Pattern formation in DC driven "barrier" discharges

Danijela Sijacic and Ute Ebert
Centrum voor Wiskunde en Informatica, P.O.Box 94079, 1090 GB Amsterdam

We investigate a homogeneous planar short gas discharge gap with a high ohmic semiconductor cathode that is driven by a stationary DC voltage. Such systems can spontaneously generate a variety of spatial, temporal or spatio-temporal patterns [1].

In our theoretical approach to these systems, we investigate the minimal model of low current discharges in non-attaching gases which consists of continuity equations for the charged species (electrons and ions) with impact ionization reaction by electrons in the bulk and by ions at the cathode (Townsend's α- and γ-processes), coupled to the Coulomb equation.

As a starting point, we have determined the stationary homogeneous solutions and the current-voltage characteristics at the working point of the experiments which is at the transition from Townsend to glow discharge. We derived our solutions both numerically from the full equations and analytically by second order perturbation theory about the Townsend limit, which is in excellent agreement with the numerics.

In the region of the experiments, the transition from Townsend to glow can follow the standard subcritical curve (the voltage at the glow is lower than the break-down Townsend voltage), and it also can be supercritical. We sketch how this could be related to the transition to either spatial or temporal spontaneous pattern formation.

References

[1] see, e.g., E. Ammelt *et al.*, Phys. Rev. E **55**, 6731 (1997) and C. Strümpel *et al.*, Phys. Rev. E **62**, 4889 (2000).