Online ISSN: 2249-4626
Print ISSN: 0975-5896

Global Journal of Science Frontier Research: A

Physics and Space Science

Highlights

Space Debris Mitigation

New Electrostatic Generator

De-Orbit Kit Technology

Asymmetric Electrostatic Force

Discovering Thoughts, Inventing Future

VOLUME 15 ISSUE 5 VERSION 1.0

Global Journal of Science Frontier Research: A
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Volume 15 Issue 5 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

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Open Scientific Standards

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Wakefield MASSACHUSETTS, Pin: 01880,
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Offset Typesetting

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2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
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Packaging & Continental Dispatching

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Contents of the Issue

Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 15 Issue 5 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

De-Orbit Kit Technology for Space Debris Mitigation

By Sourabh Kaushal, Nishant Arora, Kellen McNally, J. P. Coadou & Niraj Pachpande

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Abstract- Space debris has become an important issue to deal with in the past few years as the probability of collision in space has augmented. Spacecrafts, Satellites, International Space Station, Probes and various other space objects are under threat as risk of collision at high orbital velocities can be damaging and highly destructive. It has hence become a prior need to find a solution for mitigation of space debris as armouring and shielding satellites and other objects is no longer feasible as it prolongs mission's and makes it cost derivative. The following is an arbitrary paper to solve the important issue of space debris and its mitigation. This paper is a semi technical survey of the expanding literature of the subject. The paper explores the different sources and mitigation methods of space debris. We have proposed a simple method to deal with this problem of space debris. We feel it can be very effective in the process of mitigation of space debris. The paper proposes the technique of a De-orbit Kit Technique and Magnetic Whipple Cone & Hydraulic Press. This paper inspires to remove all forms of debris orbiting space regardless of its size or material.

Keywords: satellite de-orbiting, orbital debris, space junk, space debris, defunct satellites, orbital debris mitigation, space remediation.

GJSFR-A Classification : FOR Code: 020199

DEORBITKITTECHNOLOGYFORSPACEDEBRISMITIGATION

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De-Orbit Kit Technology for Space Debris Mitigation

Sourabh Kaushal [α], Nishant Arora [σ], Kellen McNally [ρ], J. P. Coadou [Ѡ] & Niraj Pachpande[¥]

Abstract- Space debris has become an important issue to deal with in the past few years as the probability of collision in space has augmented. Spacecrafts, Satellites, International Space Station, Probes and various other space objects are under threat as risk of collision at high orbital velocities can be damaging and highly destructive. It has hence become a prior need to find a solution for mitigation of space debris as armouring and shielding satellites and other objects is no longer feasible as it prolongs mission's and makes it cost derivative. The following is an arbitrary paper to solve the important issue of space debris and its mitigation. This paper is a semi technical survey of the expanding literature of the subject. The paper explores the different sources and mitigation methods of space debris. We have proposed a simple method to deal with this problem of space debris. We feel it can be very effective in the process of mitigation of space debris. The paper proposes the technique of a De-orbit Kit Technique and Magnetic Whipple Cone & Hydraulic Press. This paper inspires to remove all forms of debris orbiting space regardless of its size or material.

Keywords: satellite de-orbiting, orbital debris, space junk, space debris, defunct satellites, orbital debris mitigation, space remediation.

I. Introduction

Man made orbital debris continues to pose a threat to manned and unmanned missions in Earth orbit. Not only does the problem of orbital debris put at risk man made craft, it also endangers the lives of passengers in current and future manned spaceflight. An analysis of currently proposed methodologies for orbital debris mitigation and space remediation was compiled and an evaluation of their potential applications was performed. The analysis covers a broad spectrum of proposed solutions for a variety of different types of orbital debris. During our analysis the realization was made that the highest concentration of defunct satellites is found in Low Earth Orbit (Henceforth referred to as L.E.O.). Also determined was that current methodologies proposed for de-orbiting satellites in L.E.O. were mostly designed for de-orbiting a single space craft per mission. This helped narrow our search for a solution. We began developing a methodology with the primary objective of de-orbiting multiple defunct space craft within the scope of a single mission.

We propose a solution in the form of a satellite system serving as a delivery unit which houses a plurality of remote operated semi-self-attaching de-orbiter modules. These are assisted in deployment via robotic arm which is fixed to the delivery satellite chassis.

In this technique our main target is 46% non-functional satellites or other defunct objects in LEO. We began developing a methodology with the primary objective of de-orbiting multiple defunct space craft within the scope of a single mission. We propose a solution in the form of a satellite system serving as a delivery unit which houses a plurality of remote operated semi-self-attaching de-orbiter modules. These are assisted in deployment via robotic arm which is fixed to the delivery satellite chassis. The whole mission is divided into four phases from launching to de-orbiting of de-functional object followed by ejection of satellite system (delivery unit) into LEO at a height of 600-2000KM (depend upon the target object) and detection & de-orbit installation system phase (Detection can be done with the help of photon camera/sensor attached on satellite, optical sensors or database from IADC).

II. Modules used in Technique

The proposed solution presented here is a satellite package consisting of the following systems.

a) Communication System

Comprises of two way radio communications arrays enabling live broadcast of satellite telemetry from all systems and providing ground control with an interface for controlling satellite systems.

b) Electrical Power System

The electrical power system is made up of a dual axis gimbal actuated solar panel array which provides power to a battery bank through a power converter. A power supply then supplies electricity to individual satellite systems.

c) Orbital Intercept and Thrust Control System (OITCS)

This system records space craft velocity, altitude and orbital information and performs orbital maneuvers to intercept targeted debris. These intercept operations are performed following a preprogrammed

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course determined to be the most efficient path between targeted debris.

d) Attitude Determination and Control System (ADCS)

This system records and controls the satellites rate of rotation and orientation. It is responsible for stabilizing disturbance torques, and is composed of an assembly of ultra-high precision rotary incremental actuators.

e) De-orbit Module installation system

This system is comprised of a robotic armature assembly which collects de-orbit modules from a rack fixed to the inside of the chassis.

This rack can be designed to hold multiple de-orbit modules.

f) De-Orbit Module

The de-orbit module consists of an assembly of systems in a compact package. It includes an automated installation system comprised of guided drills in an armature affixed to the de-orbit module, a computer control module, communications array which connects remotely to the satellite, power system and a pulsed plasma thruster system using solid Teflon as fuel, as well as a GPS device intended to enable tracking on de-orbit. This module connects to the arm via an electromechanical connection.

III. Parameters

We understand that debris can be thoroughly differentiated by its size and the strength of material it has been made up of. It has been observed that most hazardous space debris size more than 1 cm in diameter. Let us classify various types of debris according to their size.

OA: Size (1cm – 10 cm)

This debris mainly consists of paint flakes, lost tools, slag and dust from solid rocket motors, surface degradation products such as paint flakes, clusters of small needles.

OB1: Size (10cm – 150 cm)

Lost equipment, spare parts of rockets, satellites.

OB2: Size (150cm – 300cm)

Rocket boosters, dead spacecraft parts.

OC: Size (Debris > 300 cm)

Non functional spacecrafts, defunct satellites.

Table 1 : Table predicting the space debris behaviour

Debris size φ(cm)	Speed (m/s)	Mass (kg)	Momentum (kgm/s)	kinetic energy(joule)	Impact time (s)	Impulse force(N)
Φ< 1cm	7350					
0.01	-	*0.001*	*7.35*	*27011.25*	*10-3*	*7350*
0.04	-	0.004	29.4	108045	10^{-3}	29400
0.08	-	0.008	58.8	216090	10^{-3}	58800
1<φ<10	7350					
4	-	0.04	294	1080450	10^{-3}	29400
6	-	0.06	441	1620675	10^{-3}	441000
8	-	0.08	588	2160900	10^{-3}	588000

As most of the artificial spacecrafts and human inhibitions have taken place in the Low Earth Orbit (LEO). It has been found that a debris of size() 10 cm will have the mass of 1kg. So taking this mass as a referral mass we have calculated and formed the list of the impact force the debris will do.

If 10 cm of debris has mass = 1 kg, so 1 cm of debris will have the mass = 0.1 kg.

Momentum (p) equation is given as = mass * velocity.

Average speed at low earth orbit = 7350m/s.

Impulse force = Rate of change of momentum = dp/dt

From the table we can predict the even the smallest of the debris (i.e. φ = 0.01cm) is possessing a high amount of energy and can a possible collision threat.

With respect to the strength of material, we need to know if any particular debris can be burned into the atmosphere and if not, how it can be safely bought down to Earth. As it is unfeasible for us to send debris out of orbital limits by giving enough thrust to reach its escape velocity, it is only easier to bring it back down to Earth or burn it in the atmosphere.

Thus, every size comes with a simple and effective solution.

Object A:

Let us consider debris of the size (1cm – 10 cm) as Object A (OA). Our simple solution for OA is to decrease its velocity, bring it to lower orbits and burn them in the atmosphere.

Object B1:

Let us consider debris of the size (10 cm – 150 cm) as Object B1 (OB1). We can use hydraulic press. It will generate enough power to break the speed of the debris travelling at orbital velocities without causing it damage and redirecting it's trajectory into lower orbits where the debris will get burned in the atmosphere.

Object B2:

Object B2 (OB2) will be of the size (150 cm – 300 cm). Although the same process of hydraulic press will be used to break orbital velocities for OB2, however if it does not burn in the atmosphere, to avoid catastrophe, OB2 will be attached to a De-Orbit Kit. The De-Orbit Kit will mainly consist of a GPS tracker and a Parachute. The remnants of this debris will be brought down safely to Earth.

Object C:

For object C (OC) as defined above we can use De-orbit kit technique followed by retro thrusters followed by De-orbit kit.

IV. Methodology

In order to achieve the goals of this project, we are proposing this program as a multifaceted approach to the issue of space junk mitigation. The primary steps of this project are the establishment of a test bed for future expansion of this project, and the establishment of protocols, standards and best practices in this attempt to mitigate space junk.

In the beginning, a selection process would be brought forward to determine a target satellite forde-orbit. This selection process would involve the space-faring community at large as there are several international, legal and specific implications to a project with such scope.

Once candidate target orbital debris has been selected, and all relevant information about the target is fully studied, the project would move forward to the next step.

To accomplish the objectives of said test mission we would propose the construction of Debris De-orbit Satellite, containing de-orbit modules for four distinct sizes that are proportional to the size of the debris. This satellite will be designed to be equipped with a De-Orbit Kit (DOK) and a Harpoon Retro Thruster. It will also be equipped with autonomous robotic arms, drilling tools, radar, photon cameras, Inertial Reference System (IRS)

The servicer craft would next locate and meet with the defunct satellite unit, by using its remote sensors to intercept the defunct satellite and achieve orbit lock. Once in orbit lock, controllers on earth can manipulate the on board robotic arm in real-time via a relayed down-link, and pull itself into a close operating range to the defunct unit. Once the servicer is in position, a securing "foot/claw" would deploy from the base of the servicer, securing the servicer craft to the orbital debris, freeing up the robotic arm for the next task at hand. Once the debris is identified categorically, one of the above mentioned methods will be implemented.

OA: For objects falling under this category, we can use the hydraulic press to decrease its velocity and change the trajectory. Once completely enveloped, the debris will be released from the "foot/*claw*" arrangement. The press will decrease its velocity, sending it into lower orbits and burning it into the atmosphere.

OB1: For debris falling under this category, the captured debris will match the orbital velocity and lock and align itself with the spacecraft. After a detailed analysis of the debris, a hydraulic punch via the hydraulic press will be initiated on the debris, to move it out of its current trajectory and also decreasing its speed to lower orbits where it will be obliterated into the atmosphere. Before the hydraulic punch, the robotic arms will release the debris. We have to keep in mind that only sufficient power will be used such that it does not destroy the debris and create further junk, but only changes it trajectory and reduces its velocity.

OB2: For debris falling under this category, once it is secured and locked, a DOK will be attached to its body, once attached, a tug test will be initiated with a visual and mechanical confirmation of a secured de orbit kit. The arms will be released and again the hydraulic press will be initiated. Once in lower orbits, the timer circuit with altitude reading capabilities will open a chute, to bring the debris safely back on Earth if it does not get obliterated in the atmosphere. The DOK can be recovered and reused.

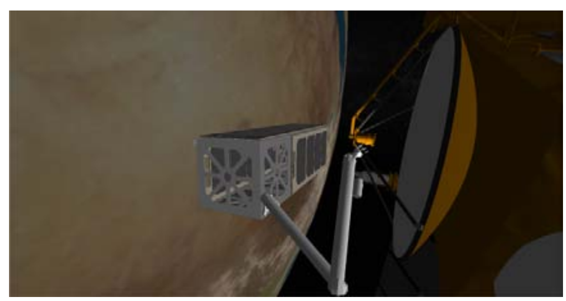

Figure 1 : Artistic View of project

OC: For debris under this category, after the lock, the spacecraft will attach a thruster to the debris, with a high tensile rope and at the other end of the rope will be a retro thruster. Once secured, again a tug test will be initiated. After confirmation, the debris will be undocked from the craft. Finally the retro thrusters will be initiated; thus provided thrust in the opposite direction will reduce the velocity of the defunct satellite. Later a chute from the thrusters will be deployed at preset altitude and the debris will be brought down to Earth safely.

All systems will be controlled and activated by teams working on ground stations. Mathematical calculations will be made to bring down Debris safely and land them on water bodies.

Due to the experimental nature of this test mission, the servicer craft will then be tasked to perform it's own de-orbit sequence in order to gather mission data, such as temperatures, speeds, as well as a video feed, and relay it to ground stations in real-time. This will simultaneously accomplish our obligation to not leave behind any debris ourselves in the course of this work.

V. Advantages

One of the key advantages of this system-solution is its easy implementation in comparison to currently proposed techniques. We are striving to keep the project costs low and will be relying on a launch of the small-satellite to be executed via the Indian Space Research Organization (ISRO) space agency.

The most crucial aspect of this newly proposed system-solution is that while current techniques are limited to the de-orbiting of only one inactive satellite in one year, we are working to offer its new technology that has the potential to be scaled up to target hundreds of inactive satellites in one mission.

The total aim of the project is the elimination of 43% of the total inactive satellites in orbit. Our design team's meticulous attention to detail, as well as intensive study of existing small sat and larger sat technologies provide our partnership with several advantages, namely: lower mission costs, more efficient weight management, small size of system-sat, and longer and more efficient mission duration. Additional benefits are rooted in the fact that this is a complete system-solution, a package that can deliver de-orbiter units to orbital debris. The system is evolutionary and modular, we have incorporated features such as serviceability, eg. refueling capability as well as re-loadable payload bay, which translates to very long system life, versatility, etc.

VI. Conclusion

All attempts to remove orbital debris from the Earth's orbit will be valuable to the international community, as it will provide for not only optimal solutions in solving the space junk and space debris crisis, but also the subsequent accumulation of scientific and intellectual knowledge will be of extreme value for the future.

As we have found that some aspects of this type of technology are not readily available in the international market place. This project needs to be created from scratch, the most logical and effective means to achieve this goal is by employing the strategy of crowd-sourcing expertise from all scientific and research domains in order to ensure all systems meet and exceed industry standards. We also believe an injection of funds from an outside conglomerate of investors would greatly benefit this project.

The future of space flight is at risk due to the *Kessler Syndrome, space* remediation is necessary in order to secure that future. Our proposed system provides multiple solutions to problems faced in space remediation. For this reason we have delivered this preliminary proposal in the hopes of producing critical data which may help improve the state of space above earth and promote the safe and responsible use of space to the international community.

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Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 15 Issue 5 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

A New Electrostatic Generator that is Driven by Asymmetric Electrostatic Force

By Katsuo Sakai
Electrostatic Generator Research Laboratory, Japan

Abstract- The new electrostatic generator that is driven by Asymmetric electrostatic force is a very interesting new idea, because it will continue to generate electricity by an electret without any adding energy. The theory predicts that a charge carrier transports some charges from a low potential charge injection electrode to a high potential charge recovery electrode by Asymmetric electrostatic force. However, this phenomenon has not yet been confirmed by a real experiment. Because a leak current that was produced by a high voltage power supply cancel the transported charges.

Therefore, a friction charged Teflon sheet was used as a high voltage source in place of the high voltage power supply. As a result, it was confirmed by a simple experiment that the charge carrier transported +3.0nC charges from 0 volts to +160 volts.

Keywords: electrostatic generator, asymmetric electrostatic force, charge carrier, friction charging of the teflon sheet: high voltage source.

GJSFR-A Classification : FOR Code: 240504

ANEWELECTROSTATICGENERATORTHATISDRIVENBYASYMMETRICELECTROSTATICFORCE

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I. Introduction

"Electrostatic generator" has long history and it had been greatly studied in 17th and 18th century, after that it has been almost forgotten because electromagnetic generators become very popular. Today, safety pollution-free and low cost energy is strongly required. Therefore, electrostatic generator must be reconsidered.

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.
This body is called the charge carrier.

The most popular electrostatic generator is the Van de Graaff type electrostatic generator [1]. 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 1 shows an example of this generator.

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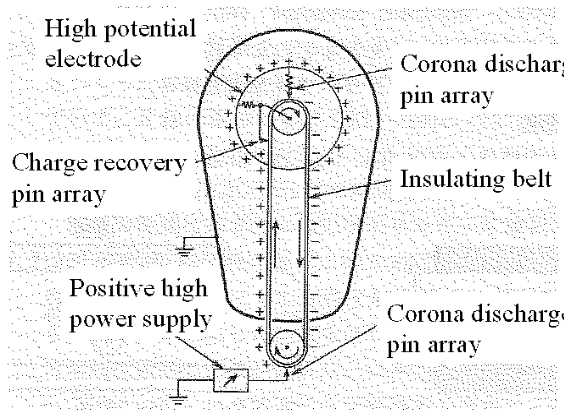

Figure 1 : Schematic layout of the Van de Graaff Electrostatic Generator

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. Then, the positive charges are recovered to the high potential electrode.

In contrast, a new electrostatic generator was recently invented by this author [2]. Even if it is said as a new electrostatic generator, the basic principle of the generation is the same as the former electrostatic generator. Namely, the generator picks up charges into a charge carrier at a low electric potential place and transports the charge carrier to a high electric potential place.

For that purpose, an ordinary electrostatic generator has used a mechanical force. On the contrary, the new electrostatic generator uses an electrostatic force in place of a mechanical force.

Usually, the magnitude of the electrostatic force is the same when the direction of the electric field is reversed. However. This is true only for a point charge or a charged spherical shape conductor. On the contrary, the magnitude of the electrostatic force that acts on a charged asymmetric shape conductor is different when the direction of the electric field is reversed.

This very interesting new phenomenon was found by a simulation [3] and was recently confirmed by a experiment [4] This phenomenon was named Asymmetric electrostatic force. The new electrostatic generator is driven by Asymmetric electrostatic force in place of a mechanical force.

A basic unit of the new electrostatic generator that is driven by Asymmetric electrostatic force is concretely shown in figure 2.

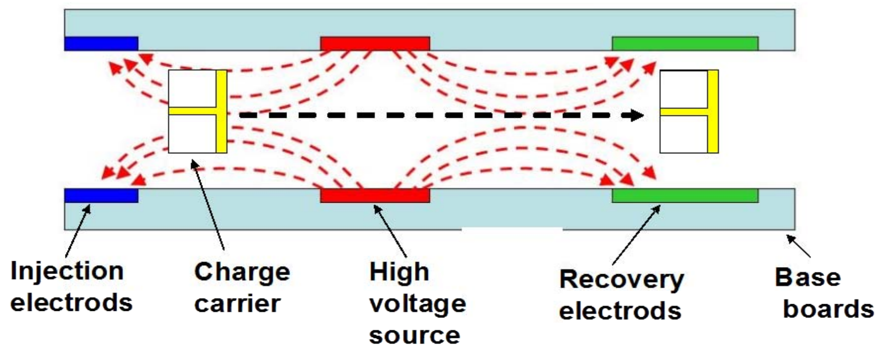

Figure 2 : Schematic Layout of A basic unit of the New Electrostatic Generator

This generator mainly consists of charge injection electrodes, high voltage sources, charge recovery electrodes and charge carrier. 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 recovery 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 recovery 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 2.

A "T" character shape conductor is used as a charge carrier that carries negative charge (electron) from the injection electrodes to the recovery electrodes through the high voltage source.

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

This is the principle of the new electrostatic generator. This principle is a little different from that of the Van de Graaff electrostatic generator.

The principle of the both electrostatic generators is shown schematically in Fig. 3.

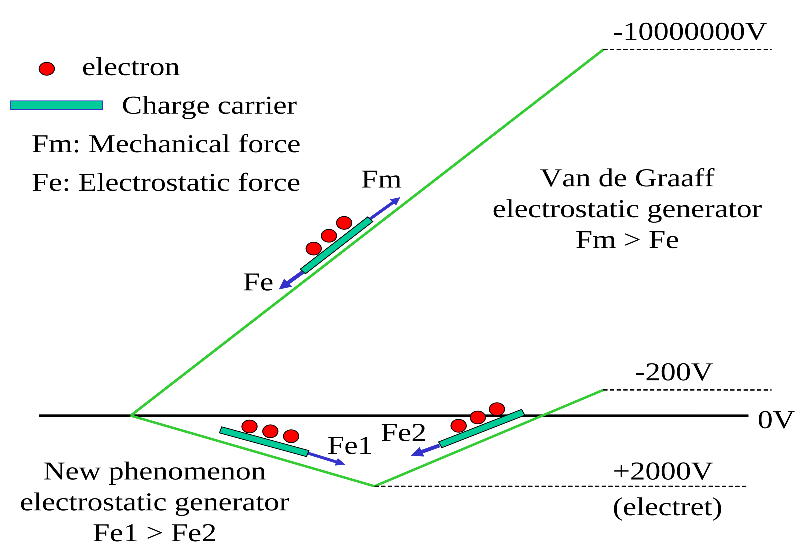

Figure 3 : Schematic Explanation of the Principles behind the Two Electrostatic Generators

In figure 3, 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 new electrostatic 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 reverse 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 larger (-200 V) than the initial potential (0 V).

The new electrostatic generator cannot produce ten million volts, but it does not require mechanical force. If the lifetime of the electret was infinite, the new electrostatic generator could generate electric energy forever without adding energy. As a result, this new electrostatic generator can solve the CO2 problem and the energy crisis at the same time.

At the first step of the development of the new electrostatic generator, a experiment instrument confirmed that Asymmetric electrostatic force can work as a driving force of the new electrostatic generator. Namely, the charge carrier could reach at the recovery electrode [5]. If Asymmetric electrostatic force did not work, the charge carrier could not reach at the recovery electrode.

However, it is not yet confirmed that charges had been really carried from the injection electrode to the recovery electrode. If charges are recovered by the recovery electrode, its potential becomes higher. This is a very simple measurement, but it has not yet been performed.

In this step, a high voltage power supply was used as the high voltage source. However, there was a few leak current from the high voltage power supply to the recovery electrode. As a result, the recovered charges were cancelled by this leak current. This was because they had the other charge polarity and the quantity of them was almost the same.

Therefore, this measurement must be done with the other high voltage source that does not produce any leak current. This is the subject of this experiment.

II. Experiment Instrument

The high voltage source without leak current is of course the wellknown electret. Unfortunately, there was not the electret in this laboratory.

Therefore, a friction charged Teflon sheet was used in place of an electret. Both surfaces of a Teflon sheet were strongly rubbed by a nylon cloth one hundred times. As a result, both surfaces of the Teflon sheet was charged up minus high potential. .

This friction charged Teflon sheet was used as the high voltage source in the following experiment.

Figure 4 shows a photograph of the main part of the experiment equipment. Figure 5 shows the front view. And figure 6 shows a photograph of the capacitor and the surface potential meter.

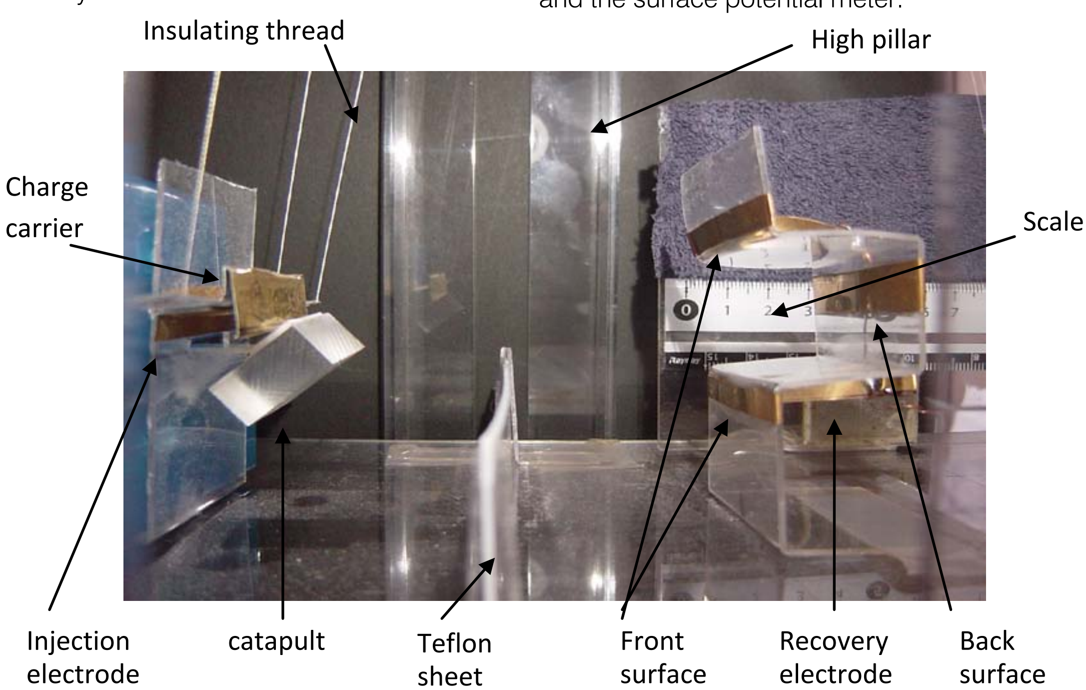

Figure 4 : A Photograph of the Main Part of the Experiment Equipment of the New Electrostatic Generator

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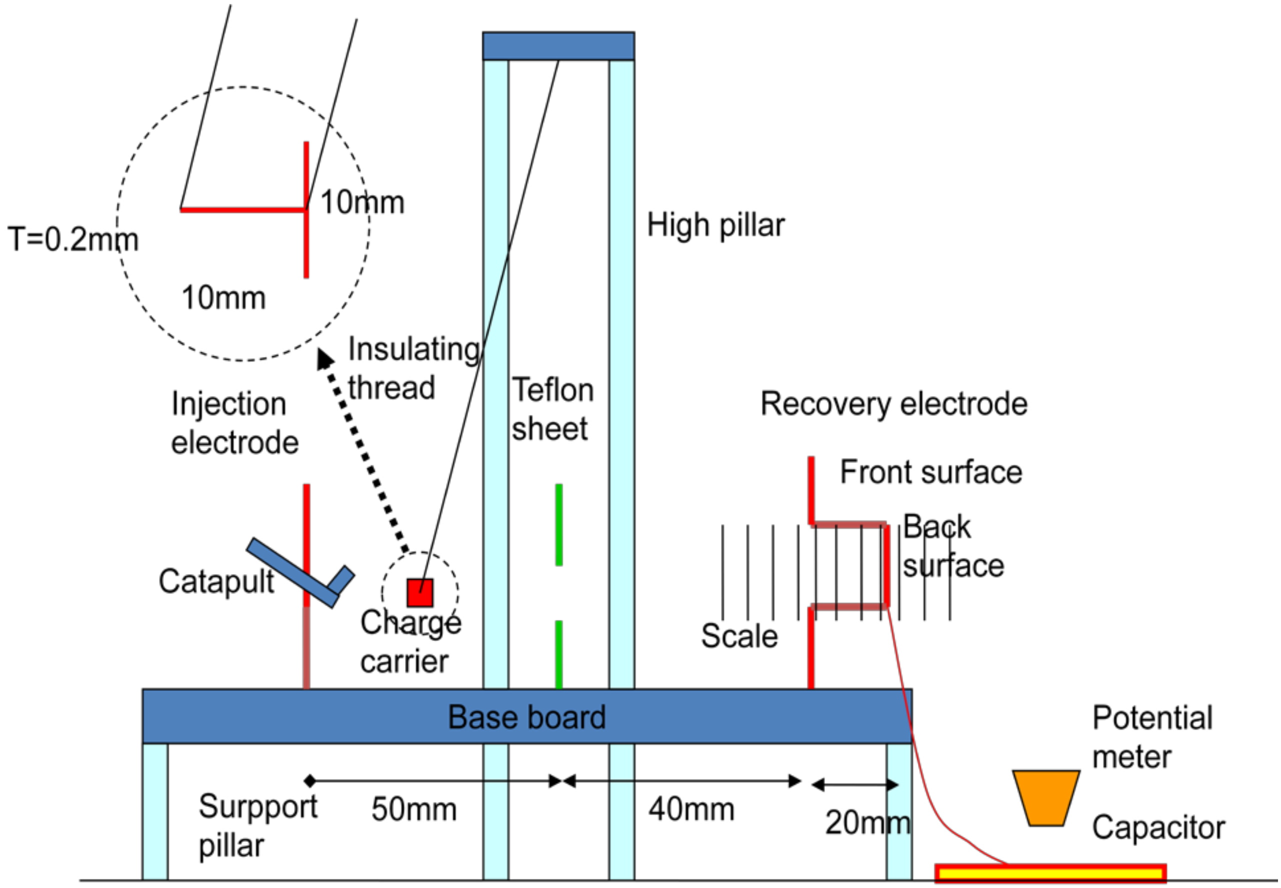

Figure 5 : Front View of the Experiment Instrument of the New Electrostatic Generator

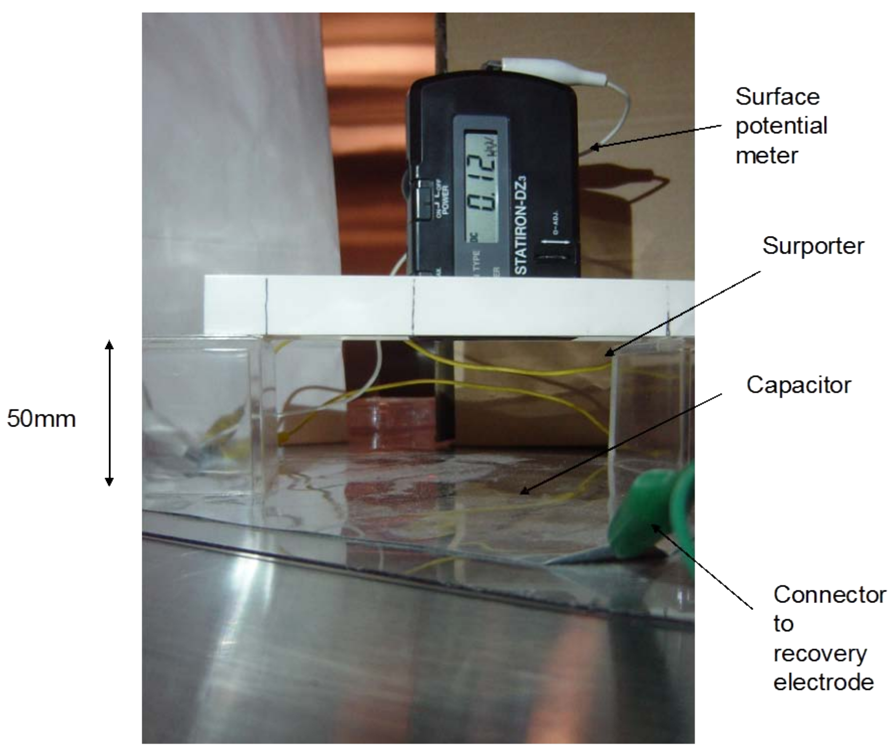

Figure 6 : A Photograph of the Capacitor that was Connected to the Recovery Electrode, and the Surface Potential Meter that is Displaying +0.12kv

This equipment mainly consists of a charge injection electrode, a friction charged Teflon sheet, a charge recovery electrode, and a charge carrier.

On the early stage of this experiment, upper and lower Teflon sheets was used as shown in figure 5. However, only lower Teflon sheet was used as shown in figure 4 on the following experiment. Because the potential of the Teflon sheet rapidly declined in a few minutes as shown in figure 7. Therefore, the potential of the lower Teflon sheet became useless before the upper Teflon sheet was prepared. Nevertheless, two electret sheets will be used on the future experiment. Because the potential of the electret does not decline for a long time.

The charge injection electrode has a catapult that releases the charge carrier from the charge injection electrode. The charge recovery electrode consists of a front surface electrode and a back surface electrode. And it was connected to the capacitor. The potential of it was measured by the surface potential meter.

In figure 5, the inside of big circle on the left is an enlarged picture of the charge carrier.

The injection and the recovery electrodes were made from aluminium plates with 0.2mm thickness and the charge carrier was made from one side gold gilding aluminium plates with 0.1mm thicknesses.

The injection electrode has a catapult at its center. The catapult holds the charge carrier temporary, and releases it automatically.

The charge recovery electrode had front surface electrodes and back surface electrode as shown in figure 5. As a result, the charge recovery electrode can perform semi-Faraday gauge. When the charge carrier touches the back surface of the charge recovery electrode, 90% charge on the charge carrier is transferred to the charge recovery electrode (simulation result).

The charge carrier was hung by the insulating thread at the center of this experiment instrument at first, then it was set on the catapult before an experiment start.

The insulating thread was made from raw silk that is used in Japanese kimono. A scale was placed on rear of the charge recovery electrode as shown in figure 5 for measuring the arriving position of the charge carrier.

The distance between the charge injection electrode and the center of this experiment instrument was 50mm. And the distance between the center of this experiment instrument and the front surface of the charge recovery electrode was 40mm.

The height of the friction charged Teflon sheet were 30mm. The heights of the lower part and the upper part of the front surface of the charge recovery electrode were 35mm and 20mm respectively. The width of the side part of the charge recovery electrode was 20mm. And the height of the back part of the charge recovery electrode was 30mm.

The height and the width of the charge carrier were 10mm and 10mm respectively as shown in figure 5. The height of high pillars and the support pillars were 500mm and 150mm respectively. The length of the threads were 305mm.

The charge carrier consists of a T character shape conductor and a PET resin sheet. This sheet supported the conductor and it was hung by the insulating thread. As a result, this charge carrier was always maintained as electrically floating condition.

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 aluminium sheet, a PET film and a top aluminium sheet. The thickness of the film was 1.0mm and the Relative permittivity is 3.2. As a result, the electric capacitance of this capacitor becomes 1100pF.

III. Experiment Results

At the first experiment, the Teflon sheet without friction was placed at the center of this equipment. In this situation, there was no electric field because the Teflon sheet was not charged. Then, a weight of a catapult of the charge injection electrode was picked up.

As a result, the charge carrier was released from the catapult automatically. And It started to move to right direction by a tension of a thread against an air resistance. The charge carrier passed the no charged Teflon sheet. And it passed through the front surface of the charge recovery electrode. But, it never reached the back surface of the charge recovery electrode.

The distance between the center of this equipment and the charge injection electrode was 50mm and the distance between the center and the front surface of the charge recovery electrode was 40mm. Therefore, the charge carrier can pass through the front surface against an air resistance. The arriving position of the charge carrier was about 45mm from the center. This result means that, the lost distance by the air resistance was about 5mm.

However, the distance between the center and the back surface of the charge recovery electrode is 60mm. Accordingly, the remained distance to the back surface of the recovery electrode was 15mm. Therefore, Asymmetric electrostatic force must add an energy that can transport the charge carrier longer than15mm.

At the next trial experiments, the Teflon sheet was charged by strong friction. And it was set up at the center of the experiment instrument as shown in figure 4.

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In this forward electric field, induction charges are injected from the grounded charge injection electrode to the charge carrier. An strong electrostatic force acts on this charge. Then, the charge carrier was released from the catapult and It started to move to right direction by this strong electrostatic force and the tension of the thread, against the air resistance force.

This time, the charge carrier passed the friction charged Teflon sheet, and hit the back surface of the charge recovery electrode.

When the charge carrier hit the back surface of the charge recovery electrode, charges that was carried by this charge carrier was almost recovered to this charge recovery electrode automatically.

After that, the charge carrier returned to the charge injection electrode automatically. Because the distance between the center and the back surface was 60mm and the distance between the center and the charge injection electrode was 50mm.

Then, the returned charge carrier will get a next injection charge and hit the recovery electrode again. This hitting and return movement will be repeated until the voltage of the friction charged Teflon sheet becomes to the lower limit voltage.

A capacitor that has 1100pf was connected between the charge recovery electrode and the ground. Therefore the surface potential of the capacitor changes from 0 volts to about +3 volts, when a +3nC charge (Simulation result) is recovered from the charge carrier to the charge recovery electrode.

However, the minimum unit of this surface potential meter is 10 volts.

Therefore, the potential difference that is more than 10 volts is required to confirm the charge transfer from the grounded charge injection electrode to the charge recovery electrode.

Namely, the charge carrier must hit the back surface of the charge recovery electrode more than 4 times continuously.

Unfortunately, the best result of this trial ten experiments was only 2 times .

The main reason of less than 3 times was that the charge on the Teflon sheet leaks quickly. Figure 7 shows a change of the surface potential of the Teflon sheet after friction charging.

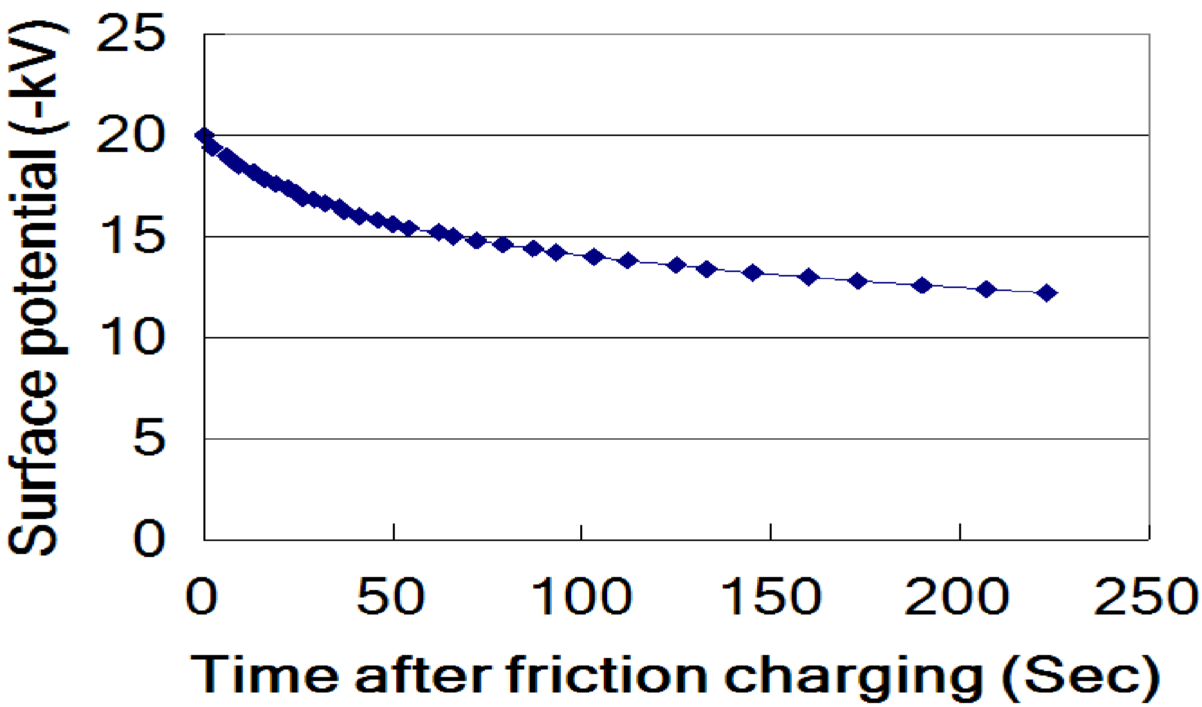

Figure 7 : A change of the surface potential of the Teflon sheet after friction charging

This was measured at 15℃,10%RH condition. Therefore, the rapid decline of the potential of the friction charged Teflon sheet can not be improved at any other conditions.

When a high voltage power supply was used as the high voltage source, the lower limit of the voltage for transporting the charge carrier to the back surface of the recovery electrode was about 20kV. Therefore, when the friction charged Teflon sheet was used as the high voltage source, the charge carrier will hit the recovery electrode only one time. This was because the decrease of the surface potential of the charged Teflon sheet was very rapid as shown in figure 7.

However, if this experiment would be repeated many times, the potential of the recovery electrode must rise gradually in proportion to the number of hitting of the charge carrier. Therefore, the final experiments confirming that charges were really transported from the injection electrode to the recovery electrode, were many times repeated with using the friction charged Teflon sheet.

Figure 8 shows the result of this many times repeated experiment.

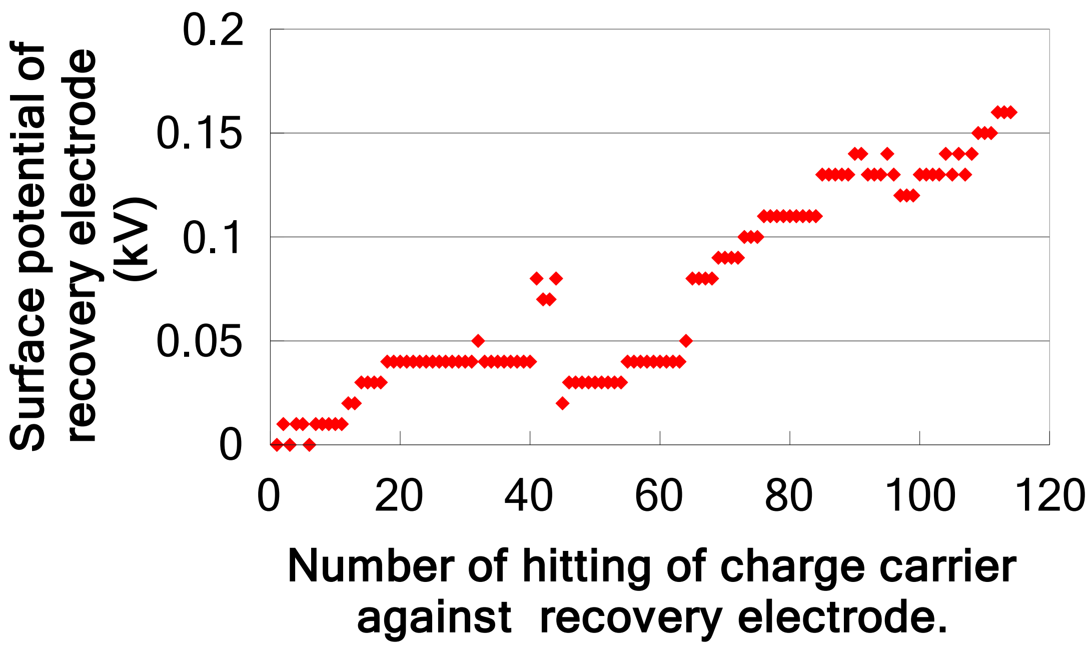

Figure 8 : The Surface potential of the recovery electrode as a function of the number of hitting of the chargecarrier against the recovery electrode

It is apparent from this graph that the potential of the recovery electrode almost becomes higher in proportion to the number of hitting by the charge carrier. However, there are two times decline of the potential. The reason of this two declines is thought as a partial discharge by a mistake hand touch to the top aluminium sheet of the capacitor. The raise rate of the potential is about same after the two declines. It is about 2.7 volts per one hitting. Namely, the charge carrier transported about +3.0nC charges every time from the injection electrode to the recovery electrode. The potential of the recovery electrode of the last experiment was +160 Volts. Therefore, it was confirmed that charges were really transported from the low potential injection electrode to the high potential recovery electrode by the charge carrier.

IV. Conclusion

In the new electrostatic generator that is driven by Asymmetric electrostatic force, theoretically the charge carrier can transport a few charges from the low potential charge injection electrode to the high potential charge recovery electrode. This phenomenon has been confirmed by the simple experiment equipment that use the friction charged Teflon sheet as high voltage source.

However, this equipment needed every time friction charging of the Teflon sheet because its charge decrease was very rapid. Therefore, on the next research, the new equipment must use an electret as the high voltage source. The charges of the electret does not decrease for a long time. As a result, the new equipment will continue to generate electricity for a long time with only one electret.

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Global Journal of Science Frontier Research: A
Physics and Space Science
Volume 15 Issue 5 Version 1.0 Year 2015
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Temperature Dependence of Dielectric Loss Tangent in KDP (KH_2PO_4)Type Crystals

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Abstract- Considering third- and fourth-order phonon anharmonic interactions terms in the four particle cluster model Hamiltonian proposed by Blinc *et al* [1982 *J Phys,* C15 4661] for the stochastic motion of $H_2PO_4^-$ groups for KDP (KH_2PO_4) type ferroelectrics, expressions for soft mode frequency and loss tangent are evaluated. For the calculations, method of double time temperature dependent Green's function has been used. By fitting model values of physical quantities, the dielectric loss in paraelectric phase of KDP (KH_2PO_4) crystal at 9.2 GHz for field along the a-axis $(\tan\delta_a)$, and c-axis $(\tan\delta_c)$ have been calculated which compare well with experimental results of Kaminow *et al* [1963*Phy Rev*,129 1562]. A good agreement has been found. In the microwave frequency rage, an increase in frequency is followed by an increase in transverse and longitudinal dielectric loss tangent. The loss decreases with increase in temperature for KDP (KH_2PO_4) crystal, in their paraelectric phase. This shows Curie-Weiss type behavior of the dielectric loss tangent.

Keywords: KDP (KH_2PO_4), soft mode frequency, transverse dielectric loss tangent $(\tan\delta_a)$, longitudinal dielectric loss tangent $(\tan\delta_c)$.

GJSFR-A Classification : FOR Code: 020302

Strictly as per the compliance and regulations of :

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Keywords: KDP (KH_2PO_4), soft mode frequency, transverse dielectric loss tangent $(\tan\delta_a)$, *longitudinal dielectric loss tangent* $(\tan\delta_c)$.

I. Introduction

The dynamical properties of ferroelectrics KDP (KH_2PO_4) type crystals have attracted much interest in recent years, due to their promising applications in electro-optical, thermal detectors, optical communication, memory display, and electronic ceramics industry[1]. Cowley[2] has given the soft mode frequency which largely determines the dielectric, thermal and scattering properties in the ferroelectrics crystals. At transition temperature the frequency of polar soft mode tends to zero and lattice displacement associated with this mode become unstable which explains the anomalous behavior of many of the physical properties of ferroelectric crystals[3] such as dielectric constant and loss. In KDP (KH_2PO_4) crystal (T_c=123 K) the soft mode is connected with the pseudo spin-type motion of the proton between two equilibrium positions in the double minimum type O-H..O bond potential.

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Many workers[4-10] have investigated theoretically the dielectric and other properties of KDP (KH_2PO_4) type crystals using pseudo spin model and its extension, i.e., pseudo spin lattice coupled mode model. Wang *et a1*[1l] and Jhang *et al* [12] have applied undetermined constant method to pseudo spin model with spin coupling term. They have not considered phonon parts in their calculations which however has a very important contribution in crystal. Ganguli *et al*[10] have used PLCM model with fourth order phonon anharmonic interaction term. They however decoupled the correlations at an early stage. In doing so some important interactions were disappeared. In this way they could not obtain better and convincing results to explain dielectric and phase transition properties of KDP (KH_2PO_4) type crystals. Yoshimitsu and Matsubara[13] and Havlin and Sompolinsky[14] performed extensive calculations for the static thermodynamics behavior in the four-particle cluster approximation and found satisfactory agreement with the experimental data, but they could not explain the dielectric properties. Ganguli *et al* [10] modified Ramakrishnan and Tanaka[9] theory by considering anharmonic interaction terms. Their treatment explains many features of order-disorder ferroelectrics. However, due to insufficient treatment of anharmonic interactions, they could not obtain quantitatively good results and could not describe some interesting properties, like dielectric, ultrasonic attenuation, etc.

In the present study, the authors consider the four- particle cluster model Hamiltonian with the anharmonic contributions up to fourth order of KDP (KH_2PO_4) crystal. This model successfully describes the static as well as dynamic properties of KDP (KH_2PO_4) system along z-directions[6, 1,4,15]. The phonon anharmonic interactions have been found very important in explaining dielectric, thermal and scattering properties of solids by many authors[4, 16-20] in the past. We use the double-time thermal dependent retarded Green's functions techniques[18-21] and Dyson's equation treatment for the development and evaluate expressions for proton renormalized frequency of the coupled system, collective proton wave half widths, and loss. Using the model parameters given by Ganguli *et al* [10] in the theoretical expression for width, shift, and loss tangent have been calculated for KDP (KH_2PO_4).

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The frequency and temperature dependence of the transverse dielectric loss tangent $(\tan\delta_a)$, and longitudinal dielectric loss tangent $(\tan\delta_c)$ of KDP (KH_2PO_4) at 9.2 GHz and in the temperature ranges (120-150K)for field along the a-axis $(\tan\delta_a)$ and c-axis $(\tan\delta_c)$ for KDP (KH_2PO_4) have been calculated and compared with experimental results of Kaminow *et al*[22]. At higher temperature the loss deviates from the Curie-Weiss type behavior and increases linearly with temperature. This behavior suggests that at higher temperatures the phonon anharmonicity contributes significantly in the observed loss.

II. Model Hamiltonian

We use the four - particle cluster model Hamiltonian[7] by including third and fourth order phonon anharmonic interaction terms, which is expressed in our previous paper as[23]:

$$H=-2\Omega\sum_i S_i^x-\frac{1}{2}\sum_{ij}J_{ij}S_i^zS_j^z-\frac{1}{4}\sum_{ijkl}J'_{ijkl}S_i^zS_j^zS_k^zS_l^z+\frac{1}{4}\omega_k(A_k^+A_k)+B_k^+B_k)-\sum_i\bar{V}_{ik}S_i^xA_k$$

$$+\sum_{\vec{k}_1,\vec{k}_2,\vec{k}_3}V_3(\vec{k}_1\vec{k}_2\vec{k}_3)A_{\vec{k}_1},A_{\vec{k}_2},A_{\vec{k}_3}+\sum_{\vec{k}_1,\vec{k}_2,\vec{k}_3,\vec{k}_4}V_4(\vec{k}_1\vec{k}_2\vec{k}_3\vec{k}_4)A_{\vec{k}_1},A_{\vec{k}_2},A_{\vec{k}_3},A_{\vec{k}_4}, \quad (1)$$

III. Green's Function: Shift, Width and Soft Mode Frequency

Following Zubarev[24] we consider the evaluation of Green's function as

$$G_{qq'}^{zz}(t-t')=\langle\langle S_q^z(t);S_{q'}^z(t')\rangle\rangle=-j\theta(t-t')<[S_q^z(t),S_{q'}^z(t')]>, \quad (2)$$

where $\theta(t-t')$ is Heaviside's unit step function, $\theta(t-t')=1$ for $t>t'$; and $\theta(t-t')=0$ for $t<t'$.

The Green's function (2) is evaluated using Hamiltonian (1) following the procedure of our earlier paper[23] which finally takes the forms

$$G_{qq'}^{zz}(\omega+j\varepsilon)=\pi^{-1}<S_q^x>\delta_{qq'}[\omega^2-\tilde{\tilde{\Omega}}^2+j\Gamma_s(q,\omega)]^{-1}, \quad (3)$$

$\tilde{\tilde{\Omega}}$ is the proton renormalized frequency of the coupled system, which on solving self consistently takes the form:

$$\tilde{\tilde{\Omega}}^2=\tilde{\Omega}^2+2\Omega\Delta_s(q,\omega), \quad (4)$$

where $\Delta_s(q,\omega)$ the proton mode frequency shift, Ω is the proton tunneling frequency, and $\tilde{\Omega}$ the renormalized frequency. The collective proton wave half width $\Gamma_s(q,\omega)$, and collective phonon mode frequency, and collective phonon half widths is given in our previous paper as[25]:

a) collective proton wave half width

$$\Gamma_s(q,\omega)=\frac{-4\pi\bar{V}_q^2\omega_q^2<S_q^x>\delta'_{qq}\Gamma_p}{\Omega[(\omega^2-\tilde{\tilde{\omega}}_q^2)^2+4\omega_q^2\Gamma_p^2]}+\frac{\pi bc^2}{2\tilde{\Omega}}\{\delta(\omega-\tilde{\Omega})-\delta(\omega+\tilde{\Omega}\} \quad (5a)$$

$$+\frac{\pi a^2\hat{\Omega}}{2b}\{\delta(\omega-\hat{\Omega})-\delta(\omega+\hat{\Omega}\}$$

b) collective phonon mode frequency

$$\tilde{\tilde{\omega}}_{q\pm}^2=\frac{1}{2}(\tilde{\omega}_q^2+\tilde{\tilde{\Omega}}^2)\pm\frac{1}{2}\left[(\tilde{\omega}_q^2+\tilde{\tilde{\Omega}}^2)^2+16\bar{V}_q^2\omega_q\Omega<S^x>\right]^{1/2} \quad (5b)$$

where

$$\tilde{\omega}_q^2=\omega_q^2+8\omega_q(2V_3+V_4)\coth\left(\frac{\beta\omega_q}{2}\right) \quad (5c)$$

c) collective phonon half width

$$\Gamma_P = \frac{-4\bar{V}_q^2\,\Omega^2 < S_q^x > \Gamma_s(q,\omega)}{[(\omega^2-\tilde{\tilde{\omega}}^2)^2+4\Omega^2\Gamma_s^2(q,\omega)]} + 6\pi\sum_q V_3^2(q,q')\frac{\omega_q n_q}{\tilde{\omega}_q}[\delta(\omega-2\tilde{\omega}_q)-\delta(\omega+2\tilde{\omega}_q]$$

$$+12\pi\sum_q \frac{V_3^2(q,q')\,\omega_q\,\omega_{q'}}{\tilde{\omega}_q^2\,\tilde{\omega}_{q'}^2}[(1+2n_q n_q{}'+n_q^2)\{\delta(\omega-2\tilde{\omega}_q-\tilde{\omega}_{q'})-\delta(\omega+2\tilde{\omega}_q+\tilde{\omega}_{q'})\}$$

$$+(n_q^2-1)\{\delta(\omega-2\tilde{\omega}_q+\tilde{\omega}_{q'})-\delta(\omega+2\tilde{\omega}_q-\tilde{\omega}_{q'})\}+2(n_q^2-1)\{\delta(\omega-\tilde{\omega}_{q'})-\delta(\omega+\tilde{\omega}_{q'})\}]$$

$$+36\pi\sum_q V_4^2(q,q')\frac{\omega_q^2}{\tilde{\omega}_q^2}\left[\frac{(1+3n_q^2)}{3\tilde{\omega}_q}\left\{\delta(\omega-3\tilde{\omega}_q)-\delta(\omega+\tilde{\omega}_q\right\}+(n_q^2-1)\left\{\delta(\omega-\tilde{\omega}_q)-\delta(\omega+\tilde{\omega}_q\right\}\right] \tag{5d}$$

In the vicinity of transition temperature or in the paraelectric phase one may expand $\tilde{\tilde{\omega}}$ in the power of (T-T_c) around its value at T_c getting immediately

$$\tilde{\tilde{\omega}}_{q-}^2 = \left(\frac{\partial\tilde{\tilde{\omega}}_{q-}^2}{\partial T}\right)_{T=T_c}(T-T_c) \tag{6a}$$

$$\tilde{\tilde{\omega}}_{q-}^2 = K(T-T_c) \tag{6b}$$

IV. Loss Tangent

Following Kubo[26] and Zubarev [24]. The dielectric susceptibility is obtained as

$$\chi_{mn}(\omega) = \lim_{\varepsilon\to 0} -2\pi N\mu^2 G_{mn}(\omega+j\varepsilon), \tag{7}$$

where N is the number of unit cell in the sample, and μ is the effective dipole moment per unit cell. The dielectric constant can be calculated by using the relation $\varepsilon = 1+4\pi\chi$, and the real part of which is given by

$$\varepsilon'(\omega)-1 = 8\pi N\mu^2\tilde{\omega}(\omega^2-\tilde{\tilde{\omega}}^2)\left[(\omega^2-\tilde{\tilde{\omega}}^2)^2+4\omega^2\Gamma_p^2(\omega)\right]^{-1} \tag{8}$$

and the tangent loss

$$\tan\delta = \frac{\varepsilon''(\omega)}{\varepsilon'(\omega)} = -\omega\Gamma_p\left[(\omega^2-\tilde{\tilde{\omega}}_{\pm}^2)\right]^{-1}, \tag{9}$$

The frequencies $\tilde{\tilde{\omega}}_{\pm}$ are the normal modes of the system. The $\tilde{\tilde{\omega}}_+$ mode gives the contribution for weakly temperature transverse relaxation behavior of the observed transverse loss tangent $(\tan\delta_a)$ and $\tilde{\tilde{\omega}}_-$ mode contribution to the longitudinal relaxation behavior of the observed longitudinal loss tangent $(\tan\delta_c)$. The $\tilde{\tilde{\omega}}_+$ mode corresponds to transverse E(x, y) mode, which is responsible for the observed transverse dielectric properties of KDP. In the simplest approximation $\tilde{\tilde{\omega}}_+$ can be written as $\tilde{\tilde{\omega}}_+ = K_1 + K_2 T$, ($K_1$, K_2 are temperature independent parameter). At microwave frequencies, $\omega, (\omega/\tilde{\tilde{\omega}} = 10^{-3})$, one may approximate $\tilde{\tilde{\omega}} >> \omega$ and $\tilde{\tilde{\omega}} >> \Gamma(\omega)$ so that eq.(9) reduces to

$$\tan\delta = -\omega\Gamma(\omega)\tilde{\tilde{\omega}}^{-2} \tag{10}$$

Now writing $\Gamma(\omega)$ in the form of $\Gamma(\omega) = \alpha+\beta T+\gamma T^2$ and by making use of Eq.(6) for $\tilde{\tilde{\omega}}$ we obtain eq. (10) in the form of

$$\left(T-T_C\right)\tan\delta = -\omega(A+BT+CT^2), \tag{11}$$

Where A= αK^{-1}, B= βK^{-1}, and C= γK^{-1}, K being given by eq (6) and α,β and γ are obtained with the help of Eqs. (5a to 5d) which comes out as

$$\alpha = \frac{2\pi \bar{V}_q^2\, \omega_q^2\, \Omega}{\tilde{\Omega}(\omega^2-\tilde{\tilde{\omega}}^2)^2}\left[\left\{\delta(\omega-\tilde{\Omega})-\delta(\omega+\tilde{\Omega})\right\}+\left\{\delta(\omega-\hat{\Omega})-\delta(\omega+\hat{\Omega})\right\}\right] \tag{12}$$

$$\beta = \frac{24\pi \bar{V}_q^2\, \omega_q^2\, \Omega k}{(\omega^2-\tilde{\tilde{\omega}}^2)^2}\sum\left|V_{3(qq')}\right|^2 \frac{\omega_q\omega_{q'}}{(\omega_q\omega_{q'})^2}\left[(\tilde{\tilde{\omega}}_q+\tilde{\tilde{\omega}}_{q'})^2\left\{\delta(\omega-2\tilde{\tilde{\omega}}_q-\tilde{\tilde{\omega}}_{q'})-\delta(\omega+2\tilde{\tilde{\omega}}_q+\tilde{\tilde{\omega}}_{q'})\right\}\right.$$

$$\left.+(\tilde{\tilde{\omega}}_q^2-1)\left\{\delta(\omega-2\tilde{\tilde{\omega}}_q+\tilde{\tilde{\omega}}_{q'})-\delta(\omega+2\tilde{\tilde{\omega}}_q-\tilde{\tilde{\omega}}_{q'})\right\}+2(\tilde{\tilde{\omega}}_q^2-1)\left\{\delta(\omega-\tilde{\tilde{\omega}}_{q'})-\delta(\omega+\tilde{\tilde{\omega}}_{q'})\right\}\right] \tag{13}$$

$$\gamma = \frac{144\pi \bar{V}_q^2\, \omega_q^2\, \Omega K}{(\omega^2-\tilde{\tilde{\omega}}^2)^2}\sum\left|V_{4(qq')}\right|^2 \frac{\omega_q^2}{(\omega_q)^4}\left[(1+3\tilde{\tilde{\omega}}_q^2)\left\{\delta(\omega-3\tilde{\tilde{\omega}}_q)-\delta(\omega+3\tilde{\tilde{\omega}}_q)\right\}\right.$$

$$\left.+(\tilde{\tilde{\omega}}_q^2-1)\left\{\delta(\omega-\tilde{\tilde{\omega}}_q)-\delta(\omega+\tilde{\tilde{\omega}}_q)\right\}\right] \tag{14}$$

V. Numerical Calculations

By using Blinc-de Gennes model parameter values for KDP (KH_2PO_4) crystal as given by Ganguli *et al* [10] have been given in Table-1, we have calculated loss tangent of KDP (KH_2PO_4) at 9.2 GHz for fields along the a-axis ($\tan\delta_a$), and c-axis ($\tan\delta_c$), collective phonon mode frequency ($\tilde{\tilde{\omega}}$), and Collective phonon half width $\Gamma(\omega)$ in paraelectric phase, given in Table-2.

Table 1 : Blinc de Genns model parameters for KDP (KH_2PO_4) as given by Ganguli *et al*[10]

Ω (cm^{-1})	J (cm^{-1})	J' (cm^{-1})	T_C (K)	V/kT_C
82	334	440	123	0.299

Table 2: Calculated values for KDP (KH_2PO_4) crystal

Temperature (K)	125	130	135	140	145	150
$\tan\delta_a$	0.004	0.00398	0.00397	0.00396	0.00395	0.00394
$\tan\delta_c$	0.068	0.033	0.0279	0.0253	0.0247	0.0241
$\Gamma(cm^{-1})\times10^{-3}$	2.87	2.31	1.76	1.88	1.90	1.92
$\tilde{\tilde{\omega}}(cm^{-1})$	45.65	57.04	58.69	63.04	64.91	66.78

VI. Frequency Dependence of Loss Tangent

Loss tangent is frequency dependent. For microwave engineering, lossy materials are given with dielectric constant (ε_r) and loss tangent $(\tan\delta)$ .Putting calculated values of $\Gamma(\omega)$ and $\tilde{\tilde{\omega}}$ for different temperatures into equation (10) or (11), loss tangent is obtained in paraelectric phase of KDP (KH_2PO_4) in 9.2 GHz at 98 K for field along the a-axis $(\tan\delta_a)$, and c-axis $(\tan\delta_c)$. The variations of dielectric loss tangent versus frequency are shown in Fig. 1 and 2. The increases in frequency (1-30GHz) is followed by an increase in loss (1-12) X10^{-2}. Our theoretical results fairly agree with experimentally reported results[22] within experimental errors.

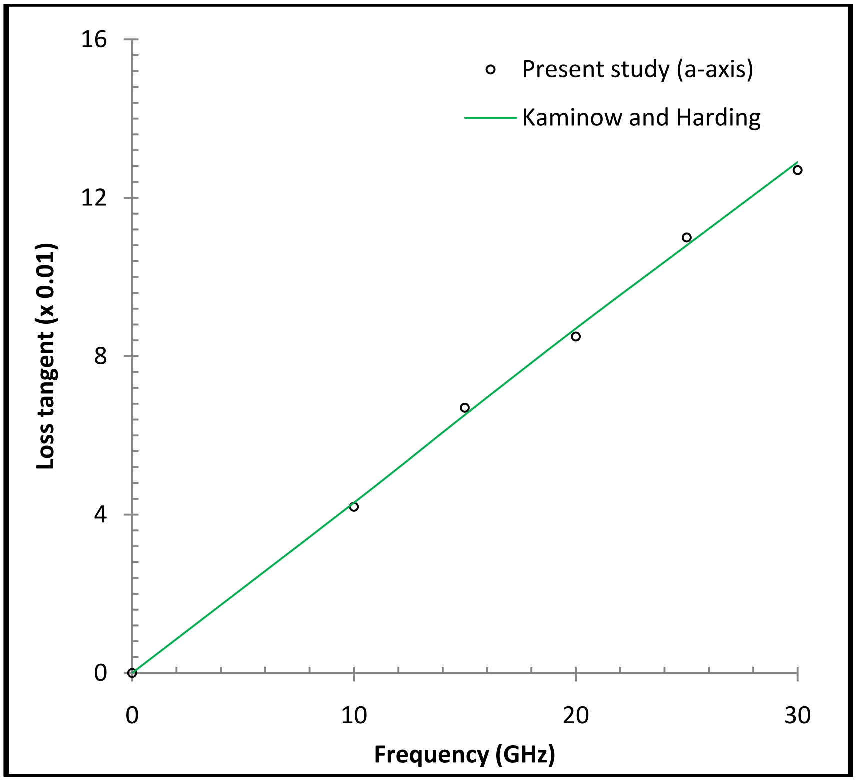

Figure 1 : Frequency dependence of loss tangent of KDP (KH_2PO_4) at 98 K for fields along a -axis, $(\tan \delta_a)$ [22], o our calculation

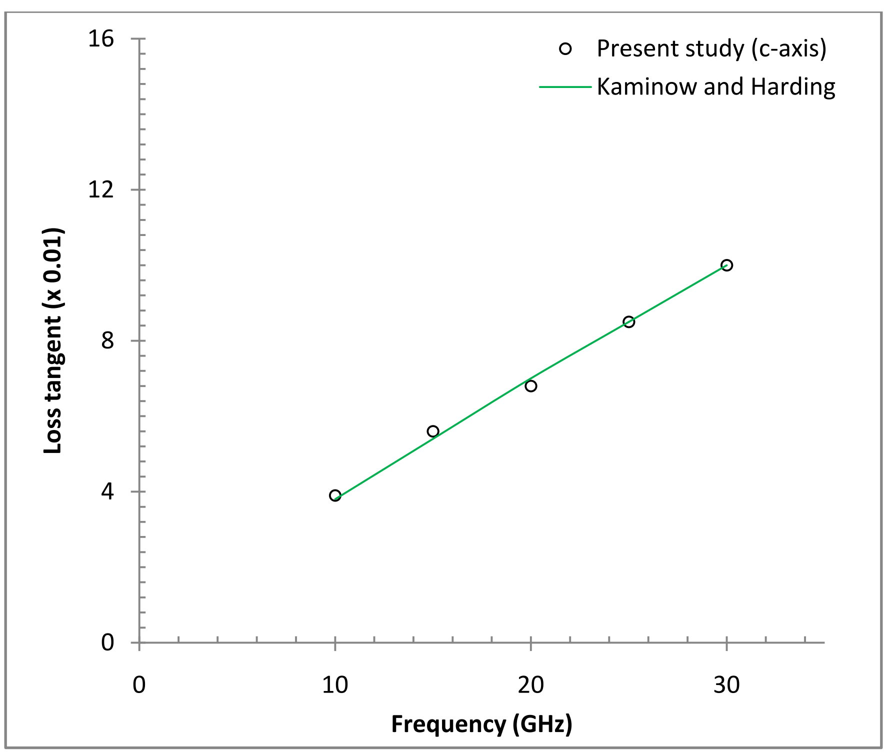

Figure 2 : Frequency dependence of loss tangent of KDP (KH_2PO_4) at 98 K for fields along the c-axis, $(\tan \delta_c)$ [22], o our calculation

VII. Teperature Dependence of Loss Tangent

Using equations (10) or (11) and our calculated values from Table- 2, we have calculated loss tangent at 9.2 GHz in the temperature range (120 -150 K) for fields along the a – axis $(\tan\delta_a)$, and c – axis $(\tan\delta_c)$ for KDP (KH_2PO_4) crystals. We have calculated losses at 9.2 GHz frequency because we have experimental data available only at this frequency range. The transverse dielectric tangent loss $(\tan\delta_a)$, and longitudinal dielectric tangent loss $(\tan\delta_c)$ versus temperature are shown in Fig. 3 and 4. It is found to have a relatively low $\tan\delta$ value, indicating that it possess lesser number of electrically active defects, which is a vital parameter of electro-optics device fabrications. It is also observed that the higher dielectric loss occurs at high temperatures. Our theoretical results are in good agreement with experimental results of Kaminow and Harding [22].

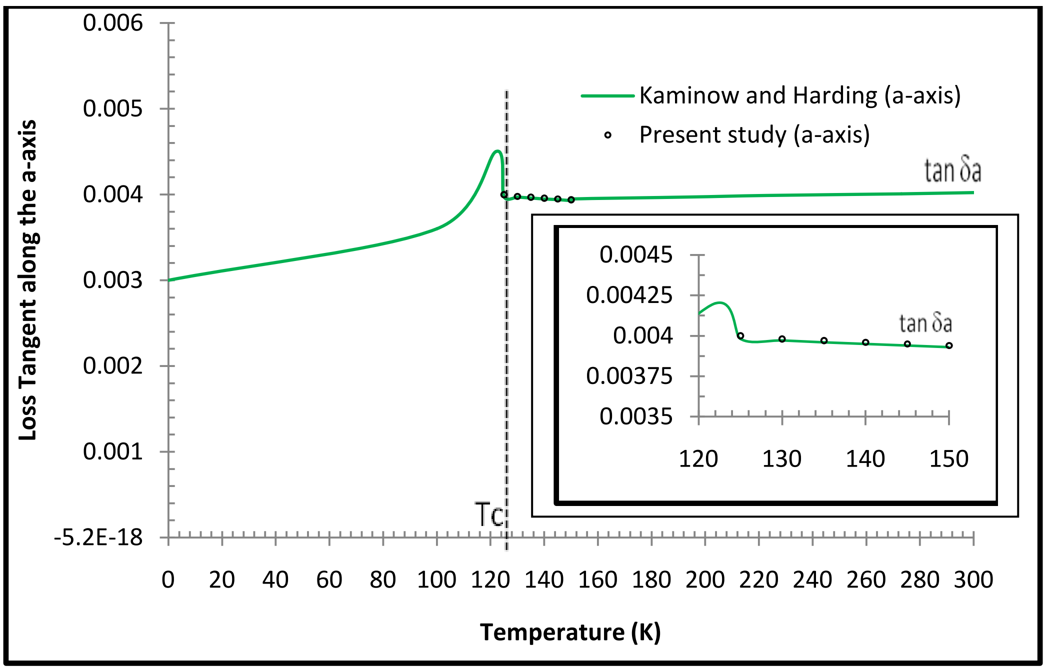

Figure 3 : Temperature dependence of loss tangent of KDP (KH_2PO_4) at 9.2 GHz. for fields along a - axis $(\tan\delta_a)$ [22], o our calculation

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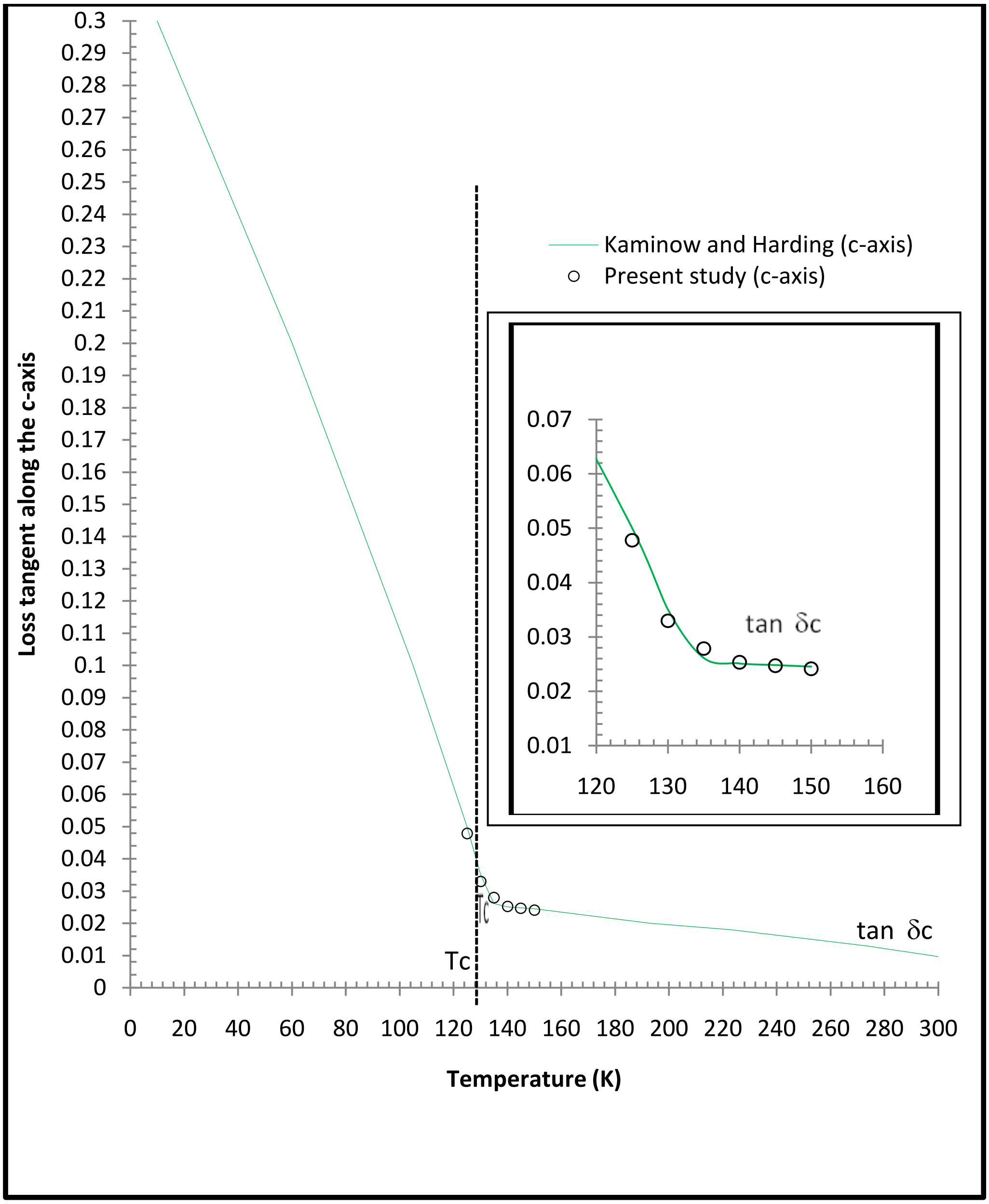

Figure 4 : Temperature dependence of loss tangent of KDP (KH_2PO_4) at 9.2 GHz. for fields along the c-axis, $(\tan\delta_c)^{22}$, o our calculation

VIII. Conclusion

In this paper, by modifying the four-particle cluster model for KDP (KH_2PO_4) type ferroelectric crystal by adding anharmonic contributions upto fourth order, we have evaluated theoretically the expressions for the soft mode frequency, and loss tangent. Using Blinc-de Gennes model parameter value given by Ganguli et al[10] we have calculated temperature variation of loss tangent of KDP (KH_2PO_4) at 9.2 GHz. From the present study, it is concluded that the consideration four-particle cluster model Hamiltonian alongwith the third and fourth-order anharmonicity for the KDP (KH_2PO_4) type ferroelectrics leads to renormalization and stabilization of the relaxational soft mode. The decoupling of the correlations appearing in the dynamical equations after applying Dyson's equation, result in shift in frequency and facilitate the calculation of damping parameter, which is related to loss tangent. The present results reduce to results of others workers[5,6,9,11,12] if width and shift are neglected. Only Ganguli et a[10] have considered fourth-order anharmonic term but they also could not do it in a convenient way as they truncated the spin correlations at an early stage, and so could not obtain width and shift. In this way they could not explain dielectric loss and also could not obtain better results as reported by us. Our equations (10) and (11) along with figures 1 and 2 show that loss tangent loss vary linearly with frequency which is in agreement with experiments The temperature dependence of loss tangent in paraelectric phase of KDP (KH_2PO_4) at 9.2 GHz for field along the a-axis $(\tan\delta_a)$, and c-axis $(\tan\delta_c)$ have been calculated which compare well with experimental results of Kaminow *et al* [22]. A good agreement has been found. At higher temperature the losses deviates from the Curie-Weiss type behavior and increases linearly with temperature. This behavior suggests that at higher temperatures the phonon anharmonicity contributes significantly in the observed loss.

IX. Acknowledgements

The authors wish to thank Prof. B S Semwal, Ex-Head, Department of Physics, HNB Garhwal University Srinagar Garhwal) for their kind suggestions and encouragement.

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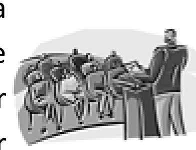

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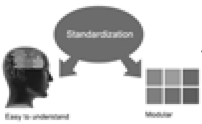

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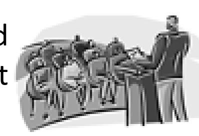

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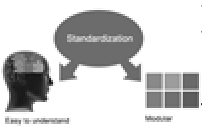

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Standard Usage, Abbreviations, and Units: Spelling and hyphenation should be conventional to The Concise Oxford English Dictionary. Statistics and measurements should at all times be given in figures, e.g. 16 min, except for when the number begins a sentence. When the number does not refer to a unit of measurement it should be spelt in full unless, it is 160 or greater.

Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

Structure

All manuscripts submitted to Global Journals Inc. (US), ought to include:

Title: The title page must carry an instructive title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) wherever the work was carried out. The full postal address in addition with the e-mail address of related author must be given. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining and indexing.

Abstract, used in Original Papers and Reviews:

Optimizing Abstract for Search Engines

Many researchers searching for information online will use search engines such as Google, Yahoo or similar. By optimizing your paper for search engines, you will amplify the chance of someone finding it. This in turn will make it more likely to be viewed and/or cited in a further work. Global Journals Inc. (US) have compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Key Words

A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy and planning a list of possible keywords and phrases to try.

Search engines for most searches, use Boolean searching, which is somewhat different from Internet searches. The Boolean search uses "operators," words (and, or, not, and near) that enable you to expand or narrow your affords. Tips for research paper while preparing research paper are very helpful guideline of research paper.

Choice of key words is first tool of tips to write research paper. Research paper writing is an art.A few tips for deciding as strategically as possible about keyword search:

- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

References to information on the World Wide Web can be given, but only if the information is available without charge to readers on an official site. Wikipedia and Similar websites are not allowed where anyone can change the information. Authors will be asked to make available electronic copies of the cited information for inclusion on the Global Journals Inc. (US) homepage at the judgment of the Editorial Board.

The Editorial Board and Global Journals Inc. (US) recommend that, citation of online-published papers and other material should be done via a DOI (digital object identifier). If an author cites anything, which does not have a DOI, they run the risk of the cited material not being noticeable.

The Editorial Board and Global Journals Inc. (US) recommend the use of a tool such as Reference Manager for reference management and formatting.

Tables, Figures and Figure Legends

Tables: Tables should be few in number, cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g. Table 4, a self-explanatory caption and be on a separate sheet. Vertical lines should not be used.

Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

Preparation of Electronic Figures for Publication

Even though low quality images are sufficient for review purposes, print publication requires high quality images to prevent the final product being blurred or fuzzy. Submit (or e-mail) EPS (line art) or TIFF (halftone/photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Do not use pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings) in relation to the imitation size. Please give the data for figures in black and white or submit a Color Work Agreement Form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution (at final image size) ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs) : >350 dpi; figures containing both halftone and line images: >650 dpi.

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Figure Legends: Self-explanatory legends of all figures should be incorporated separately under the heading 'Legends to Figures'. In the full-text online edition of the journal, figure legends may possibly be truncated in abbreviated links to the full screen version. Therefore, the first 100 characters of any legend should notify the reader, about the key aspects of the figure.

6. AFTER ACCEPTANCE

Upon approval of a paper for publication, the manuscript will be forwarded to the dean, who is responsible for the publication of the Global Journals Inc. (US).

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The corresponding author will receive an e-mail alert containing a link to a website or will be attached. A working e-mail address must therefore be provided for the related author.

Acrobat Reader will be required in order to read this file. This software can be downloaded

(Free of charge) from the following website:

www.adobe.com/products/acrobat/readstep2.html. This will facilitate the file to be opened, read on screen, and printed out in order for any corrections to be added. Further instructions will be sent with the proof.

Proofs must be returned to the dean at dean@globaljournals.org within three days of receipt.

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Before start writing a good quality Computer Science Research Paper, let us first understand what is Computer Science Research Paper? So, Computer Science Research Paper is the paper which is written by professionals or scientists who are associated to Computer Science and Information Technology, or doing research study in these areas. If you are novel to this field then you can consult about this field from your supervisor or guide.

TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

Please carefully note down following rules and regulation before submitting your Research Paper to Global Journals Inc. (US):

Segment Draft and Final Research Paper: You have to strictly follow the template of research paper. If it is not done your paper may get rejected.

- The **major constraint** is that you must independently make all content, tables, graphs, and facts that are offered in the paper. You must write each part of the paper wholly on your own. The Peer-reviewers need to identify your own perceptive of the concepts in your own terms. NEVER extract straight from any foundation, and never rephrase someone else's analysis.
- Do not give permission to anyone else to "PROOFREAD" your manuscript.
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- To guard yourself and others from possible illegal use please do not permit anyone right to use to your paper and files.

Criterion for Grading a Research Paper (Compilation) by Global Journals Inc. (US)

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals Inc. (US).

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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ISSN 9755896