Dielectrophoretic Control of Macroscopic Media for In-Space Applications

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Introduction

Dielectrophoresis (DEP) is a phenomenon in which matter moves when placed in a non-uniform electric field. DEP is widely used in microscale applications, but there are scant applications of DEP at macroscopic scales. The authors wish to investigate DEP for large scale applications, such as voltage-controlled artificial gravity for crewed spaceflight. We initiated this research by measuring DEP-induced forces generated in a test bed.

Diagnostics

Electric \( (E) \) fields are generated by an electrode charged by a 50kVDC power source. A test object, suspended from a low-mass pendulum arm, is placed in the \( E \) field. DEP-induced forces attract the object to the electrode. We carefully slide the electrode from its center position. Force is derived from the maximum angle at which the electrode holds the object at its surface.

Test objects are spheres roughly 1 cm in diameter. Materials are chosen for their representative electrical properties: glass (an insulator), metal (a conductor), and wood (organic matter). Three electrodes (fig. 2) are used to test four simple electrode geometries. A 2 mm coating of polymer clay eliminated arcing from the electrodes.

Results

- Electrode geometries used in these trials did not greatly impact force production. Larger electrodes appear to provide greater force.
- Glass consistently experienced more force than wood. Metal experienced no force in direct-current \( E \) fields.

Conclusions & Future Research

- DEP was utilized to generate a macroscopic body force on 1 cm scale nonconductive objects.
- A pendulum test bed enabled mechanical measurement of DEP-induced force.
- Glass and wood objects experienced 10-36% of Earth’s gravitational force during trials.
- This work provides the foundation and experimental validation for larger scale applications of DEP.
- A proposal to NASA has been invited to be submitted for a voltage-controlled artificial gravity environment for crewed missions to Mars as an outgrowth of this summer’s research.

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