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Numerical Simulation of Nanosecond Pulsed Dielectric Barrier Discharge Actuator for Flow Control J.G. ZHENG, Temasek Laboratories, National University of Singapore, Z.J. ZHAO, Department of Mechanical Engineering, NUS, J. LI, Y.D. CUI, B.C. KHOO, Temasek Laboratories, NUS, TEMASEK LABORATORIES, NUS TEAM — Recently, nanosecond pulsed dielectric barrier discharge (DBD) actuator has emerged as a promising active flow control means. In this study, numerical simulation is carried out to investigate fluid dynamics induced by nanosecond pulsed gas discharge. Two types of so-called phenomenological approaches reported in the literature are employed to model effects of plasma discharge. In the first methodology, the plasma region over covered electrode is modelled as preheated and pressurized gas layer. The second method is based on a quasi-one-dimensional self-similar, local ionization kinetic model. The plasma models are then coupled with compressible Navier-Stokes equations governing the external flow. The two models are validated against experimental data obtained for flow field arising from single voltage pulse discharge in quiescent air and proved to be valid. The numerical method is then applied to study flow separation control over NACA0015 airfoil with the actuator placed on the leading edge of airfoil. The goal is to numerically reproduce the formation and development of complex vortex structures due to plasma actuator induced shock propagation through the airflow. Special interest is focused on how the generated vortex interacts with and suppresses the separated shear layer.

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