

Fluid Modeling Of Dielectric Barrier Discharges For Plasma Technology

A. P. Jovanović¹, M. Stankov¹, D. Loffhagen¹, M. M. Becker¹

¹INP Greifswald, Germany

Abstract

COMSOL Multiphysics® with LiveLink™ for Matlab® is used for the numerical analysis of dielectric barrier discharges (DBD), which are widely used in various fields of plasma technology, such as surface processing, plasma medicine, and agriculture. The fluid model comprises balance equations for the particle number densities of relevant plasma species, the electron energy density, and the density of surface charges, which are accumulated at the dielectric surfaces. The set of balance equations is coupled with Poisson's equation for a self-consistent determination of the electric field. Physics-based boundary conditions and initial values are applied to close the coupled system of partial differential equations. The in-house code MCPlas is used for an automated implementation of the COMSOL® model on the basis of given input files specifying the plasma species and plasma-chemical reactions to be included, relevant coefficients, the geometry, and further input data. MCPlas is implemented in Matlab and uses the LiveLink™ for Matlab® interface to set-up the equation-based COMSOL® model. The main advantage of this automated and equation-based approach is that large systems including tens to hundreds of species and hundreds to thousands of plasma-chemical reactions can be quickly implemented using individual modeling approaches. The present contribution highlights how MCPlas is used to build-up time-dependent DBD models in spatially 1D and axisymmetric 2D geometries. The COMSOL® models thus generated are used to study diffuse and filamentary DBD in argon at different conditions.

This work is funded by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) - project numbers 368502453 and 407462159.

Figures used in the abstract

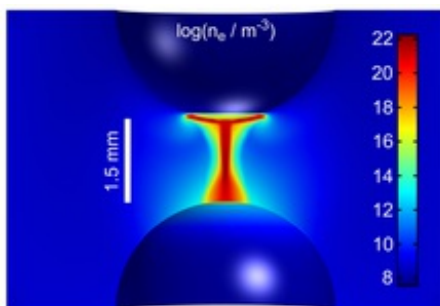


Figure 1 : Electron density in a single-filament dielectric barrier discharge in argon at atmospheric pressure.