Simulation Tool for Dielectric Barrier Discharge Plasma Actuators

Can be used at atmospheric and subatmospheric pressures

Traditional approaches for active flow separation control using dielectric barrier discharge (DBD) plasma actuators are limited to relatively low speed flows and atmospheric conditions. This results in low feasibility of the DBDs for aerospace applications. For active flow control at turbine blades, fixed wings, and rotary wings and on hypersonic vehicles, DBD plasma actuators must perform at a wide range of conditions, including rarified flows and combustion mixtures. An efficient, comprehensive, physically based DBD simulation tool can optimize DBD plasma actuators for different operation conditions.

Researchers are developing a DBD plasma actuator simulation tool for a wide range of ambient gas pressures. The tool will treat DBD using either kinetic, fluid, or hybrid models, depending on the DBD operational condition.

Applications

NASA

- Active flow separation control:
  - Subsonic and hypersonic flights
- Optimize gas discharges at different ambient pressures (e.g., plasma-assisted combustion for the reduction of carbon emissions)

Commercial

- Active flow separation control for subsonic and hypersonic programs:
  - Flow separation control for commercial airplanes during takeoff or landing
  - Active flow control for hypersonic vehicles
  - Increase in lift for tiltrotor aircraft
  - Improvement of engine performance
- Plasma aerodynamics applications:
  - Plasma-assisted combustion
  - Flow control using different types of discharges
  - Reduction of carbon emission
  - Optimization of air vehicle operation
  - Magnetohydrodynamic (MHD) and electrohydrodynamic (EHD) applications
  - Plasma processing and plasma medicine

Phase II Objectives

- Extend chemical and physical discharge model in VORPAL® software application
- Extend hybrid capabilities of the proposed model
- Enhance computational speed of the proposed DBD simulation tool
- Demonstrate the DBD simulation tool through validation against experimental data at a wide range of DBD operational conditions

Benefits

- Provides an efficient and effective simulation tool for DBD plasma actuators
- Is optimized for a wide range of ambient gas pressures

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Proposal Number: 09-2: A2.05-9058