Enhanced Dielectric-Barrier-Discharge Body-Force Generation using Nanofoam Materials with Infused Catalytic Layer

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Dielectric-Barrier-Discharge (DBD) actuators are surface-mounted, weakly ionized gas (plasma) devices consisting of pairs of electrodes separated by a dielectric and operated at high AC voltages. The electrically charged dielectric surface attracts charged ions in the air plasma, imparting momentum to the non-ionized air through many molecular collisions. Increasing the surface charge magnitude and/or increasing the ion density in the air plasma can increase momentum exchange to create an aerodynamic body force that accelerates neutral gas in the vicinity of the plasma for boundary layer separation control. The main barrier to widespread use of DBD's is low force generation capability relative to aeronautical flow requirements. The potential for this technology to enable new flight applications and game-changing flight vehicle concepts can be moved forward by examining currently employed dielectric materials from a fundamental materials perspective. The goal of this study is to better understand those features that favor higher body force generation. Favorable characteristics include low dielectric constant, high breakdown strength, low dielectric loss, a catalytic layer to enhance the charge density in the air adjacent to the surface, operational robustness and manufacturing formability. Scant attention is being paid to these requirements in the literature where the body of reported work is largely focused on the plasma science. In Phase I of this Seedling work, the relevant dielectric properties were determined for materials that can be used for these actuators and the body force generated were also measured. These parameters will feed into models to predict properties that guide the optimized design of these devices. Characterization was completed for a range of existing commercially available and NASA-developed materials that have potential to yield higher body forces and are suitable for expanded applications in various flight regimes. Implications of these properties on enhanced DBD performance will be discussed.