More about the Nanolite Discharge

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Background

The experiments I want to talk about were published in steps over the years [1] . Improved diagnostics with subnanosecond time resolution now provide more detailed information about pulse shapes, lightrise and time jitters. This has stimulated new interests for early spark channel development. The search for controlled highpower diffuse plasma presently is being organized in the puls-power program. Fast and low jitter switching appears a key application.

Wanted is a plasma without a space charge controlled statistical streamer (H. Raether), which determines spark breakdowns in many environments. The initial channel of the narrow gap "Nanolite", however, appears to grow diffuse from both electrodes without streamer formation and no instabilities, as is demonstrated in Fig. 2.

Results

Simplicity of high rep. rate "Nanolite" Spark Light Source [1] operation is well known and demonstrated. Fig. 1 shows the Nanolite including dry-cell power supply and electric puls pick-up box.

Fig. 1 Nanolite Assembly, operational set up

This small, ~ 800 p Fd Standard Nanolite has a 3-4 ns electric pulse and a ~ 6-8 ns lightpuls, depending upon gas and pressure. Pulswidth of the max. currentrise ($d_i/d_t = U/L$; U = voltage, L = inductance) close to aperiodic discharge simply can be altered by changing the length of the plated coaxial capacitor. Pulses between ~ 15 - 1 ns normally are produced. The trigger jitter can be reduced to a few 100 ps, when pulsed. Max. power densities in the ~ 0.01 cm spark channel may approach the Terrawatt/cm^3 magnitude. Controlled high rep. rate bursts up to 50 kcycles are possible.

The foremost thermal spark channel approaches opacity and a rectangular intensity profile with elevated gaspressure and increased energy input. Max. "Saturation" brightness with surface radiation temperatures between 30-60 thousand K are reached [2] . Light pulses in the 10 ns range broaden to over 100 ns halfwidth as a result of "trapping".

Low intensity initial channels in the $\gtrsim 1$ ns range follow the current pulse closely. The cylindric, approx. 20-30 micron diameter initial channel in 1 at air develops from both electrodes joining at center gap, growing uniform in length with time and increasing capacity [3] .

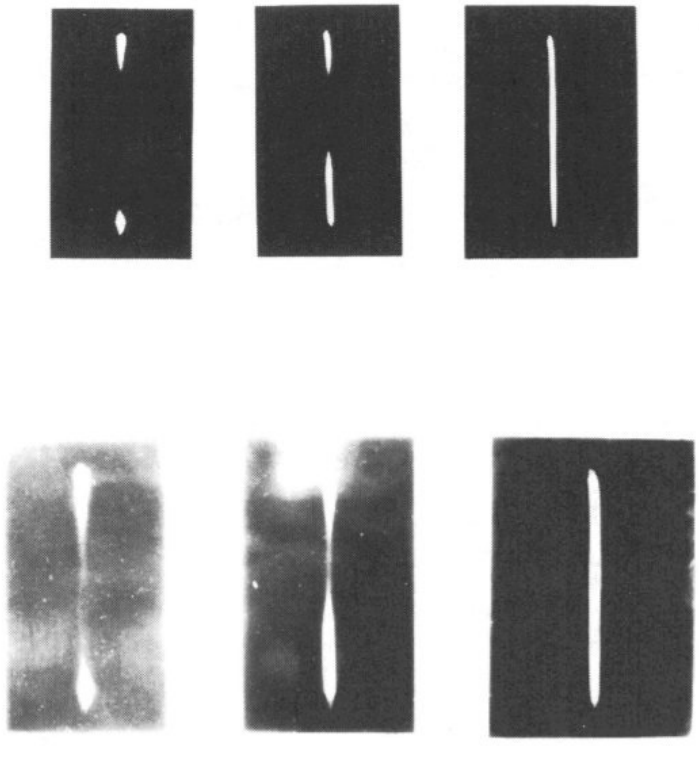

Fig. 2 Initial channel in a ~150 pFd discharge

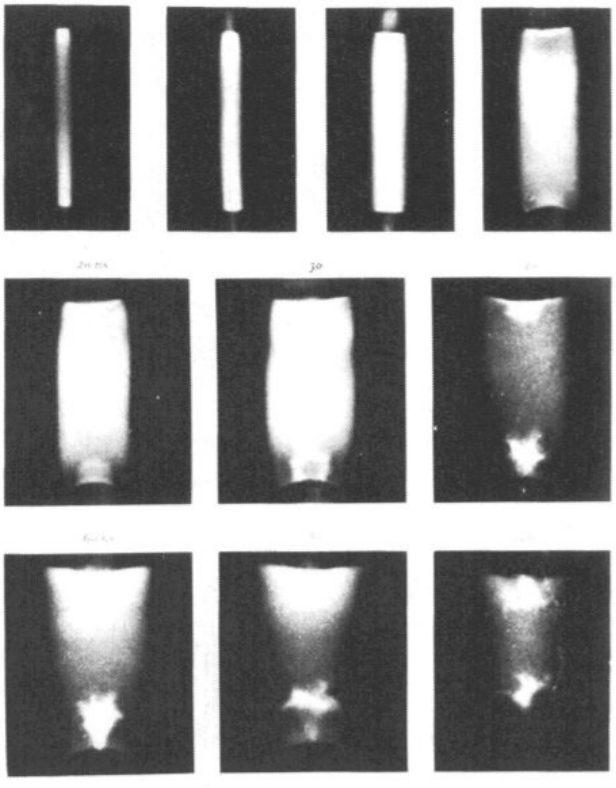

Fig. 3 Anode erosion jet in a 15 ns discharge

The pictures in Fig. 2 show three phases of not pulsed initial channel development. The second row are overexposed copies of the same photographic film, demonstrating that a faint and much more narrow ionisation thread connects the gap before the initial channels have grown together. The analysis of intensity contrasts in shorttime optical radiation structures appears to be a problem especially when using subnanosecond high amplification image-intensifiers, as is being realized.

The initial channels from both electrodes are diffuse and cylindric with a close to equal diameter.

Electrode erosion is negligeable with discharges $\lesssim$10 ns. An explosive anode jet develops after a longer duration discharge (See Fig. 3) [4] . The apparent lack of erosion and missing follow up instabilities appears the reason for the many shot constancy of the close to aperiodic shorttime Nanolite discharge.

The smallest Nanolite demonstrate a ~2/10 ns risetime. This makes the source an interesting tool for photoelectric response analysis. The principle of the Nanolite system and its applications are described in Literature [5].

References

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