Testing the Possibility of Weight Changes in Highly-Polarized Electrets

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To defy gravity is one of mankind's earliest dreams. Recent patents by Kita as well as others claimed that electrically polarized materials show anomalous weight readings over time. We decided to assess this phenomena in our own setup under controlled laboratory conditions. An electret mixture of carnauba wax, rosin and beeswax was made and polarized between two electrodes connected to a high voltage power supply. The electrostatic field was applied at the beginning from the liquid state to complete solidification until room temperature was reached. To measure the resulting electrostatic field, an electrostatic voltmeter was used. The weight was measured with a laboratory balance. The first electrets were created inside a polycarbonate container and measured in an open environment. The weight measurement showed a particular fluctuation and also a constant increase. A similar fluctuation could be seen in a separately executed electrostatic field measurement. The measurements of non-polarized electrets showed the same overall increase in weight as the polarized electrets. The second container type was made out of glass with a lid for even better sealing in addition to a sealed box to isolate the whole measurement setup. The glass container further improved the weight measurement, but made the measurement of the electrostatic field unreliable. We observed similar trends of the weight readings over time for both polarized and non-polarized control electrets that do not confirm any polarization-induced influence on weight. After implementing significant sealing procedures, our weight changes with carnauba wax electrets in the polarized and non-polarized state were in the several mg range per day compared to claimed weight variations by Kita using a mixture of carnauba wax and 1,2,3-trichlorobenzene of up to 140 mg after 21 days. Our measurements show the need to carefully design gas-tight containers and to characterize the weight balance drifts. Further investigations with better stabilized materials and seals as well as long-term measurements are needed to further improve our measurement resolution.

I. Introduction

GRAVITY is one of nature's fundamental forces and also the weakest. It's is best described by Einstein's general relativity theory although alternative models exist that look for deviations to make gravity more accessible to experimentation. One thought that has emerged is that gravitation might be a residual effect of a considerably higher natural force. Assis[1-3] theoretically derived such an alternative model using Weber's laws where gravitation is derived as a fourth order magnitude effect of electromagnetism. It is based on the oscillation of electric charges that are thought to be the main constituents of mass itself. If that would be true, one may then think if electric polarization of a material may influence mass. Several experiments were reported in the past that seem to make a link between charges and possible weight anomalies. For example, Brown[4] described weight anomalies of different materials which were created through friction based procedures which may be connected to charges and/or polarization. Reiter[5] investigated agitated crystals that showed weight anomalies, which may have also resulted from mechanically induced electric polarization. The largest result was produced with a quartz crystal with a weight of around 24 g that showed a weight deviation up to 2 mg. More recently, Kita[6,7] published several patents where he

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claimed that an electrically polarized electret showed weight changes. He used a 50:50 mixture of 1,2,3-trichlorobenzene and carnauba wax as the electret material due to it's excellent polarization characteristics. It was stated that the initial overall mass of around 278 g showed a weight increase of 140 mg in a time frame of 21 days and in another 21 days it decreased to the initial weight again. The patent claimed that all necessary steps for sealing were done in order to prevent any interaction with the ambient air. Also, a control measurement is reported where a non-polarized electret showed stable weight readings in a humid atmosphere. However, no detailed measurements or balance characterizations were given.

To make an assessment of this phenomenon, we planned to investigate this phenomenon under controlled laboratory conditions. Electrets are materials which exhibit a relatively high permanent electrostatic field. Through the use of an external electrostatic field, the dipoles can be aligned and the charges separated. We measured the weight while it's electrically polarized as well as during the relaxation of the electrets. We decided to used electret mixtures of carnauba wax, rosin and beeswax only which were produced and cooled down to room temperature while an electrostatic field was applied. The electrostatic field was generated between two electrodes connected to a high voltage power supply. In comparison to the patent by Kita[7], 123-trichlorobenzene was not used, because hydrogen chloride could be produced during heating being a health hazard. Measurements of the weight and the electrostatic field were taken. **Figure 1** shows the different setups which were investigated. The first part of this paper discusses electrets that were manufactured with polycarbonate containers and measured in an open environment. In the second part, electrets with glass containers are discussed. The glass containers were sealed with a lid and measured inside a sealed box.

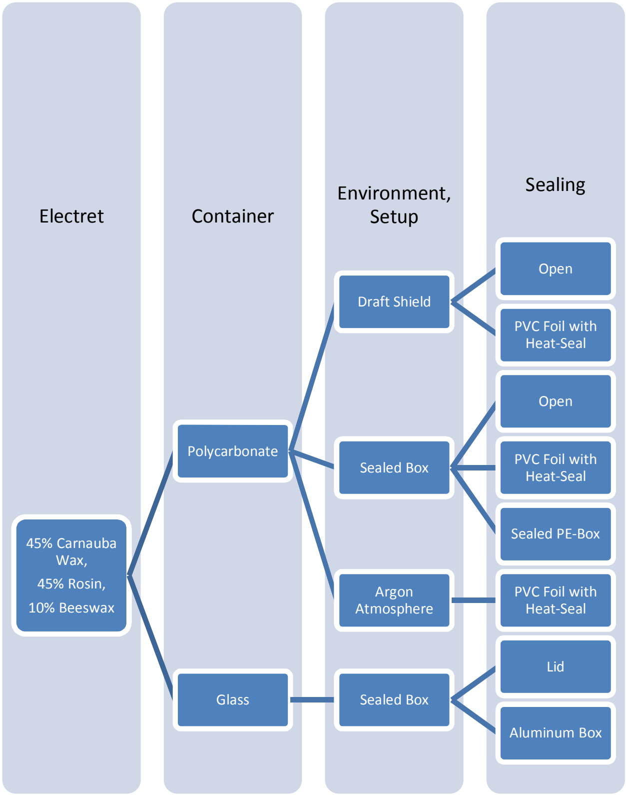


Figure 1. Different Experimental Setups.

II. Electret Manufacturing

One of the earliest mixtures for electrets reported by Eguchi[8] was a combination of carnauba wax, rosin and beeswax. An overview of the procedure is shown in **Figure 2**. Here, a mixture of 45% carnauba wax, 45% rosin, and 10% beeswax was used. Carnauba wax is a natural, hard and brittle wax, which is manufactured from the leaves of a Brazilian tree. It has a melting point of around 84°C and a dipole relaxation time[9] of 10^2-10^5 s. With its suitable properties it was used as the main component for the electret. Rosin or colophony is a natural resin obtained from trees. It is hard, brittle and the melting point varies between 70-120°C. Beeswax is a soft and natural wax and is manufactured by separating it from honey. The melting point is around 63°C.

Before the polarization could be started, the electret had to be molten. The electret was put inside an appropriate container and then heated until it completely liquefied. For the heating, a furnace with good temperature stability and adjustable heating stages was used. The chosen temperature for melting the electret was 120°C. The temperature was high enough to melt all the components of the electret. A higher temperature would have affected the containers.

After the electret was completely liquefied, the electrostatic field was applied. The electrostatic field was generated between two conductive plates. One plate is connected to the ground and the other plate is connected to a high voltage. The high voltage was supplied by a HEINZINGER HNCS 10000-1 power supply with a voltage output up to 10kV and currents up to 1 mA. To start the polarization process, a strong electrostatic field needed to be applied. The voltage had to be high enough to penetrate deep inside the electret and it had to overcome the internal dipole moments. With a sufficient voltage, the dipoles started to align and the charges were separated. The electric field had to be maintained until the electret completely solidified. After room temperature was reached, the polarization process was completed and the electret displayed a quasi-permanent electrostatic field. The model in **Figure 3a** shows a non-polarized electret and **Figure 3b** shows a polarized electret with the connected electrodes. While in **Figure 3a** the charge distribution and dipole orientation is chaotic, **Figure 3b** shows the alignment of the charges to the electrostatic field. Because the electric dipoles are influencing each other, one dipole alone cannot easily change its orientation. Therefore, the electrostatic field of a polarized electret is also called quasi-permanent.

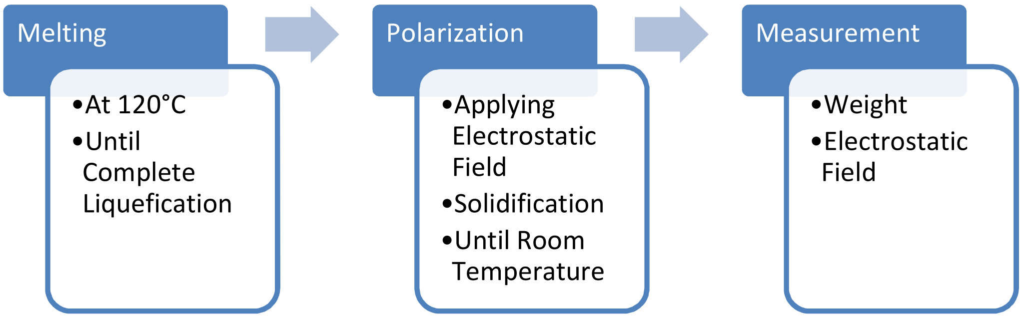
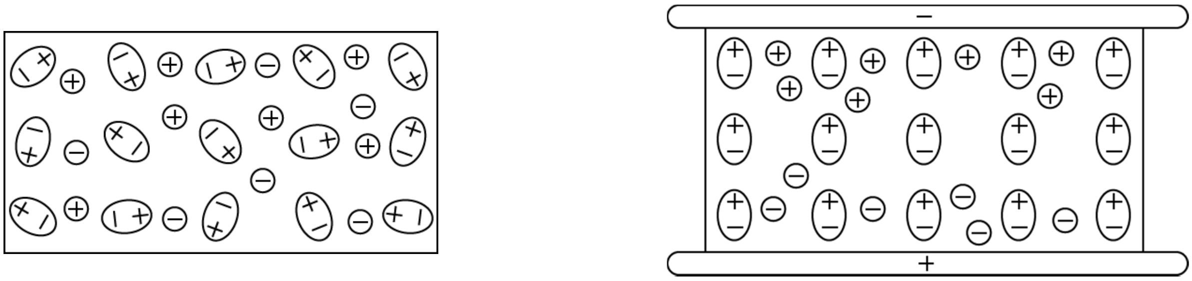


Figure 2. Procedure of Electret Manufacturing.



a) Non-Polarized Electret b) Polarized Electret

Figure 3. Model of Different Charges inside an Electret.

The generated electrostatic field of an electret is not constant. Changes are observable and a polarity reversal is possible. A reversal of the polarity is an effect of electrets which have heterocharges and homocharges. At first the electret is heterocharged. The side with the positive electrode has a negative charge and the side with the negative electrode has a positive charge. But some charges, the heterocharges, have a shorter relaxation time than the others, the homocharges. With the relocation of the charges, the cumulative charge changes. On the surface of the electret is a reversal of the electrostatic field measurable.

Jefimenko[10] compared this effect to a system of tubes which are filled with water. In his description are two tubes. The first tube has a high water level and a valve with a large opening to the outside. The second tube has a low water level and it is connected with the first tube through a valve with a small opening. The water of the first tube corresponds to the heterocharges of an electret and the water in the second tube corresponds to the homocharges. The valves symbolize the relaxation process of the charges. The high water level of the first tube decreases through its own valve with the large opening, the water also partly flows to the second tube through the second valve with the small opening. While the water level in the first tube decreases, the water level in the second tube increases. The water flows until the same level of both tubes is reached. Now the water in the first tube decreases quicker than the water level of the second tube, because its valve to the outside has a larger opening. Therefor the first tube has now a lower level than the second tube. In case of the electret, a polarity reversal is seen.

III. Electrets inside a Polycarbonate Container

Polycarbonate containers were used for the first part of the investigations. The material can withstand the melting temperature of the electret and it has approximately the same relative permittivity of $\varepsilon_r \approx 3$ as the electret. They were self-made from polycarbonate plates. **Figure 4** shows the design of the container. The container was manufactured out of polycarbonate plates with a thickness of 0.75 mm. The balance used was a Sartorius AX224 which had a weight capacity of 220 g. Therefore the dimensions of the container were chose accordingly in order to use the full measurement range considering that the box will be filled with our wax mixture.

After the heating and liquefaction of the electret, it was electric polarized. Two conductive plates with the dimensions of 160 mm x 160 mm were used. One plate was connected to the high voltage power supply while the other was connected to the ground. The polycarbonate container with the liquefied electret inside was placed between the conductive plates. By activation of the high voltage power supply an electrostatic field was generated through the container. **Figure 5** shows a schematic view of this system.

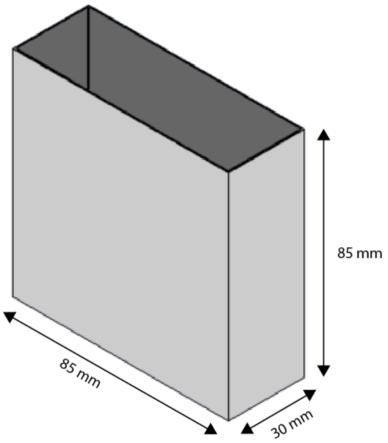


Figure 4. Polycarbonate Container for Electrets.

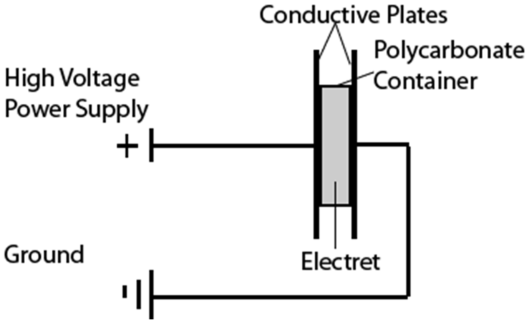


Figure 5. Schematic View of the Electret Polarization with a Polycarbonate Container.

The balance had a weight capacity of 220 g, readability of 0.1 mg, and a standard deviation of ± 0.2 mg. To measure the electrostatic field, the Isoprobe® Electrostatic Voltmeter Model 244A from Monroe Electronics was used which could measure voltages up to ± 3000V DC at a distance up to a few millimeters away from our electret. **Figure 6** shows the basic measurement setup.

To shield the balance from the electrostatic field, the electret was wrapped in aluminum foil. For the measurement of the electrostatic field of the electret, the aluminum wrapping had to be partly opened. It was attempted to measure the exhibited electrostatic field and the weight simultaneously. However, because of the operation principles of the electrostatic voltmeter, the probe generated the same voltage which it measured. The subsequent effect was an electrostatic repulsive force and the measured weight was inaccurate. Because a relay circuit showed no improvement, the measurements of weight and electrostatic field were carried out separately. For the separate weight measurement, the electrostatic voltmeter was located as shown in **Figure 6**. To ensure that the probe of the electrostatic voltmeter does not influence the weight measurement, the mounting frame including the probe was removed.

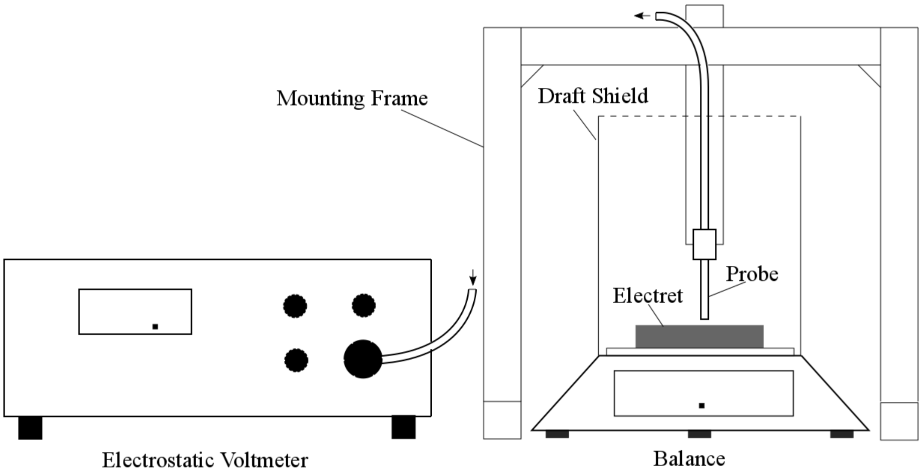
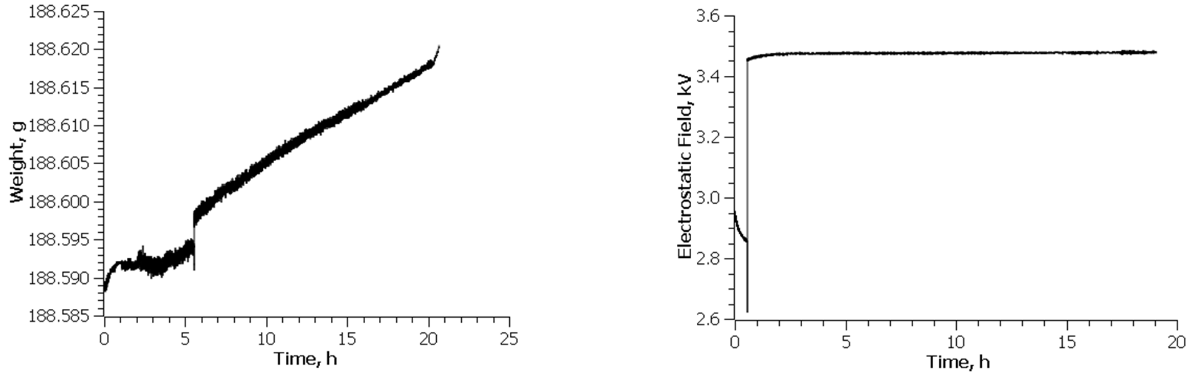


Figure 6. Schematic View of the Measurement Setup for Polycarbonate Container Electrets.

Figure 7a shows the weight measurement of an electret polarized with a voltage of +10kV**.** The mixture was 45% carnauba wax, 45% resin, and 10% beeswax. In 21 hours the weight increased over 30mg. A particular point is the sudden weight increase of around 4 mg after 5.5 hours. **Figure 7b** shows a diagram of the electrostatic field of another similar electret. The used electret had the same composition as in **Figure 7a** and was also polarized with +10kV. At first the measured voltage was decreasing. From the initial 2850 V it went 100 V down. After half an hour, the voltage showed a rapid decrease and an even higher voltage increase to over 3.4 kV afterwards where it reached the saturation of the electrostatic voltmeter. In both diagrams, a sudden change in the measurement is discernable, but the corresponding times are different. An explanation for the time difference between the weight measurement and electrostatic field measurement could be that both electrets had approximately the same parameters, but were not identical. The change in the electrostatic field could be considered as a part of the polarity reversal mechanism; because different charges have different relaxation times, the cumulative charge changes. The sudden change in the characteristic of **Figure 7a** and **Figure 7b** show some similarity.

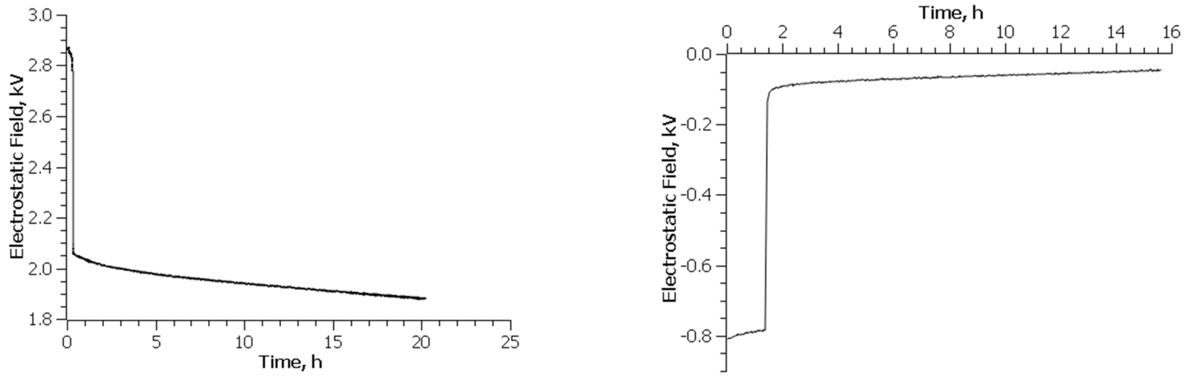


a) Weight Plot of a 10kV Polarized Electret

b) Electrostatic Field Plot of a 10kV Polarized Electret

Figure 7. Characteristics of Polarized Polycarbonate Container Electrets.

Figure 8a and **Figure 8b** show two more diagrams of the electrostatic field of comparable electrets. They show a comparable trend like the one seen in **Figure 7b**. For **Figure 8** the electret composition was the same as in **Figure 7**, but an air gap was created between the probe of the electrostatic voltmeter and the electret. Therefore, the saturation of the electrostatic voltmeter was not reached and the measured trends were qualitatively more accurate.



a) Electrostatic Field Plot of a 10kV Polarized electret, Measured on the Side where the Negative Electrode was Located

b) Electrostatic Field plot of a 10kV Polarized Electret, Measured on the Side where the Negative Electrode was Located

Figure 8. Electrostatic Field Plot of Polarized Electrets.

In comparison to the weight increase of a polarized electret, a non-polarized electret showed a similar behavior. **Figure 9** shows the weight increase of a non-polarized electret. The electret gained around 50 mg of weight over the time of nearly day compared to around 30 mg of the polarized electret from **Figure 7a**. We repeated these tests for both polarized and non-polarized samples showing similar results.

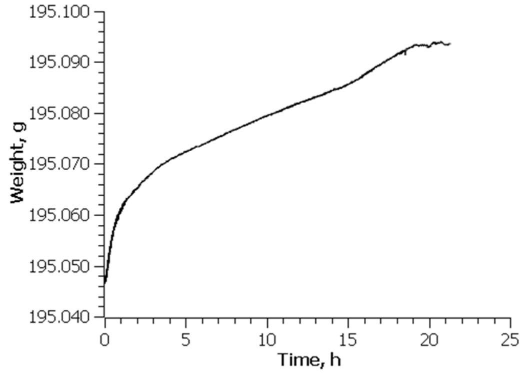


Figure 9. Weight Plot of a Non-Polarized Polycarbonate Container Electret.

The overall weight increase of the electrets was unexpected high. The measurement of the non-polarized electret which acted as a control setup confirmed that a constant weight drift existed. To eliminate the effect of humidity and other possible influences, different kinds of containers and sealing were used (see **Figure 1**). Polyethylene containers with rubber seals, a chamber that was flooded with argon in order to remove water vapor and welded polyethylene foil containers were tested. Improvements in the weight measurement were achieved; however, there was still a large drift on the balance. To further minimize the uncontrolled weight increase, a new type of container was needed. The already used containers and seals were composed of polymers and polymers have permeability for gases. Therefore a material with no or fewer polymers had to be chosen.

IV. Electrets inside a Glass Container

In the second part of this investigation of polarized electrets, glass containers were used. A model of this container is shown in **Figure 10**. The glass container was a bottle with flat sides with a volume of 100 ml that had an actual lid for sealing. With the small lid, the sealing surface was minimized and therfore a better stabillity of the weight was achieved.

After heating and liquefaction of the electret, which was located inside the glass container, the electrostatic field had to be generated. Two electrodes with the dimension of 45 mm x 55 mm were used. The electrodes were manufactured from aluminum foil and were mounted inside the glass container with a heat resistant adhesive. One electrode was connected to the high voltage power supply while the other was connected to the ground. **Figure 11** shows a schematic view of this system. After solidification, the electrodes were connected and the opening was closed with the lid. Aluminum foil was wrapped around the glass container to shield the balance.

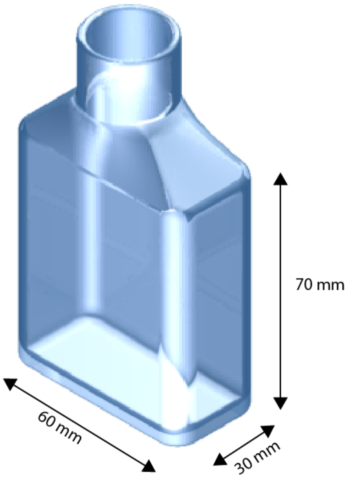


Figure 10. **Glass Container for Electrets.**

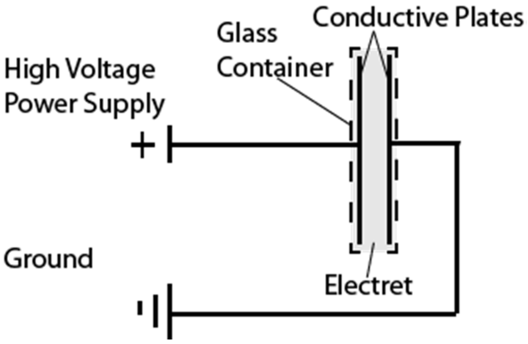


Figure 11. **Schematic View of the Electret Polarization with a Glass Container.**

For the measurements, the same balance and electrostatic voltmeter as for the measurement of the polycarbonate electrets were used. Here we also implemented a sealed box that enclosed the whole measurement setup as shown in **Figure 12**. The electrostatic field was measured before and after the weight readings. To shield the balance from the electrostatic field, the electret was also wrapped in aluminum foil. The measurement of the electrostatic field was problematic. Outside the glass container only a negative electrostatic field could be measured. Inside the glass container it was also possible to measure a positive electrostatic field. It was expected that the polarization process was successful and only the measurement of the electrostatic field was influenced through the glass container and its electrodes. The polarized electret was also modeled using FEMM and the expected voltages are shown in **Figure 13**.

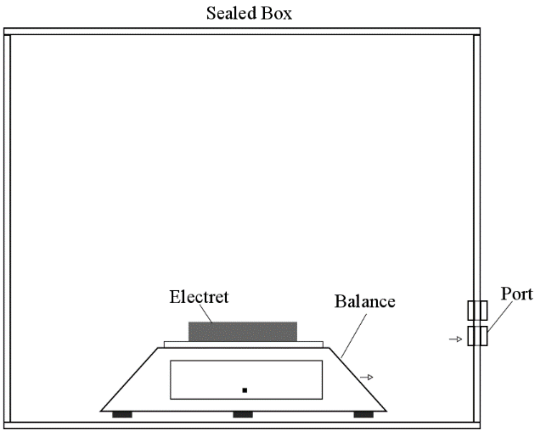


Figure 12. **Schematic View of the Weight Measurement Setup for Glass Container Electrets**

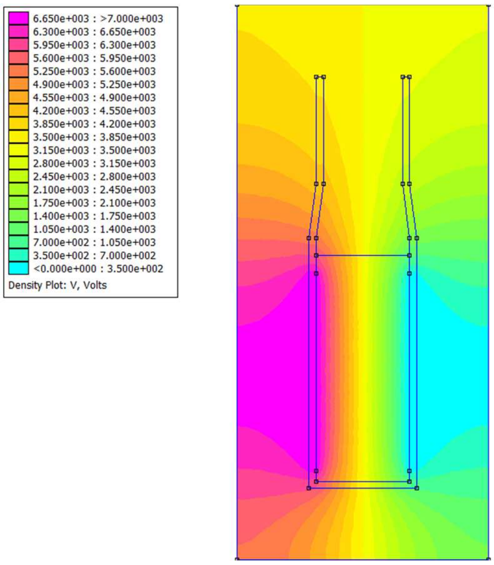
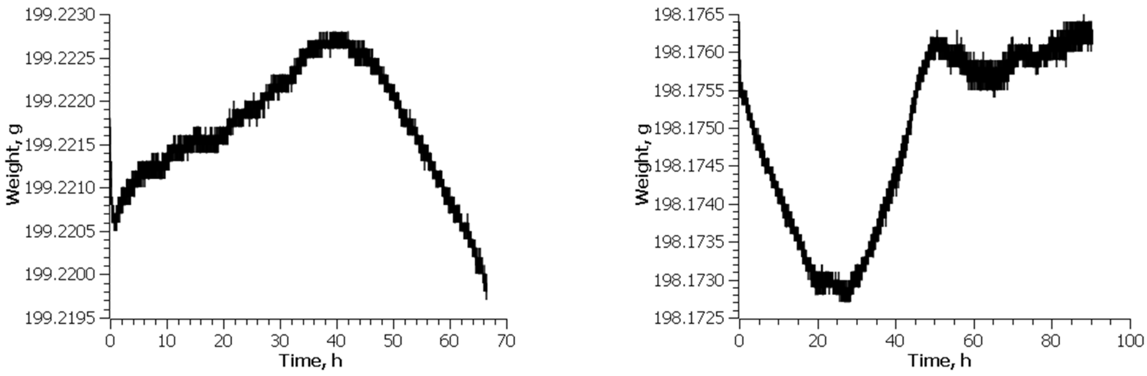


Figure 13. **Contour of the Electrostatic Field Generated by the Electrodes inside a Glass Container Electret assuming a 7kV Polarization.**

Figure 14a shows the weight measurement of an electret polarized with a voltage of 7 kV**.** The mixture was 45% carnauba wax, 45% resin, and 10% beeswax. The sealed box served as a stable environment minimizing the exchange of air and humidity. The trend shows a weight increase of around 2.5 mg and afterwards a decrease of the weight. During 60 hours, the electret gained and lost weight of around 2.5 mg. The same electret reused and polarized with the same specifics, showed a reversed trend. **Figure 14b** shows this reversed trend and the weight change of the electret showed was also approximately the same. Only the measurements of the electrostatic fields show a difference between the two electrets.

Table 1 shows the measurements of the electrostatic fields, which were taken beforehand and after the weight measurement. The electrostatic field was measured clockwise around the container starting with the side where the positive electrode was located. The last measured position was inside the glass container through its opening. For both cases the electrostatic field around the glass container was negative. The only distinction was seen in the measurements inside the container, directly on the surface through the opening. Inside the glass container of **Figure 14a** was a positive electrostatic field measured while in **Figure 14b** a negative electrostatic field was measured. Hitherto the cause for the difference in the electrostatic field of the two electrets, which were manufactured with the same specifics, is unknown. However, both electrets had different changes in weight and also had different corresponding electrostatic fields.



a) First Test of 7 kV Polarized Glass Container Electret

b) Second Test of 7 kV Polarized Glass Container Electret

Figure 14. Weight Plot of Polarized Glass Container Electrets.

Side of the Container	**Figure 14a** Electrostatic Field, kV		**Figure14b** Electrostatic Field, kV	
	At Start	At End	At Start	At End
(pos. electrode) 1	-1.20	-1.00	-1.15	-0.65
2	-1.25	-0.85	-0.95	-0.55
(neg. electrode) 3	-1.30	-0.80	-0.7	-0.60
4	-1.00	-0.80	-0.7	-0.65
(bottom) 5	-1.10	-0.85	-0.55	-0.55
(top, inside) 6	+0.8	+3.4 (max)	-3.4 (max)	-3.4 (max)

Table 1. Corresponding Electrostatic Fields of Figure 14a and Figure 14b.

Tests with non-polarized electrets in glass containers showed also a trend of weight increase. **Figure 15** shows the weight plot of a non-polarized. The fluctuation in weight of the non-polarized electret after 35 hours shows a similarity to the electrets with 7kV polarization (see **Figure 14a,b**). The measured fluctuation was only around 1 mg while the electrets with 7kV polarization had a weight change of 2.5mg. **Figure 15** serves as a demonstration that also a non-polarized glass container electret can show similar trends.

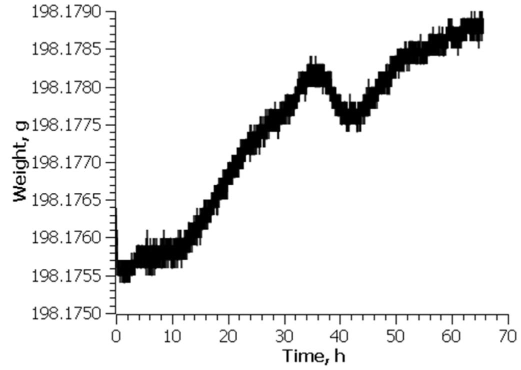


Figure 15. Weight Plot of a Non-Polarized Glass Container Electret.

In comparison to the polycarbonate containers, the use of glass containers reduced the drift of our weight measurement of electrets by at least one order of magnitude. Still an actual stability of the weight was not achieved with our control/non-polarized electrets. The sealing inside the lid of the glass containers was a polymer and polymers have permeability, thus gases may go through. Which components of the atmosphere reacted with the electret or were stored inside are unknown. The electret was a mixture of natural materials. Inorganic components of the carnauba wax could have oxidized. Therefore the percentage by volume of oxygen could have decreased, which resulted in an intake of new oxygen through the polymer sealing. The overall weight would increase because oxygen was bonded.

V. Conclusion

The weight as well as the electrostatic field of electrets was measured with different setups. Drifts as well as anomalous weight readings were found for both polarized as well as non-polarized electrets with similar trends and magnitude. This is not in favor of a possible connection between electric polarization and weight anomalies as reported by others. In particular, we found that polymer containers and seals allow for gas leaks that can lead to large drifts. By using glass containers with minimum seal surfaces, we could reduce such drifts to around several milli-grams per day. Our electret material was composed of waxes which is different than the claimed results from Kita[7] who reported weight anomalies of up to 140 g with mixtures of waxes and 1,2,3-trichlorobenzene over a period of 21 days. Our results suggest that such weight anomalies can be easily explained by a combination of balance drift and non-ideal seals which permit gas exchange. Also our large drifts of non-polarized electrets raises doubts on the validity of the claimed control experiments from Kita. For further improvement, a system needs to be created which allows the balance to recalibrate and tare itself. With a stabilized weight of non-polarized electrets, the weight of polarized electrets could be reliably measured over the relaxation time and a more accurate statement relating weight anomalies could be made.

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