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A stabilized finite element method for gas discharge modelling
MARKUS BECKER, DETLEF LOFFHAGEN, FLORIAN SIGENEGER, INP Greifswald, WERNER SCHMIDT, Department of Mathematics and Computer Science, University of Greifswald — Fluid models consisting of Poisson's equation for the electric potential, continuity equations for the relevant plasma species and the electron energy balance are widely used for the theoretical description and analysis of glow discharges. The discretization of the corresponding partial differential equations by means of standard finite difference and element methods leads to serious restrictions for the spatial mesh spacing Δx resulting from the condition $|P_e| \leq 1$ for the local Péclet number P_e whose fulfillment prevents spurious oscillations. To avoid this problem, a stabilized finite element method was developed by choosing upwind test functions instead of the same basis for the test and trial spaces. Using the example of a one-dimensional low-pressure glow discharge in argon with an electrode gap of 1 cm it is shown that this improved method yields stable and non-oscillatory results, even if the condition $|P_e| \leq 1$ is not fulfilled. As an advantage of the new technique it is demonstrated that the numerical results do not exhibit the excessive diffusive behavior as the often used stabilizing Scharfetter-Gummel scheme and upwind finite difference methods.

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