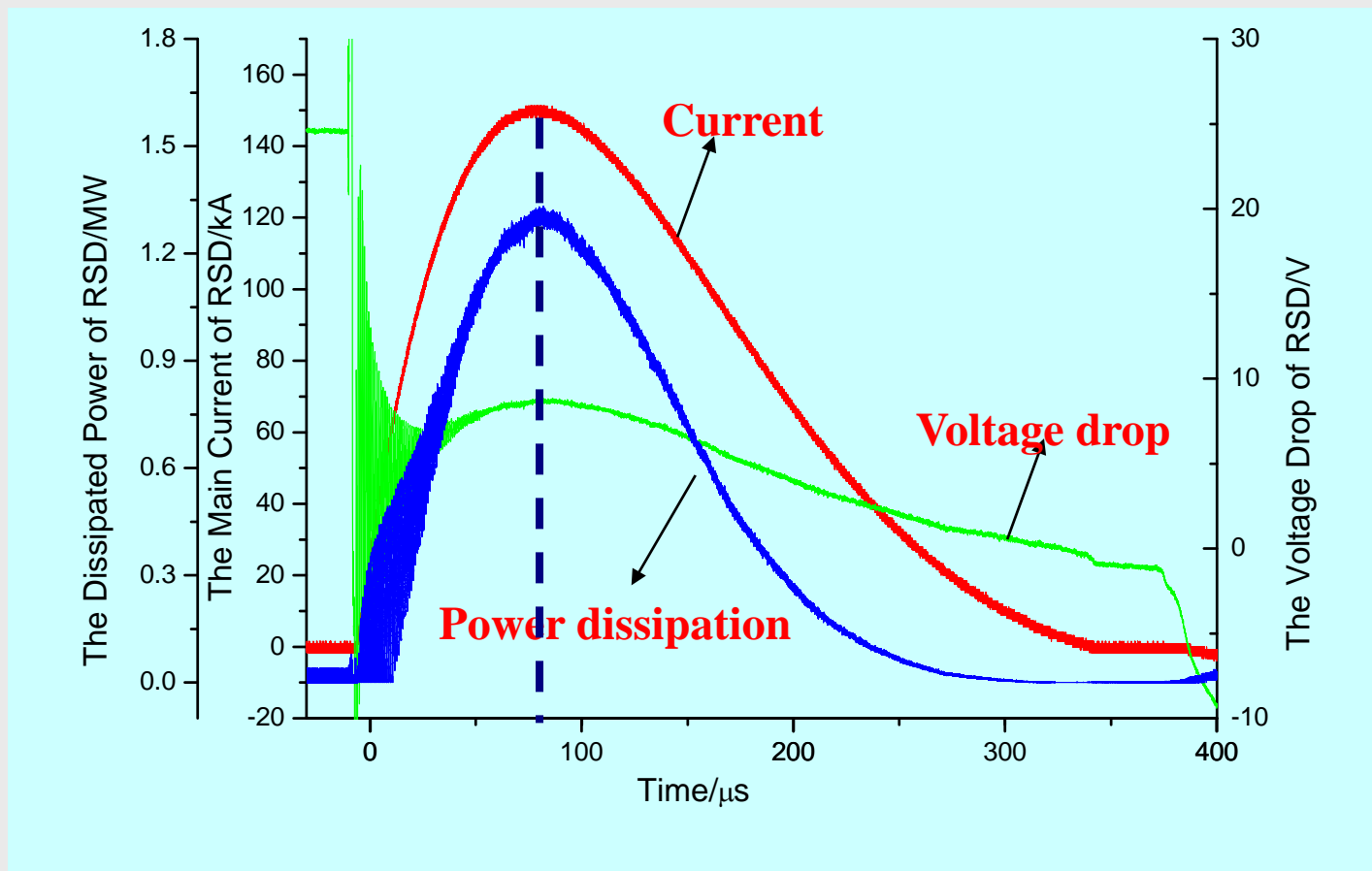


The experimental arrangement for measuring the voltage drop of RSD

The specifications of pulse generator

- Peak Current: 150kA;
- The maxim di/dt : 4kA/ μ s;
- Transferred charge : 26.5C
- Action : 2.94MA²S

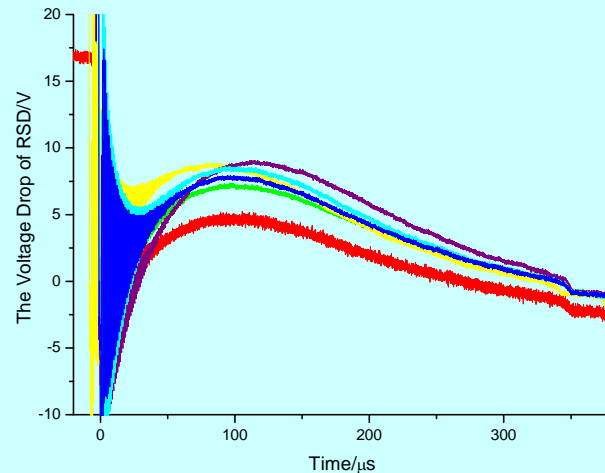
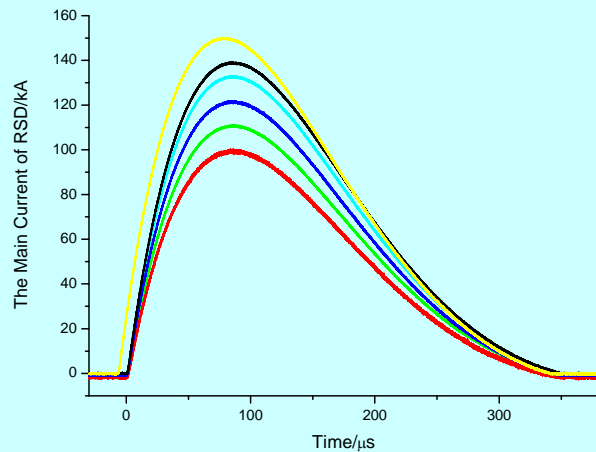
Results and Discussion



Reverse switching dynistor at a peak current of 150 kA
with a voltage drop of 9V

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Results and Discussion

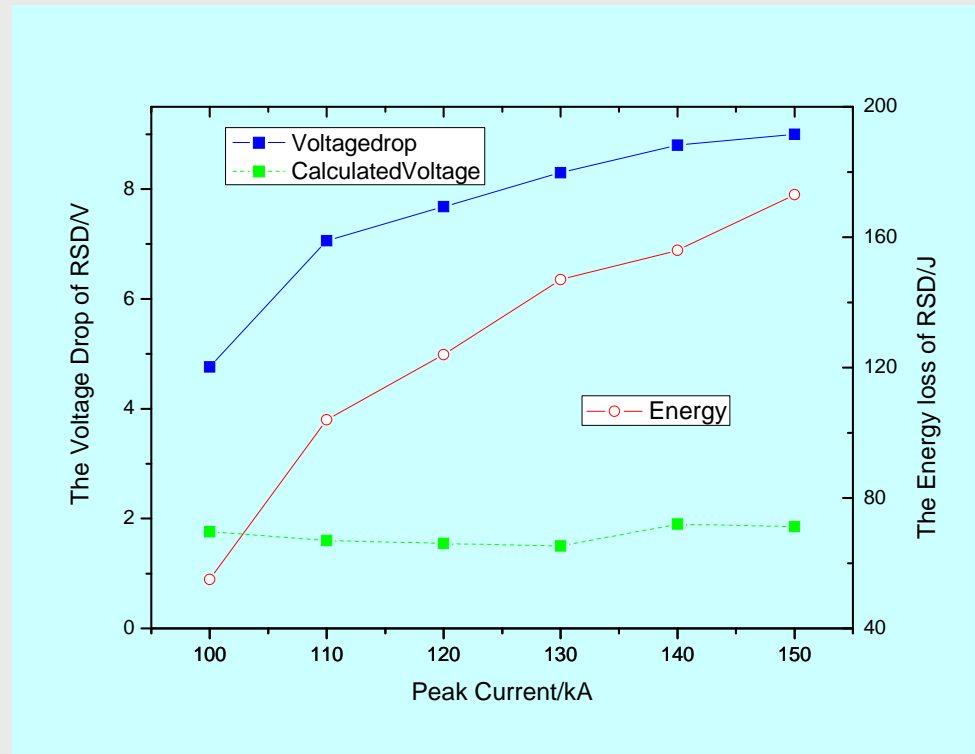


➤ **The forward peak voltage drop on RSD slowly increases with the increment of peak current.**

Voltage drop of Reverse switching dynistor at various amplitudes of peak current

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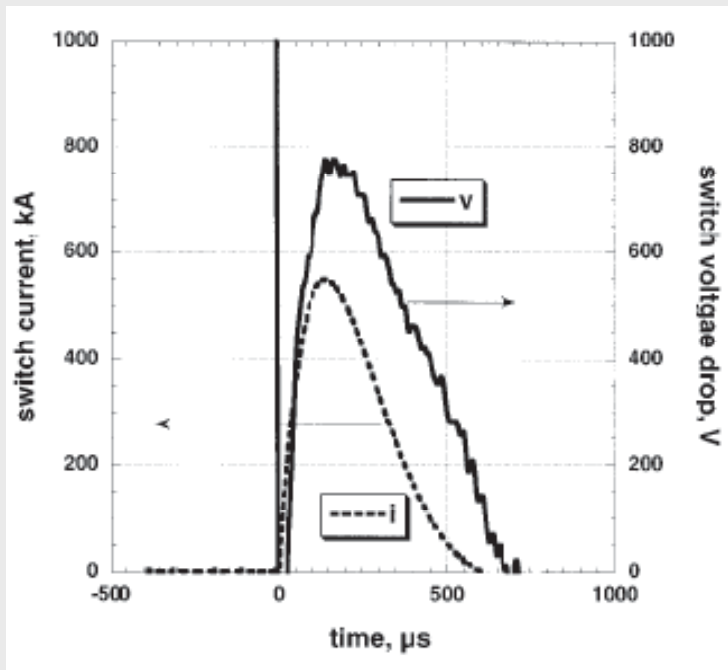
Results and Discussion



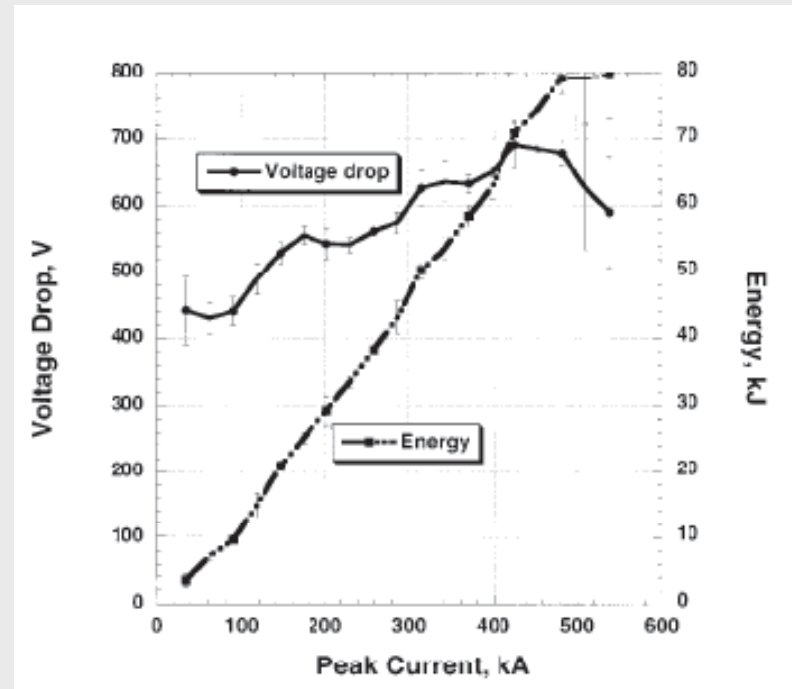
Voltage drop at peak current and energy loss of Reverse switching dynistor versus amplitude of switching current

➤ **The total energy losses of six RSDs are about 1kJ, which accounts for 0.67% of the total transferred energy.**

Results and Discussion



Current and voltage drop of ST-300



Voltage drop at peak current and energy losses in ST300 at various amplitudes of current

Conclusion

- The low switching energy losses characteristics of RSD are investigated by experiments at various amplitudes of switching current.
- The typical voltage drop at peak current of 150kA with the base width of about 300 μ s is about 9V.
- The total energy losses of six RSDs are about 1.02kJ, which accounts for 0.67 % of the total transferred energy of 153kJ.

Conclusion

- As far as the dissipated energy under the same conditions is concerned, RSD manifests an advantageous trait of low energy losses by 1-2 orders of magnitude compared to spark gap ST300.
- The experimental results of voltage drop on RSD are not consistent with the calculated, which should be deeply studied later.

Thank you !