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Fluid-Plasma-Combustion Coupling Effects on the Ignition of a Fuel Jet[1] LUCA MASSA, Virginia Tech, JONATHAN FREUND, University of Illinois — We analyze the effect of plasma-combustion coupling on the ignition and flame supported by a DBD interacting with a jet of H_2 in a air cross-flow. We propose that plasma-combustion coupling is due to the strong temperature-dependence of specific collisional energy loss as predicted by the Boltzmann equation, and that e^- transport can be modeled by assuming a form for the E-field pulse in microstreamers. We introduce a two-way coupling based on the Boltzmann equation and the charged species conservation. The addition of this mechanism to a hydrogen combustion scheme leads to an improvement of the ignition prediction and of the understanding of the effect of the plasma on the flow. The key points of the analysis are 1) explanation of the mechanism for the two-stage ignition and quenching observed experimentally, 2) explanation of the existence of a power threshold above which the plasma is beneficial to the ignition probability, 3) understanding of the increase in power absorbed by the plasma in burning conditions and the reduction in power absorbed with an increase in the cross velocity, 4) explanation of the non-symmetric emissions and the increase in luminescence at the rotovibrational H_2O band. The model is validated in part against air-H_2 flow experiments.

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