The electric field driving generator

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***Abstract*—Dr. Feynman expected that it is theoretically possible to get electric energy from an electric field. A new electrostatic generating method was proposed for realizing this dream. This method uses Asymmetric electrostatic force to transport a charge carrier of the generator. Then this generator called as the electric field driving generator.**

After many pendulum type experimental equipment have been tested, a rotation type equipment was made. At first, it could not work, but it worked very well after using ADB bearings. Because its kinetic friction coefficient is very low. And Feynman's expectation has been confirmed by an actual experiment.

Keywords
Electrostatic Generator; Asymmetric Electrostatic Force; ADB bearings,
Electric field driving, Electric energy

1. Introduction

Today there are many kinds of electric power generators. They have some merits and some demerits. Therefore, an ideal electric power generator that never produce carbon dioxide and safety, stability, low cost, long life time, is strongly desired.

The well known physicist: Richard P, Feynman estimated that in theory getting energy from an electric field is never impossible, and we will actually met the special (shape) electric field that realize this estimate [1]

Therefore the new electrostatic power generator that can get energy from an electric field will become the ideal electric power generator. However the special shape electric field have been not realized today.

A new phenomenon: Asymmetric electrostatic force [2],[3] was discovered nine years ago by the author. The getting energy from an electric field becomes possible by using this force. This new force acts on an asymmetric shape charged conductor in a normal electric field. Namely, the getting energy from an electric field becomes possible by changing the shape of the charged conductor in place of changing the shape of an electric field.

For confirming this theory by actual experiments, several trial experiments had been done with using pendulum type experimental equipment [4], [5]. However all trial experiments became fail.

2. Theory of the electric field driving generator.

A. *Asymmetric electrostatic force*

For a long time, the main purposes of electrostatic research have been electrophotography and electrospray coating. Both technologies make use of fine charged powders, which are moved by electrostatic force. The magnitude of the electrostatic force has been calculated by the well-known Coulomb's formula (1). It is apparent from this formula that the magnitude of this electrostatic force doesn't change when the direction of the electric field turns over as shown in figure 1.

$$f = qE, \quad (1)$$

where f: Electrostatic force that acts on the fine charged powder.

q: Quantity of charge on the fine powder.

E: Intensity of the electric field in which the fine powder is placed.

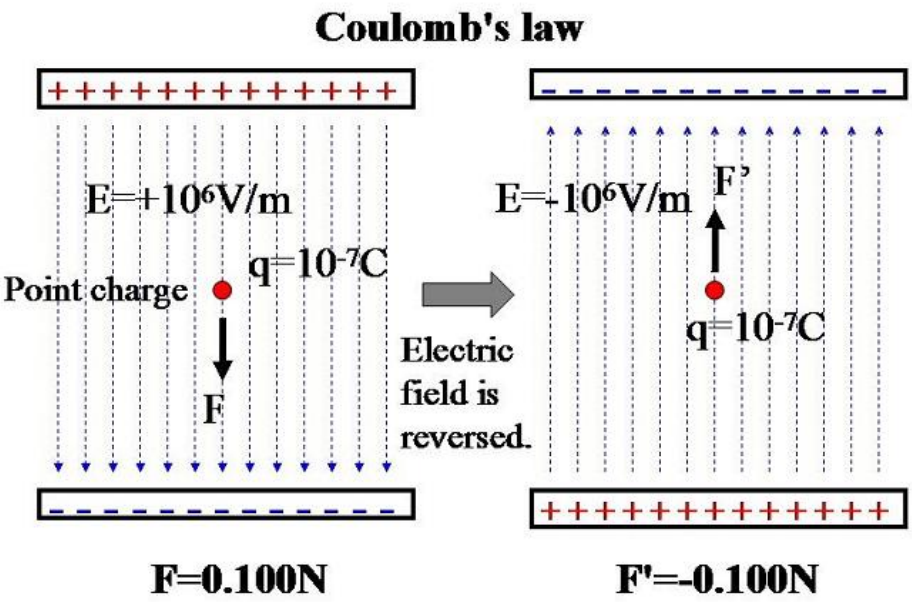

Fig. 1. Electrostatic force that acts on a point charge (Coulomb's law)

The application of this formula is limited to point charges and sphere-shaped charge carriers [6]. The charge on a fine powder has commonly been treated as a point charge.

In contrast, a new electrostatic generator that uses a non-spherical charge carrier was presented recently [7], [8]. This generator uses an asymmetric shape conductor as its charge carrier. The electrostatic force that acts on this asymmetric shape charge carrier was both simulated and experimentally measured [2]. As a result, it has become clear that the magnitude of this electrostatic force reduces when the direction of the electric field is reversed as shown in figure 2.

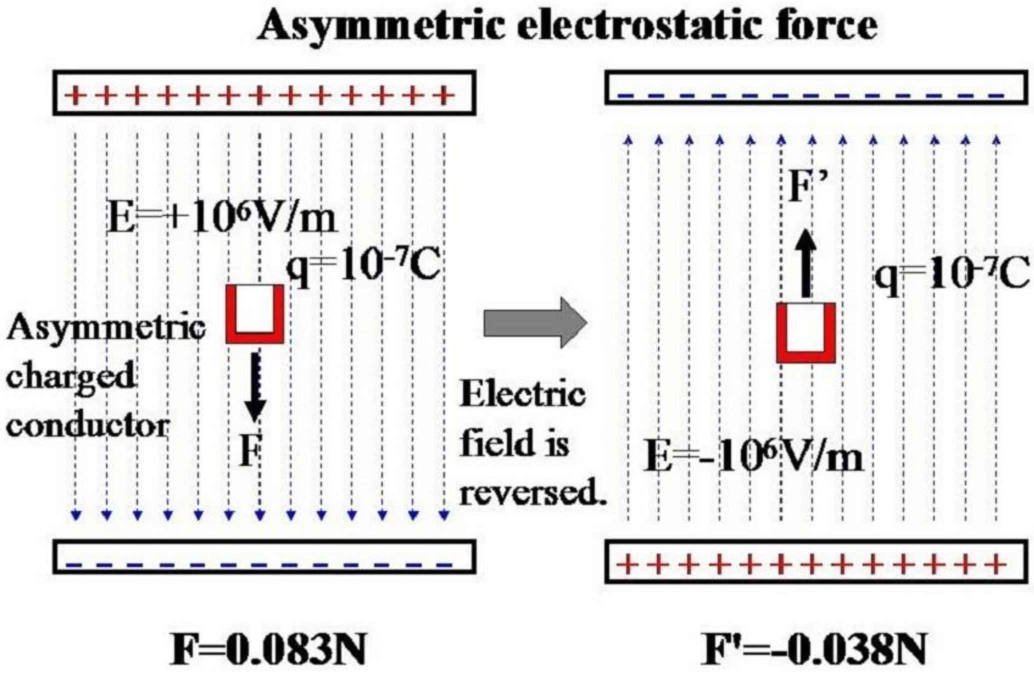

Fig. 2. Electrostatic force that acts on charged box conductor (Asymmetric electrostatic force)

And this changeable electrostatic force was named as Asymmetric electrostatic force unofficially.

And the left side electric field of figure 2 was named as a forward electric field and the right side electric field was named as a backward electric field. In the figure 2, the magnitude of the electrostatic force becomes less than half when the direction of the electric field is reversed.

B. Basic theory of the electric field driving generator

The idea behind an electrostatic generator has been defined by lifting the charge to a high potential by mechanical force against the electric force that acts on this charge. It is impossible for the mechanical force to carry the charge directly. Therefore, the charge is packed into a suitable body. We call this body the charge carrier.

The most popular electrostatic generator is the Van de Graaff type electrostatic generator [9]. This was invented by Dr. Van de Graaff in 1931 in the USA. Today, it is used with a large voltage power supply. It can produce ten million volts. In this machine, an insulating belt is used as a charge carrier. Figure 3 shows an example of this generator.

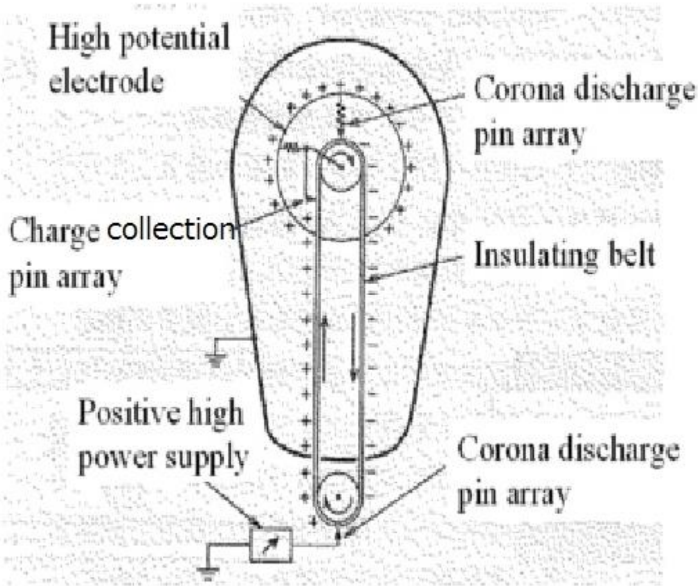

Fig. 3. Schematic layout of the Van de Graaff electrostatic generator

The insulating belt is moved in the direction of the arrow by a motor. The bottom corona discharge pin array places positive ions on the insulating belt. The positive ions on the insulating belt are carried to the high voltage electrode sphere by the mechanical force of a motor. Corona discharge occurs between the negative charge on the recovery pin array and the positive ions on the insulating belt. As a result, the positive ions on the insulating belt are neutralized by the negative corona ions. Then, positive charges (holes) are added to the high voltage electrode sphere.

The principle of this electrostatic generator is shown schematically in Fig. 4.

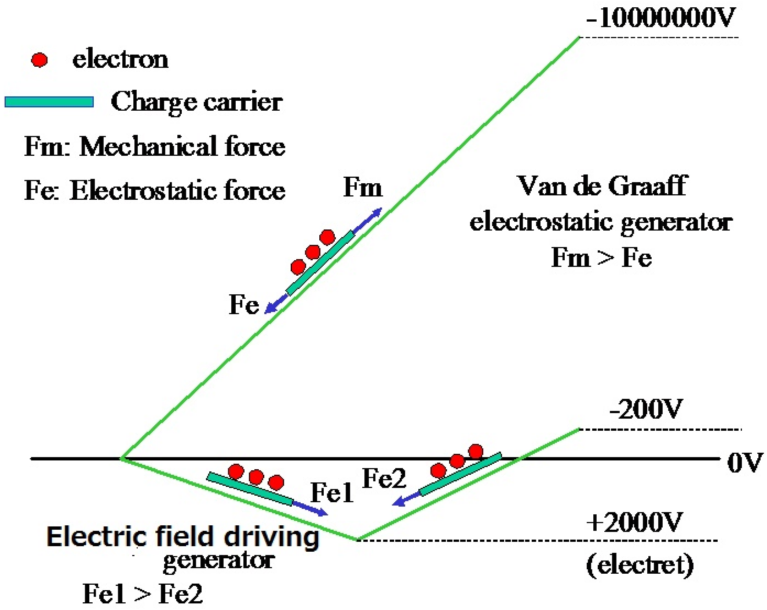

Fig. 4 Schematic explanation of the principles behind the two electrostatic generators.

In figure 4, the bold green line represents the potential, and the blue arrows represent the forces. The small red circles represent the electrons, and the sky blue plates represent the charge carriers. In the Van de Graaff electrostatic generator, the charge carrier is directly transported by a strong mechanical force, Fm, against the electrostatic force Fe.

In contrast, in the electric field driving generator, the charge carrier is firstly moved in the forward electric field caused by electrets (the high voltage source) according to the electrostatic force Fe1. In this process, the charge carrier gains kinetic energy from the electric field. Then, the charge carrier is moved in the backward electric field, expending the given energy against electrostatic force Fe2.

The shape of this charge carrier is asymmetric. Therefore, Asymmetric electrostatic force acts on this charge carrier. Thus, the absolute value of Fe1 is larger than that of Fe2. As a result, the charge carrier can arrive at a potential that is higher (-200 V) than the initial potential (0 V).

A basic unit of the electric field driving generator that is driven by Asymmetric electrostatic force is concretely shown in figure 5 .

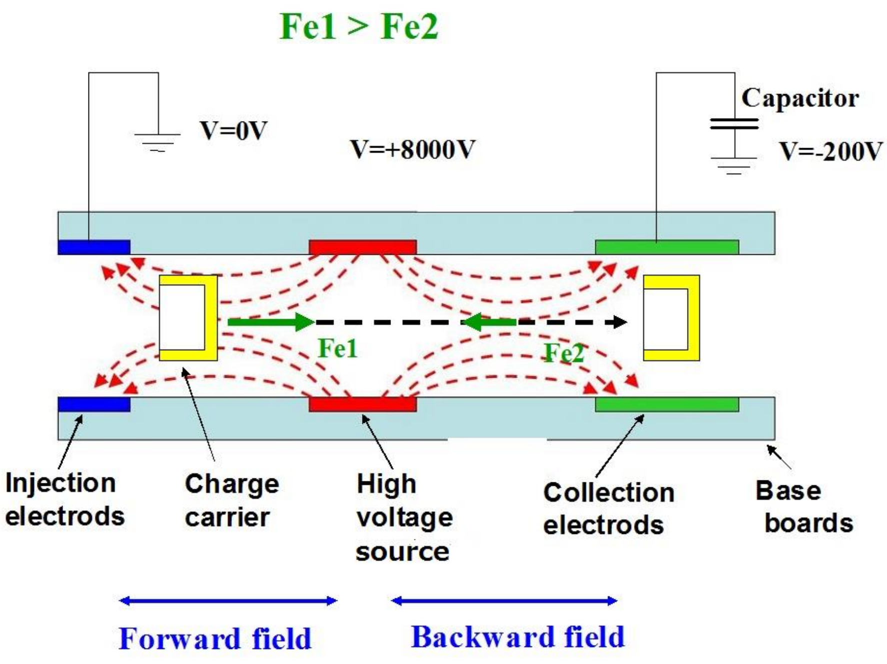

Fig. 5. Schematic layout of a basic unit of the electric field driving generator.

This generator mainly consists of charge injection electrodes , high voltage sources, charge collection electrodes and charge carriers. Those electrode and the high voltage source are disposed on insulating base board.

The high voltage source give a positive high voltage. The injection electrodes are grounded. The collection electrodes are kept at a negative low voltage. As a result, the high voltage source and the injection electrodes produce a forward electric field for a negative charge between them. The high voltage source and the collection electrodes produce a backward electric field for a negative charge between them. The line of electric force is depicted as red arrow dotted lines in figure 5.

A gutter shape conductor is used as a charge carrier that carries negative charge (electron) from the injection electrodes to the collection electrodes through the high voltage sources.

Asymmetric electrostatic phenomenon produces a large electrostatic force in the forward electric field and it produces a weak electrostatic force in the backward electric field. Therefore, the charge carrier gains large kinetic energy in the forward electric field. Then, it loses some of its kinetic energy in the backward electric field. As a result, the charge carrier maintains extra kinetic energy, when it arrives to the collection electrodes . The carried charge can be lifted to a higher potential by this extra energy.

This is the principle of the electric field driving generator. This principle is different from that of the Van de Graaff electrostatic generator.

This electric field driving generator cannot produce ten million volts, but it is low cost, safety, stable and producing no CO2. Furthermore, If the lifetime of the electret is infinite, this generator could generate electric energy forever without adding energy. Because, an electric field energy of an electret will not reduce even if the energy would be used to move a charge carrier [10].

Therefore, this new electrostatic generator will solve the CO_2 problem completely.

3.Experiment instrument

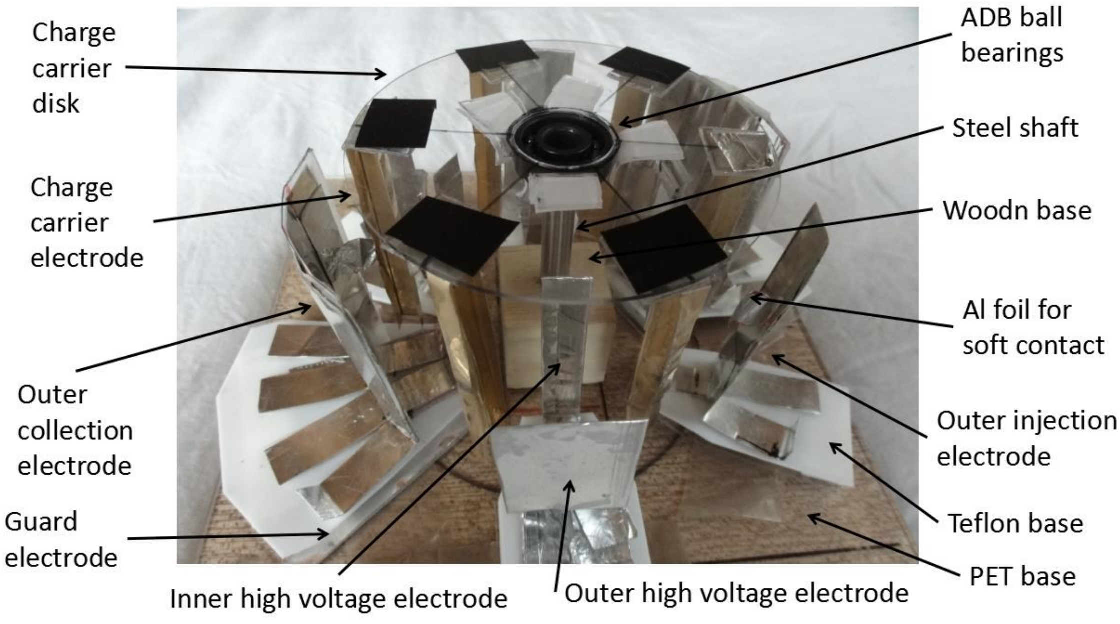

Fig. 6 A photograph of the main part of the experiment equipment of the electric field driving generator

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Figure 6 shows a photograph of the main part of the experiment equipment. Figure 7 and 8 show the front view and plane view of the experiment equipment respectively.

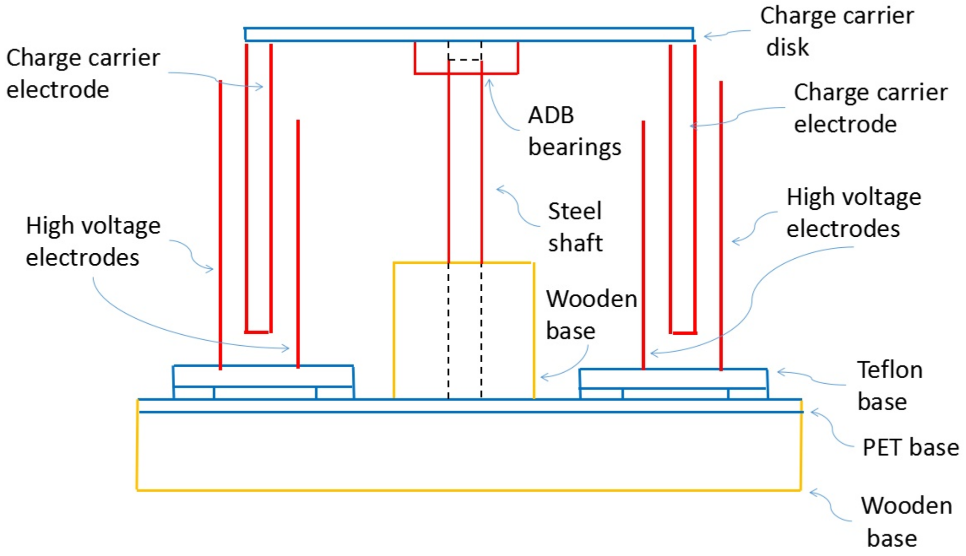

Fig. 7. Front view of the experiment instrument of the electric field driving generator

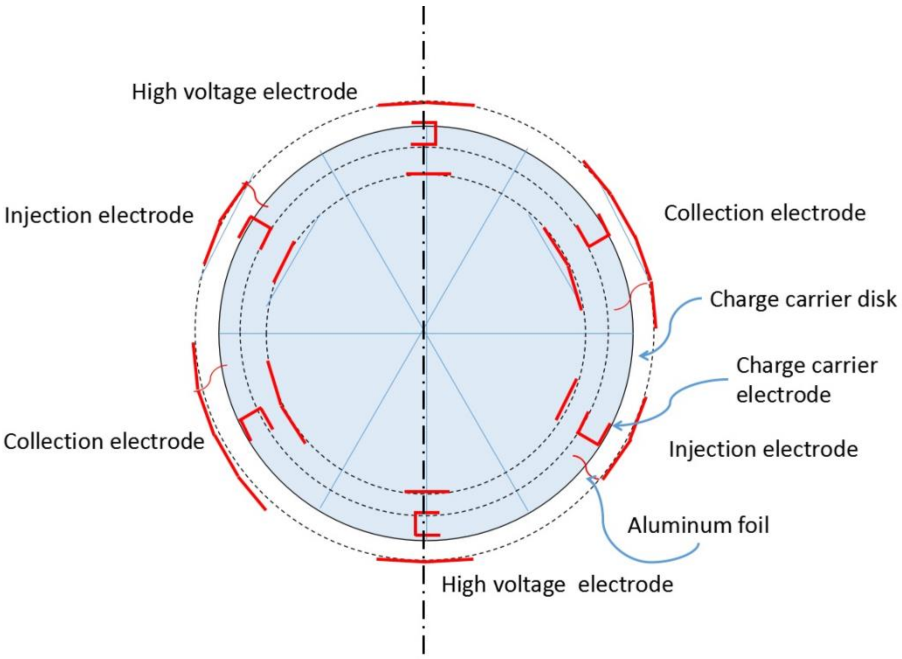

Fig. 8. Plane view of the experiment instrument of the electric field driving generator

This equipment mainly consists of a charge injection electrode, a high voltage electrode, a charge collection electrode, and a charge carrier disk.

On the early stage of this experiment, Teflon contact between the charge carrier disk and the steel shaft was used. However, a kinetic friction coefficient of Teflon is not enough to rotate the charge carrier disk by an electrostatic force only. Therefore, the ADB bearings was selected in place of Teflon contact. This detail will be explained in the next chapter.

The charge carrier disk consist of 1.0 mm thickness PET plate with a diameter of 90 mm. The ADB bearings was fixed on the center of the disk. And the ADB bearings can rotate easily around the steel shaft because the kinetic friction coefficient of the ADB bearings is only 0.015.

The charge carrier disk has six charge carrier electrodes by 60 degree interval as shown figure 8. Those

charge carrier electrodes ware made from one side gold gilding aluminum plates with 0.1 mm thicknesses. As a result, the electrostatic force always acts on those gold surfaces perpendicularly. The shape of the charge carrier electrode was a gutter shape. Its height was 60 mm and its width and breadth is 5 mm each. And its weight less than 10 grams.

There were two charge injection electrodes, two high voltage electrodes and two charge collection electrodes on the main PET base plate by 60 degree interval as shown in figure 8. Each electrodes were placed on Teflon sheets for reducing the leak current.

Those six electrodes have a outer electrode and inner electrode, And distance between them was 20 mm. The injection electrodes and the high voltage electrodes are made from aluminum plates with 0.1 mm thicknesses. And the collection electrodes are made from aluminum plate with 0.1 mm thickness and FET film with 0.5 mm thickness. It consists of three layers: aluminum plate, PET film and aluminum plate. This consist performs a capacitor and its capacitance becomes 330 pF.

The height of the outer electrodes are 60 mm and the height of the inner electrodes are 55 mm.The width of the outer injection electrode, the outer high voltage electrode and the outer collection electrode are 22 mm, 22 mm and 44 mm respectively. And The width of the inner injection electrode, the inner high voltage electrode and the inner collection electrode are 10 mm, 10 mm and 20 mm respectively. The distance between the outer injection electrode and the outer high voltage electrode and the distance between the outer high voltage electrode and the outer collection electrode are 30 mm each. And The distance between the inner injection electrode and the inner high voltage electrode and the distance between the inner high voltage electrode and the inner collection electrode are 25 mm each.

The injection electrodes are always grounded, the high voltage electrodes are connected to a high voltage power supply and the collection electrodes are connected to a capacitor. And the surface potential of this capacitor is measured by a surface potential meter.

The injection electrodes and the collection electrode have an aluminum foil on the inner surface as shown in figure 8. This foil softly connect the charge carrier electrode and the injection and collection electrode electrically.

The width of the collection electrodes are wide. As a result, this collection electrode can perform semi-Faraday gauge. When the charge carrier electrode is connected to the collection electrode by the aluminum foil, over 90% charge on the charge carrier electrode is transferred to the collection electrode (simulation result).

There is a grounded aluminum slice (10mm x 100mm) just before the collection electrode. The leak current from the high voltage electrode to the collection electrode is captured here.

The surface potential meter (SHISHIDO ELECTROSTATIC: STATIRON-DZ 3, Japan) required a large measurement area, namely 20cm*20cm. Therefore, the capacitor was made with the same area by hand. It was made with a bottom aluminum sheet, a PET film and a top aluminum sheet. The thickness of the film was 1.0mm and the capacitance Relative permittivity is 3.2. As a result, the electric capacitance of this capacitor becomes 1100pF. And the capacitance of the collection electrode capacitor is 330 pF, therefore the total capacitance is 1430 pF.

4. SIMULATION RESULT

There are three kinds force that acts on the moving charge carrier as shown in figure 9. They are the electrostatic force, the kinetic friction force and the air resistance force. The electrostatic force and the air resistance force act on the charge carrier electrodes and the kinetic friction force acts between the rotating charge carrier disk and the fixed steel shaft.

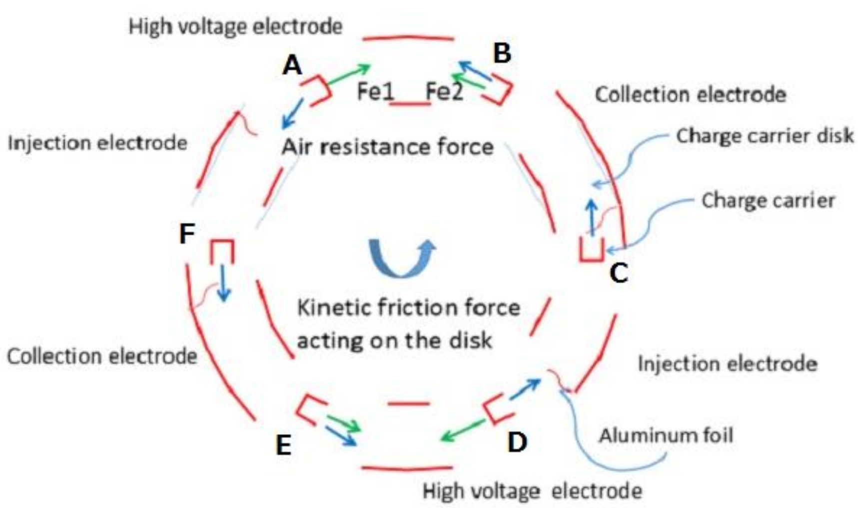

Fig. 9. Three kinds force that acts on the moving charge carrier.

The charge carrier electrode A and D are accelerated driven by a forward electrostatic force Fe1 in the forward electrostatic field between the injection electrode and the high voltage electrode. On the same time, The charge carrier electrode B and E are decelerated by a backward electrostatic force Fe2 in the backward electrostatic field between the high voltage electrode and the collection electrode. On the contrary, The charge carrier electrode C and F are not suffered any electrostatic force because there is no electric field in the area from the collection electrode to the injection electrode..

As a result, the total electrostatic force that acts on those six charge carrier electrodes is calculated by the following equation (2).

$$Fet = fe1 \times 2 - fe2 \times 2 \qquad (2)$$

Where Fet: Total electrostatic force

Fe1: Accelerating electrostatic force

Fe2: Decelerating electrostatic force

Fe1 and fe2 were simulated by two dimensional finite difference method. Of course this method can not be used to a curved material correctly. However its results are expected to be almost agree with a perfect simulation results. Figure 10 shows the simulation result of fe1 and fe2 when the high voltage was 8.0kV.

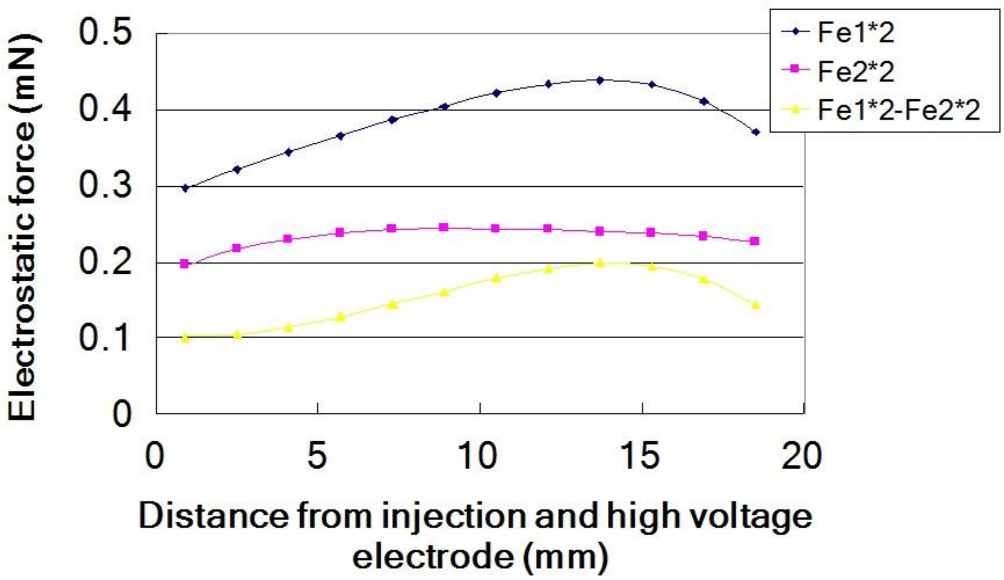

Fig. 10. Simulation results of fe1 and fe2..

It is apparent from figure 10 that average of the total electrostatic force: fe1*2-fe2*2 is about 0.15 mN. Therefore the total of the air resistance force and the kinetic friction force must be lower than 0.15 mN.

An air resistance force:fa is calculated by the following equation (3)..

$$Fa = (C_d \times \rho \times S \times v^2)/2$$

Where C_d: Air resistance coefficient

P : Air density

S : Front surface area of the charge carrier electrodes.

V: Velocity of the charge carrier electrode.

Air resistance coefficient varies with the shape of the moving material. The value for the gutter shape charge carrier electrode was decided as 1.0 because the edge of the gutter was rounded. Air density is 1.3 kg/m^3 The front surface area of the charge carrier electrode is 0.0018 m^2 because the breadth is 5.0 mm and the height is 60.0 mm. The velocity of the charge carrier electrode is 0.34 m/s, because its RPM (rotation per minute) is 72 for one measurement and the radius of the charge carrier disk is 0.045 m.

As a result the air resistance force becomes 0.135 mN. This value is about same as the total electrostatic force. Therefore the kinetic friction force must become almost zero for the charge carrier disk can rotate continuously.

The kinetic friction force Fk is calculated by the following equation (4).

$$Fk = \mu \times m \times g \qquad (4)$$

Where μ: Kinetic friction coefficient

m: weight of the charge carrier disk and electrode g: Gravitational acceleration

At early experiment, the charge carrier disk and the fixed steal shaft were contacted by Teflon and Teflon because the kinetic friction coefficient of Teflon 0.1 is the lowest value between materials. The weight of the charge carrier disk and six charge carrier electrodes is 0.0065 kg and Gravitational acceleration is 9.81 m/s^2, as a result the kinetic friction force between the charge carrier disk and the fixed steal shaft becomes 6.38 mN !! This value is about 40 times larger than the electrostatic force.

As a result the charge carrier disk can not rotate by the electrostatic force. This conclusion was confirmed by an actual experiment later.Therefore, The kinetic friction force must be largely reduced.

Fortunately, a new ball bearings that has lowest kinetic friction coefficient was found. That value is only 0.0015. This surprising new ball bearings was invented by Mr. Kawashima [11]. And it was named as ADB (Autonomous Decentralized Bearing) bearings.

The frictional main reason of a conventional bearings is the increase in slide friction between the balls and the retainer of the ball. ADB bearings make it so the loaded balls are not in contact with each other without using a retainer in order to essentially solve this problem.

The torque of this ADB bearings:T is calculated by the following equation (5)

$$T = (D_p \times F \times \mu) / 2 \qquad (5)$$

Where T: Torque of the bearings

D_p: Radius of the ball bearing

F: Load

μ : kinetic friction coefficient

D_p is 0.0015 m, F is 0.0638 N and μ is 0.0015. As a result, the Torque becomes 7.17 E-8 Nm. The radius of the charge carrier disk is 0.045 m, therefore the rotational force that needs to rotate the disk against the kinetic friction force becomes only 0.0016 mN. This is the kinetic friction force of this ADB ball bearings.

Figure 11 shows the electrostatic force, the air resistance force and this kinetic friction force

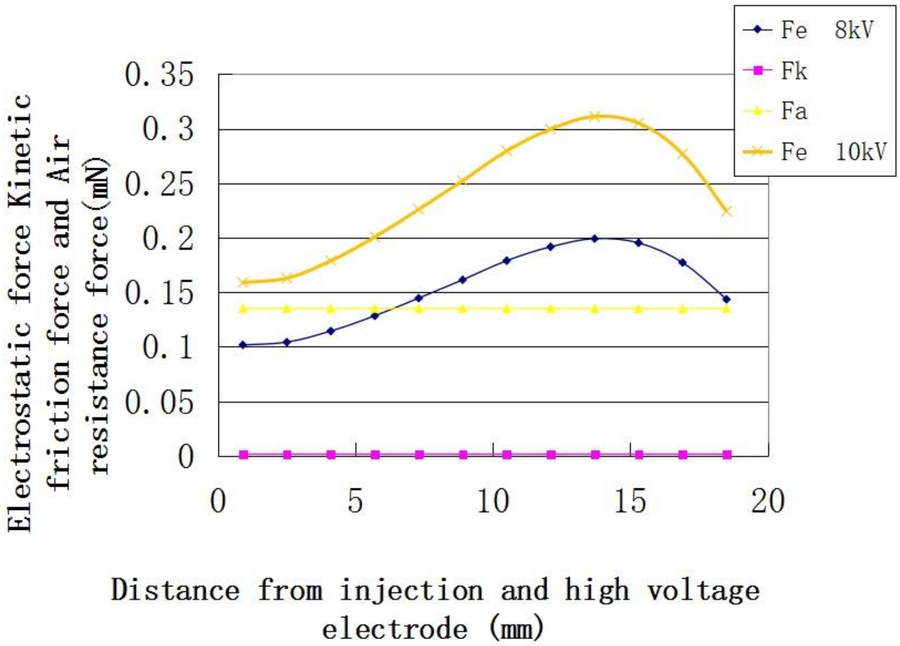

Fig. 11. The three forces that acts on the charge carrier.

It is expected from figure 11 that when the high voltage is higher than 8kV, the charge carrier disk can rotate continuously by the electrostatic force only. Because the air resistance force becomes weaker than the electrostatic force and the kinetic friction force can be ignored.

5. EXPERIMENT RESULTS

After a high voltage was applied to the high voltage electrode, then the charge carrier disk was rotated by an air flow from an air spray. The air spray was continued for 5 seconds, then the charge carrier disk continued to rotate. When the applied voltage was lower than 7.2kV. The rotation stopped after 25 seconds. On the contrary, when the applied voltage was higher than 7.4kV, the charge carrier disk continued to rotate endlessly.

This results means that the charge carrier disk can rotate endlessly by the electrostatic force against to the air resistance force and the kinetic friction force . By the way, the charge carrier disk automatically started to rotate without air flow assist when the applied voltage was 10.0kV.

When the charge carrier continue to rotate, the surface potential of the collection electrode capacitor became higher to minus direction. This results means that this experimental equipment continued to generate an electric power endlessly.

Figure 12 shows the surface potential change of the collection electrode capacitor when the applied voltage was 8.2kV.

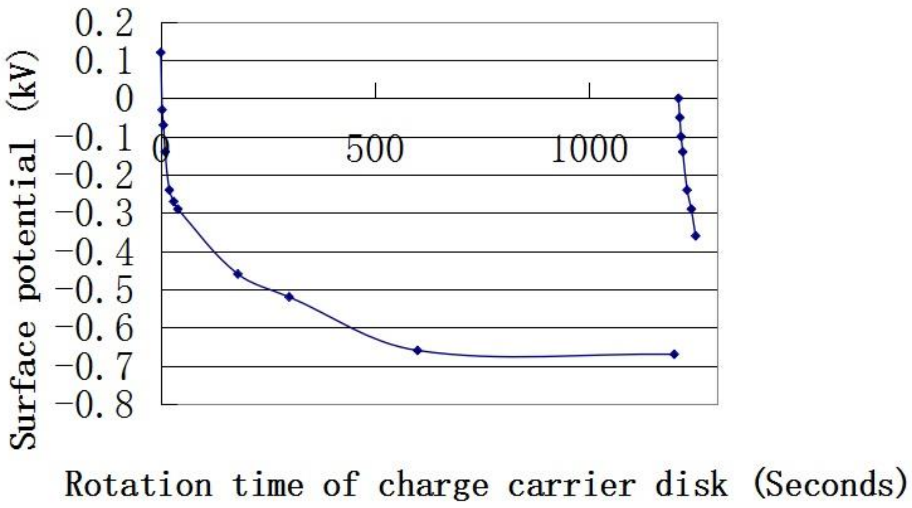

Fig. 12. The surface potential change of the capacitor of the collection electrode for the rotation time of the charge carrier disk..

In figure 12, just after the high voltage was applied to the high voltage electrode, the surface potential shows +0.12 kV. This is a float potential of the upper floating aluminum plate of the capacitor of the collection electrode.

Then the surface potential quickly increase to negative direction as shown in figure 12. However the increase rate gradually becomes slow. And after 600 seconds (10 minutes), the increase rate becomes almost zero. This increase rate of the surface potential is proportional to the collection current. Namely it is the electric power generating rate. So is this results means that the electric power generation became zero after 10 minutes rotation ? The answer is no, because after 20 minutes rotation, the surface potential increased again rapidly to negative direction when the upper aluminum plate of the capacitor was instantaneously grounded. This results means that the electric power generate occur anytime after the capacitor is emptied.

Hence the capacitor was emptied three times by grounded when the charge carrier disk continued to rotate on self at each different applied high voltages. And the collection current was calculated from this three times surface potential change of the capacitor of the collection electrode. Figure 13 shows the average collection current.

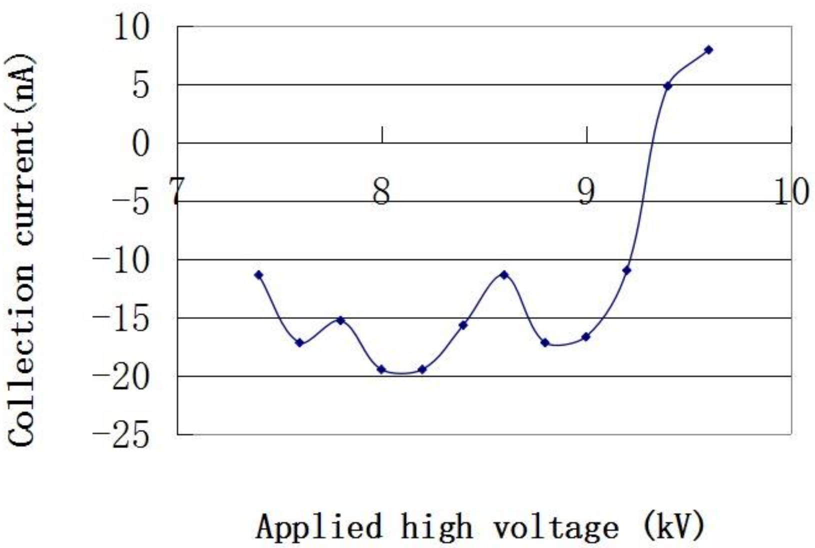

Fig. 13. The collection current change when the applied high voltage is changed.

The polarity of the collection current must be minus because the charge carrier transports a few negative charge (Electrons) from the injection electrode to the collection electrode. And the quantity of the collection current must largely increase with the applied voltage theoretically.

However the quantity of the current decreased from 8.2kV and the polarity changed to plus from 9.4kV. This unexpected results will be explained on the next chapter “Consideration”.

6. CONSIDERATION

The collection current A can be calculated by the following equation (6).

$$A = q \times r \times R \times n \times m \qquad (6)$$

Where q: injected charge quantity from the injection electrode to the charge carrier electrode.

r: Charge collection rate from the charge carrier electrode to the collection electrode

R: Rotation number of the charge carrier disk per second.

n: Number of the collection electrode.

m: Number of the charge carrier electrode.

The injected charge quantity q from the injection electrode to the charge carrier electrode was decided by a simulation. For example, it became 1.6 nC when the applied voltage was +8.0 kV.

The simulation result of the Charge collection rate r from the charge carrier electrode to the collection electrode became over 0.9, however it was decided as 0.8 because the actual experimental equipment was not ideal condition.

The rotation number R of the charge carrier disk per second was decided from an actually measured number shown in figure 14. It was decided as 40, 60, 80 and 100 for 7.4kV, 7.6kV,7.8kV and over 8.0kv respectively.

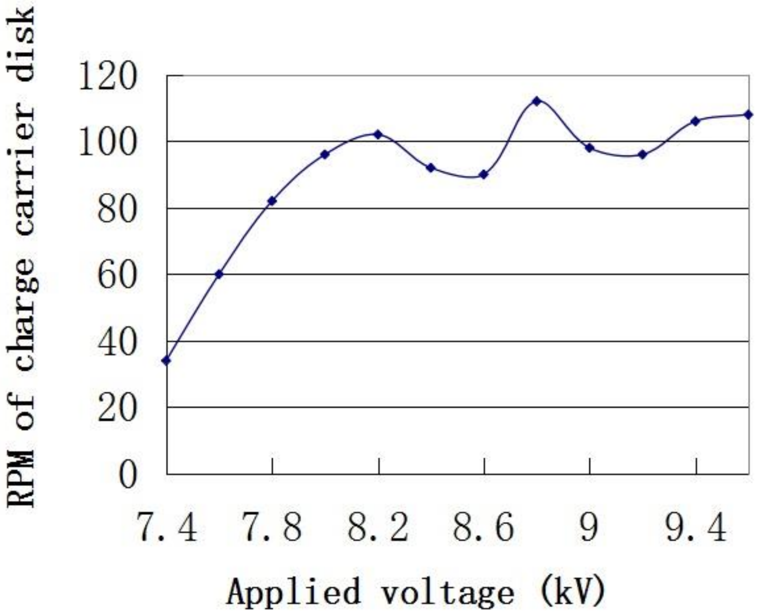

Fig.14. RPM of the charge carrier disk for a different applied voltages.

The number n of the collection electrode was two and the number m of the charge carrier electrode was six.

The calculated collection current is shown in figure 15 with the measured collection current.

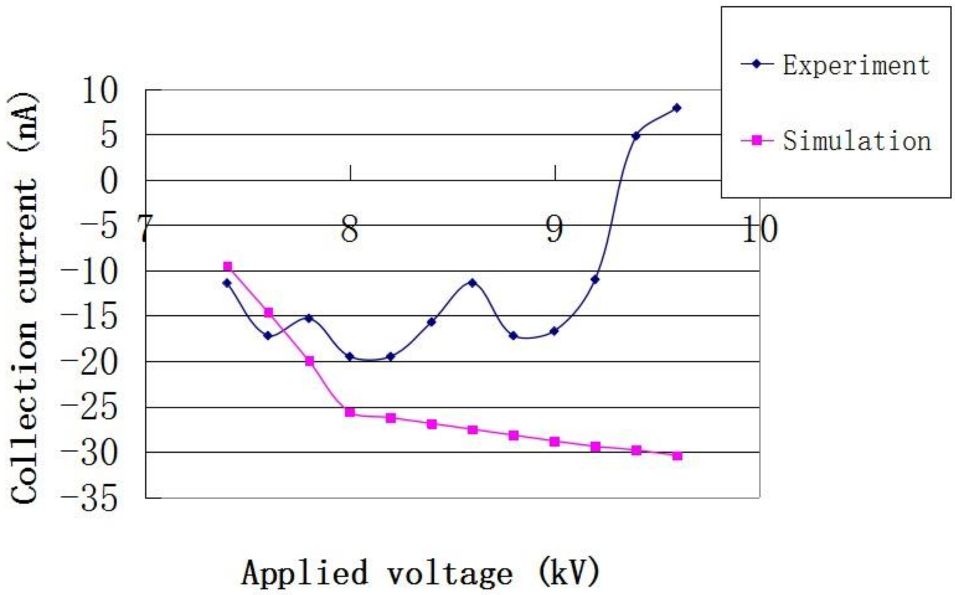

Fig.15. The simulated collection current and the measured collection current for a different applied voltages.

It is apparent from figure 15 that when the applied voltage is lower than 8kv, the calculated collection current is almost agree with the measured collection current, however when the applied voltage is higher than 8kV, they largely divorce each other.

This strange phenomenon can not be explained by a normal condition of the experimental equipment. It can be explained only by a leak current that flows from the high voltage electrode to the collection electrode. Figure 16 shows the measured leak current when the charge carrier disk did not rotate.

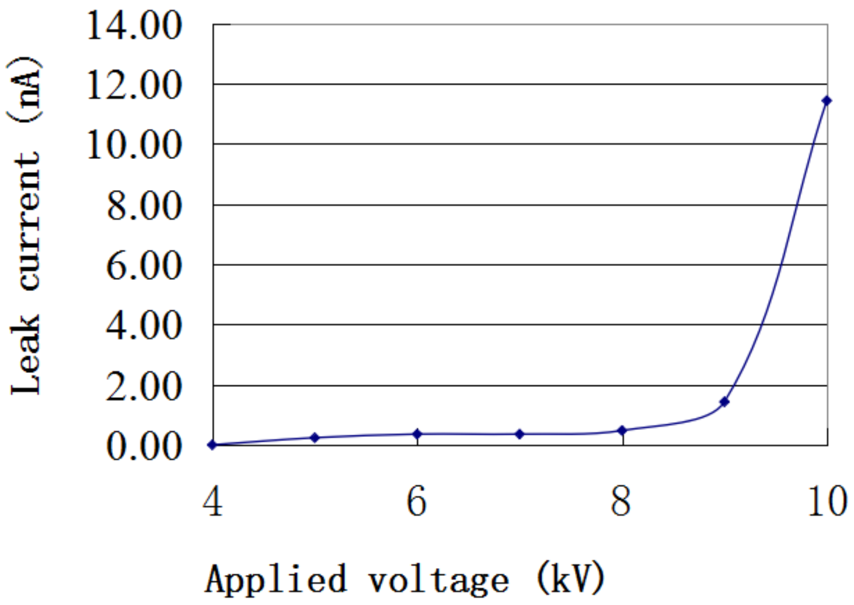

Fig.16. The measured leak current to the collection electrode for a different applied voltages.

It is apparent from figure 16 that the leak current is almost negligible when the applied voltage is lower than 8.0kV, however it rapidly increase when the applied voltage is higher than 9.0kV. As a result, the negative collection charge was canceled by the positive leak charge when the applied voltage was higher than 9.0kV.

Therefore this is the main reason of the abnormal results of the measured collection current when the applied voltage was higher than 8.0k shown in figure 15.

The leak current is a big problem for this experimental equipment. However it will be solved by the next experimental equipment because the next equipment will use an electret for the high voltage source in place of the high voltage power supply.

7. Conclusion

The experimental equipment of the electric field driving generator that is driven by Asymmetric electrostatic force succeeded to generate an electric energy continuously when this equipment use ADB bearings. Namely an electric energy was gained from an electric field. This may be the first success in the world.

Of course, there are some subjects that must be solved before making it real using. However this electric field driving generator will solve the environmental problem finally in the near future.

REFERENCES

[1] Richard P. Feynman, Robert B. Leighton, Matthew L. Sands, The Feynman LECTURES ON PHYSICS Japanese version chapter 4 Electrostatics, p.44 IWANAMI publishing company.

[2] K. Sakai, "Asymmetric electrostatic force", Journal of Electromagnetic Analysis and Applications 2014 on the Special Issue on Electromagnetic Field Theory, p.253-p.268

[3] K. Sakai, "Theory of Asymmetric electrostatic force", Journal of Electromagnetic Analysis and Applications 2017

[4] K. Sakai, "A first trial for the new electrostatic generator that will solve the CO_2 problem", Proceedings of 2014 ESA annual Conference (2014) B3

[5] K. Sakai, "A second trial for the new electrostatic generator that is driven by Asymmetric electrostatic force ", Proceedings of 2016 Electrostatics Joint Conference (2016) P4

[6] David Halliday, Robert Resnick, Jearl Walker, Fundamentals of Physics. 6th edition Japanese version Chapter "Electric Charge" question 1, Wiley & sons. Inc.

[7] K. Sakai, et al., Electrostatics: Theory and Applications, first ed. Nova Science Publish, New York, 2010 (Chapter 1)

[8] K. Sakai, Asymmetric Electrostatic Forces and a New Electrostatic Generator, first ed. Nova Science Publish, New York, 2010

[9] Handbook of electrostatic, Japan, (1998) p.962

[10] K. Sakai, "The Electric Field Energy of an Electret", Global Journal of Science Frontier Research, A Volume 15 Issue 6 Version 1.0, 2015

[11] Home page of Coo Space Co.,LTD. http://www.coo-space.com