PHYSICAL PROCESSES IN CAPILLARY DISCHARGES

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Gas discharge in a trough duct in a dielectric is called usually as capillary discharge. Geometry of the plasma – magnetic field configuration in such discharges is similar to what we have in classical Z-pinches. Capillary discharge plasma has different applications: a) as a source of UV radiation; b) as an active media for EUV and soft X-ray lasers; c) as a plasma wave-guide for long enough transportation of power laser beams; d) as a plasma lens to focus beams of accelerated charge particles; etc. This talk presents a review of physical processes that govern main properties of capillary discharge plasma. This review is based on a lot of MHD computer simulations and their comparing with experimental data.

Electric current flowing though the capillary discharge acts on the capillary plasma mainly in two quite different ways. Firstly, the electric current ***j*** excites azimuthal magnetic field ***B***. Thus, Amper’s force proportional to ***j***×***B*** tries to compress plasma to capillary axis. Secondly, the electric current causes Joule heating of the plasma. This heating rate is proportional to ***j***2/σ, where σ is electric conductivity of the plasma. Magnetic field may also leads to minor consequences like modification of thermal conduction etc.

For higher currents, hotter plasma and larger capillary diameters the first effect prevails, that leads to strong compression of the plasma towards the axis. Plasma dynamics in this case is similar to its dynamics in classic Z-pinches. Parameters of the prefilled gas, current amplitude and capillary diameter determine maximum temperature of the plasma at stagnation, its density and moment of the stagnation. These relationships will be considered in this talk.

For lower currents, relatively cold plasma and smaller capillary diameters, relatively strong Joule heating leads to that Ampere’s force becomes negligible in comparison to plasma pressure so that a quite simple mechanical and thermal equilibrium may be established in the capillary plasma. A very simple model for such equilibrium in hydrogen filled capillary was developed. It describes distribution of temperature and electron density across the discharge.

The capillary discharges are burdened often by evaporation of capillary wall material due to high enough thermal flux to the walls. Physical processes determining temperature of the capillary walls as well as methods of taking into account this evaporation will be considered also.