Phase 2 Project Summary

Firm: Tech-X Corporation
Contract Number: NNX11CA46C
Project Title: Simulation Tool for Dielectric Bar Discharge Plasma Actuators at Atmospheric and Sub-Atmospheric Pressures

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

An optimization of DBD plasmas used for actuators using efficient, comprehensive, physically-based DBD simulation tool for different operation conditions would allow NASA researchers to more quickly evaluate designs. We propose to develop a DBD plasma actuator simulation tool for a wide range of ambient gas pressures. The proposed tool will treat DBD using either kinetic, fluid or hybrid model, depending on the DBD operational condition. The proposed tool will be validated by comparison with the experimental and numerical data on the DBD investigations.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The objectives of this project are

Objective 1 - Extend chemical and physical discharge model in VSim

Objective 2 - Extend hybrid capabilities of the proposed model

Objective 3 - Enhance computational speed of the proposed DBD Simulation Tool.

Objective 4 - Demonstrate the DBD simulation tool through validation against experimental data at wide range of DBD operational conditions.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

Our accomplishments are:

We extended an air-chemistry and collision database for DBD plasma actuator modeling.

We implemented a photoionization model in VSim.

We enhanced hybrid capabilities of VSim.

We integrated the concept of multilevel meshing into VSim.

We developed an approach for adaptive timesteps in VSim.

We implemented an electric circuit model in VSim for DBD modeling.

We performed simulations of a DBD plasma actuator over a range of pressures.

We validated VSim against data from Princeton University researchers.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

The primary NASA applications of the proposed DBD simulation tool are active flow control concepts for both subsonic and hypersonic flights. Predictable active flow separation control, achieved using th e proposed tool, will benefit many NASA Projects, such as Subsonic Fixed Wing Project, Subsonic Rotary Wing Project and Hypersonic Project. In addition to the flow separation application, DBD simulation tool can be used for a number of NASA problems, associated with gas discharges at different pressures. For example, DBD simulation tool can be used for the description plasma-assisted combustion for the reduction of carbon emissions.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

Active flow control using DBD plasma actuators is of interest to a number of government agencies, private industry and universities. Proposed tool will be beneficial for subsonic/ hypersonic programs which involve active flow separation control. These programs include, but are not limited to, flow separation control at commercial airplanes during take-off or landing, increase in lift for tiltrotor aircrafts, improvement of engine performance, active flow control at hypersonic vehicles. Besides the primary application for a description of DBD operation, DBD simulation tool can be used for a wide range of plasma aerodynamics applications, such as plasma-assisted combustion, flow control using different types of discharges, reduction of carbon emission, optimization of air vehicle operation, MHD and EHD application.

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