EHD and electrostatic propulsion using multiplexed electrodes

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Abstract

Electro hydro dynamic (EHD) and electrostatic propulsion devices has no moving parts and, in the air, operates on electrical energy. Theory on the improvement of capacitance by multiplexing the electrodes of the capacitor was reported. It has been experimentally shown that the multiplexing of the electrodes improves the accumulated charge. This can be applied to an EHD device, and experiments showed that multiplexing of the electrode edges could improve the propulsion.

1.Introduction

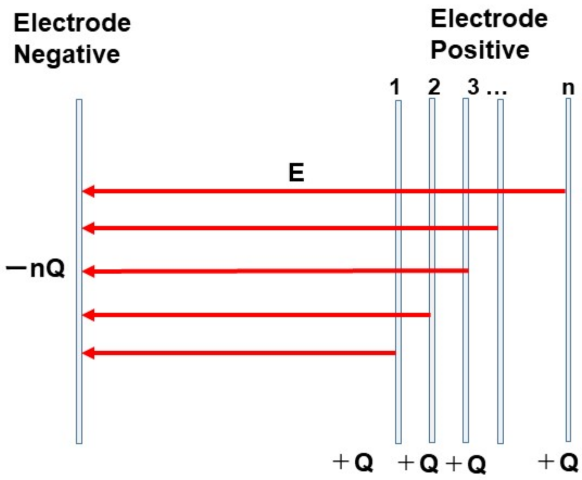
It is expected to develop electric propulsion systems without future moving parts of airplanes and helicopters propellers in the future. The advantage of this propulsion system is that 1) there are no moving parts, easy to maintain and 2) the propulsion efficiency may exceed the conventional engine.

There is a report that the principle of ion craft considered as a part of a series of thrust generation experiment by Brown effect using high voltage is propulsion by the imbalance of electrostatic force, attraction by space charge. We also think so from many experimental results other than that paper. Much research has been done on the principle of lifters.

Increases in propulsion with multiple electrodes have also been reported. It is considered that the propulsion principle is determined not by the ion wind but by the external electric field (applied voltage) and the amount of electric charge accumulated in the electrode. In the system introduced so far, the thrust density (N / kg) is low and it does not exceed the self-weight of the case where the power supply is mounted.

In this time, I investigated whether the multiplexed single electrode could improve the amount of accumulated charge or the propulsion to improve the amount of charge at the edge of the propulsion electrode.

2. Principle



$$C = \frac{S}{d}\epsilon \qquad C_2 = \frac{nQ}{V}$$

Fig.1. Principle for multiplication of capacitance.

FIG. 1 shows the principle of an increase in capacitance by a multilayer capacitor. At this time, the space between the electrodes is assumed to be filled with an insulator having a dielectric constant ε. In the case where the electrodes are one-to-one, assuming that the voltage applied to the voltage between both ends of the capacitor is V, the electric charge Q is accumulated in one of the electrodes, and the formula of the capacitance is shown next.

$$C_1 = \frac{Q}{V} = \varepsilon\frac{S}{d}. \tag{1}$$

Here, it is assumed that one electrode has single layer and single positive electrode are multiplexed to be n layers. Assuming that the charge storage amount per unit is Q, the charges that increased to nQ in total are stored in the positive electrode. Therefore, the capacitance is shown next.

$$C_2 = nC_1 = \frac{nQ}{V}. \tag{2}$$

By equation (2), the charge amount is improved by n times.

3. Experiment

Based on the above theory, a multilayer capacitor was actually manufactured, and the capacitance was measured. The experimental setup for capacitor with multiplexed electrodes is shown in Fig. 2. The size of the aluminum foil as a large electrode was 4.5 × 6 cm^2. A paper as an insulator was set between the electrodes. The number of left electrode was one, and the number of right electrode was changed to be one, two, and three. The capacitance was measured with a tester.

In this experiments, the capacitance increased proportionally to the number of electrodes as the theory indicates as shown in Fig. 3.

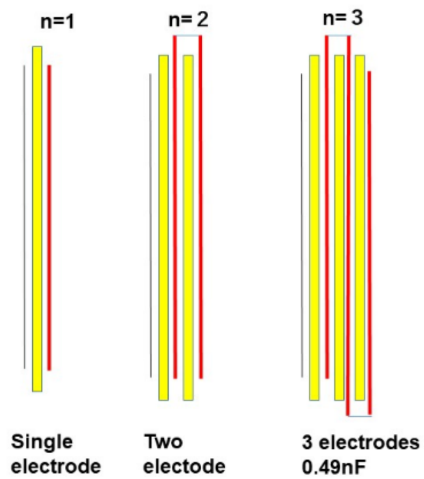


Fig.2. Capacitor. Red: multiplexed electrodes, Yelow: insulator.

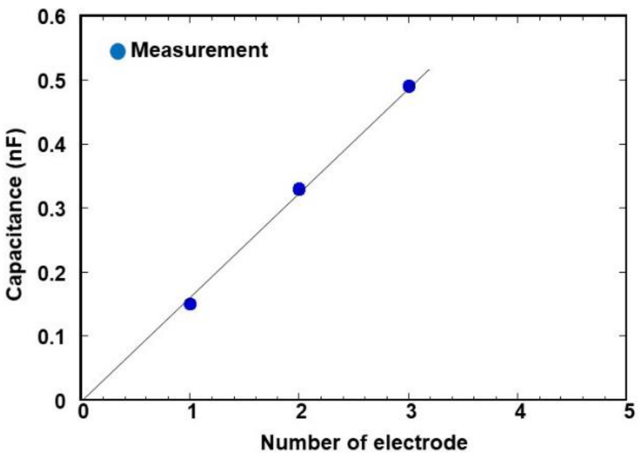
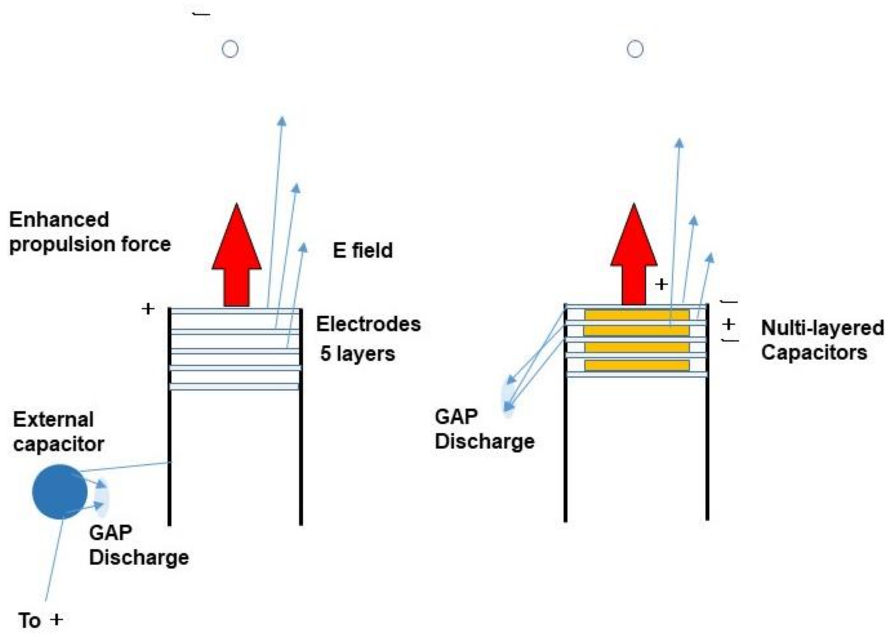


Fig.3. Measured capacitance.



(a) (b)

Fig.4. Experimental setup. Electrode without capacitor, (b) Electrode with capacitors.

FIG. 4 shows an experimental model in which the edge portion of a single electrode is multilayered. FIG. 4(a) shows that the capacitor is set outside for injecting electric charge by applying a sawtoothed high voltge pulses [9]. On the other hand, FIG. 4(b) shows that the electrode includes capacitors for applying a high pulse voltage to the outside and injecting electric charge. When the capacitor is charged and the external air gap is discharged, negative charges escape to the power supply, and a large number of positive charges remain in the large electrode. It results in increasing the thrust.

As an example, the above model was fabricated. The wire electrode as a negative electrode was attached at the center of the large electrode separated by a single plastic stick. The size of the large electrode was 250 x 40 mm. The edge part of the large electrode was multilayered. When 25 kV DC is applied and the applied voltage is pulsed by an external capacitor capacity with 2200 pF capacitance, thrust is generated as if the device was jumping. In addition, when the frequency of the high voltage pulses was increased to a few 10Hz, the thrust increased close to twice in experiments as that using single layered electrode.

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