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Kinetics of nanosecond discharges at high specific energy release[1]

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Voltage pulses 5-10 kV in amplitude and a few tens of nanoseconds in duration are capable to produce highly nonequilibrium low temperature plasma in a wide pressure range, from 0.1 Torr to 15 bar. High electric fields, up to kTd, are typical for discharge front. Behind the front the electric field stays high, hundreds of Td, providing high densities of electronically excited states, high dissociation degree and so high efficiency of nanosecond discharge as a trigger for various chemically active systems. The fact that nanosecond discharges are uniform at low and moderate gas densities, and are naturally synchronized within 0.1 ns in time in the case of a multi-streamer configuration at high gas densities, is extremely attractive for laboratory-scale research. At specific deposited energies 0.5-1 eV/molecule high rate of energy relaxation from electronically excited molecules or so-called fast gas heating provides increase of gas temperature for thousands of K during tens of nanoseconds; excitation degree becomes so high that the collisions of excited species with charged, other excited and dissociated species become important, changing "classical" low temperature plasma kinetics developed in the assumption of a small chemical perturbation of the system. A review of plasma parameters in nanosecond discharges, from fast ionization waves (FIWs) at low pressure to filamentary nanosecond surface dielectric barrier discharges (nSDBDs) at tens of bars will be given.

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