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Lumped-element Circuit Model for Single-Dielectric Barrier Discharge Plasma Actuator DMITRI ORLOV, THOMAS CORKE, University of Notre Dame, MEHUL PATEL, Orbital Research — This work presents an extension of our previous studies on a single-dielectric barrier discharge (SDBD) plasma actuators. The space-time lumped-element circuit model that had been developed for the actuator is intended to model the details of the ionization process to provide predictions of the body force for a range of parameters without the need of experimental calibration. In this model, the domain over the covered electrode is divided into several parallel equivalent circuit networks, each consisting of resistive and capacitive elements and zenor diodes. The results of this numerical model show very good agreement with the space-time resolved experimental observations of the plasma illumination over the dielectric surface for a range of applied voltage amplitudes and frequencies. These characteristics include plasma sweep-out velocity and spatial extent, and spatial intensity decay. The model provides the boundary conditions on the electric potential over the dielectric that is needed in solving for the actuator space-time body force. The plasma body force is then used in a Navier-Stokes flow solver to study the effects of the plasma actuator. Examples of simulations with the plasma actuator on a flat surface and the leading edge of an airfoil are presented. The simulations show good agreement with comparable experiments. Supported under a USAF SBIR Phase II Contract FA8650-04-C-3405.

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