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FLUID MODELLING OF SINGLE-FILAMENT DBD AND SELF-PULSING DISCHARGES AT ATMOSPHERIC PRESSURE USING FEDM

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Abstract. Non-thermal atmospheric-pressure plasmas have found many applications in various areas of science and technology in recent years (Keidar et al., 2021). An efficient way to generate these plasmas is often achieved either by limiting the current amplitude by introducing a dielectric layer over the electrode(s) in dielectric barrier discharges (DBDs) (Brandenburg et al., 2023) or the duration of the discharge using well-designed circuits in self-pulsing transient spark discharges (Janda et al., 2011 and Gerling et al., 2013). This work presents the fluid-Poisson modelling of these discharges using the Finite Element Discharge Modelling (FEDM) code (Jovanović et al., 2023), which is based on FEniCS (Logg et al., 2012). The first study focuses on a pulsed-driven single-filament DBD with two hemispherical alumina-covered electrodes with a 1 mm gas gap. The modelling is carried out at atmospheric pressure in N_2 with an admixture of 0.1 vol. % of O_2 (Höft et al., 2018) to analyse different features during discharge inception and streamer propagation. The comparison of modelling results with measured current and streamer velocity shows their good agreement with the experiment. The second study presents modelling results of a self-pulsing transient spark discharge in argon at atmospheric pressure. For this study, the model includes an additional equivalent circuit equation to describe the self-pulsing behaviour and the heat equation to account for the gas heating. The model reproduces a self-pulsing behaviour well and enables the prediction of the charge carrier densities and gas temperature during the discharge.

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