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Fluid-Plasma Coupling in Hydrogen Flames LUCA MASSA, JONATHAN RETTER, NICK GLUMAC, GREGG ELLIOT, JONATHAN FREUND, University of Illinois — Recent experiments show that hydrogen diffusion flames at low Reynolds number can be markedly affected by a dielectric barrier discharge (DBD) plasma. The flame surface deforms and flattens, and light emissions increase. We develop a simulation model to analyze the mechanisms that causes these changes, and apply it to numerical calculations of axisymmetric flames with co-annular DBD, matching the corresponding experiments. Body forces due to charge sheaths are found to be the main mechanism, with radicals produced by plasma excitation playing a secondary role for the present conditions. The non-actuated flame flickers at approximately 10 Hz, in good agreement with the experiments. As the DBD voltage is increased, the flame flattens and oscillations decrease, eventually ceasing above a threshold value. The fully flattened case has a stoichiometric surface lying flat across the fuel orifice, with flame temperature exceeding significantly the adiabatic flame value. A force based on a linearized plasma sheath model, calibrated against air experiments, reproduces the main features of the experiments and provides a good estimate for the threshold flattening potential. In faster flowing regimes, radical production by the plasma becomes more important.

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