COMPUTING DC DISCHARGES IN A WIDE RANGE OF CURRENTS WITH COMSOL MULTIPHYSICS: TIME-DEPENDENT SOLVERS VS. STATIONARY SOLVERS

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The most commonly used solvers in models of DC gas discharges are time-dependent solvers. Solutions are obtained by specifying an initial state and following the evolution of the discharge over time until a steady state is reached.

In the last 15 years multiple modes of arc-cathode attachment have been computed in high-pressure arc discharges by means of stationary solvers, see review [1]; a procedure that has now become standard practice. Apart from computing the multiple modes of arc-cathode attachment, stationary solvers have revealed the existence of hysteresis of the modes of arc-cathode attachment in high-pressure arc discharges.

Recently, multiple DC glow discharge modes have been computed by means of stationary solvers of the commercial software COMSOL MultiPhysics [1]. Some of the modes computed comprise patterns of cathodic spots which are similar to those observed in experiments [2]. Stationary solvers have also revealed hysteresis in glow discharges, even in apparently simple situations.

This work is aimed at finding whether multiple modes and hysteresis can be computed by means of time-dependent solvers in both glow and arc discharges. Capabilities of time-dependent solvers are compared of COMSOL and of a non-commercial code. It has been found that in order to compute the full pattern of multiple modes a stationary solver must be employed. At least one 2D mode of glow discharge can be computed independently with a time-dependent solver.

1. M. S. Benilov, "Multiple solutions in the theory of dc glow discharges and cathodic part of arc discharges. Application of these solutions to the modeling of cathode spots and patterns: a review", Plasma Sources Sci. Technol., vol. 23, no. 5, pp. 054019, 2014.
2. W. Zhu and P. Niraula, “The missing modes of self-organization in cathode boundary layer discharge in xenon”, Plasma Sources Sci. Technol., vol. 23, no. 5, pp. 054011, 2014.

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