International Journal of Engineering Science Invention (IJESI)
ISSN (Online): 2319-6734, ISSN (Print): 2319-6726
www.ijesi.org ||Volume 9 Issue 10 Series I || October 2020 || PP 76-82

Dielectric contribution of the peels of Allium Cepa and Allium Sativa cmposition

Anil Kumar*, SuwarnSangam
1. **Corresponding author, JawaharNavodayaVidyalayaPiprakothi, East Champaran, Bihar India, PIN-845429*
2.ManavRachna International University, Faridabad Hariyana India PIN-121001

ABSTRACT
Dried peels of Allium Cepa and Allium Sativa have remarkable responses of electric field. The highly compressed mixture of both the Alliums taken in suitable ratio exhibits medium level of relative permittivity. Samples AS, AC, ACS-3, ACS-4 and ACS-5 have been synthesized and studied their electrical properties. Resistivity of all samples is noticeable and observed in increasing order. The effect of variable frequency reveals its utility as dielectric material. Saturation polarization of the sample enables it to have significant amount of charge storage. The polarization strain remains stable even after elimination of external applied electric field. ACS-5 samples are most suitable candidates for the capacitors, memory devices as well as tunable capacitors.
KEYWORDS: *Dielectric, Permittivity, Dielectric Loss Factor, coercivity*

Date of Submission: 12-10-2020 Date of Acceptance: 29-10-2020

I. INTRODUCTION

Allium sativum is a plant of the family **Amaryllidaceae and it belongs to allium genus.** Its leaf blade is flat, linear, solid, and approximately 1.25–2.5 cm (0.5–1.0 in) wide, with an acute apex. The plant may produce pink to purple flowers from July to September in the Northern Hemisphere. The bulb is odoriferous and contains outer layers of thin sheathing leaves surrounding an inner sheath that encloses the clove. Often the bulb contains 10 to 20 cloves that are asymmetric in shape, except for those closest to the center [1]. If garlic is planted at the proper time and depth, it can be grown as far north as Alaska [2]. It produces hermaphrodite flowers. It is pollinated by bees, butterflies, moths, and other insects [3]. It is to produce in each part of world and also consumed by a large number of people in their daily kitchen consumables.

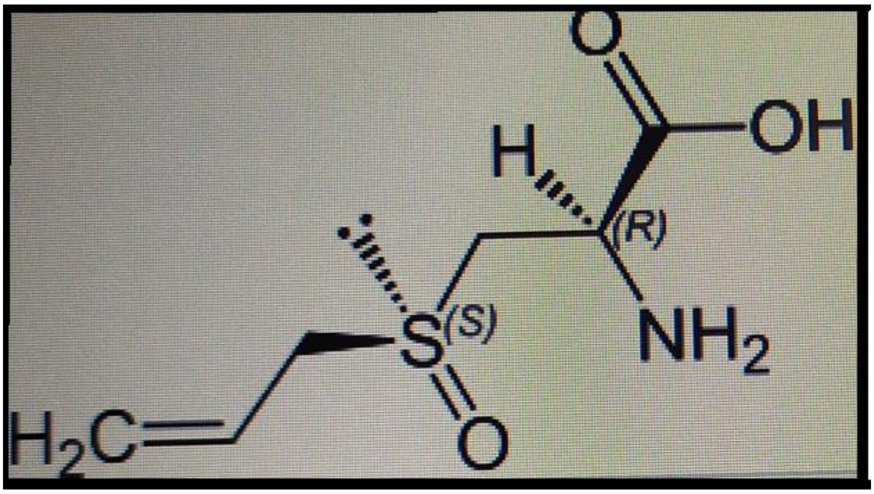

Fig. 1 Allin, a sulphor containing compound found in garlic

A large number of sulfur compounds contribute to the smell and taste of garlic. Allicin has been found to be the compound most responsible for the "hot" sensation of raw garlic. This chemical opens thermo-transient receptor potential channels that are responsible for the burning sense of heat in foods. The process of cooking garlic removes allicin, thus mellowing its spiciness.Allicin, along with its decomposition products diallyl disulfide and diallyltrisulfide, are major contributors to the characteristic odor of garlic, with other allicin-derived compounds, such as vinyldithiins and ajoene [4]. Because of its strong odor, garlic is sometimes called the stinking rose[5].

Another important bulbs of this genus is Allium Cepa (AC), commonly known as onion. There are rich in two chemical groups that have perceived health benefits for humans: flavonoids and alk(en)yl cysteine sulfoxides. Onions contain flavonols such as quercetin and its derivatives, which are responsible for the yellow flesh and brown skins of many yellow types of onions [6]. ACSOs are flavor precursors that generate the characteristic odor and taste of onions when cleaved by the enzyme alliinase [7]. Sixteen different flavonols consisting of aglycones and glycosylated derivatives of quercetin, isorhamnetin and kaempferol have been identified in onions [8]. Onion peel contains over 20 times more quercetin than onion flesh [9]. Although onion peels have high levels of flavonoids, they are usually discarded before onions are processed for human consumption. Takahama and Hirota[10] suggested that quercetin is formed by the deglucosidation of its glucosides, followed by autoxidation to produce protocatechuic acid.

Most of the country of world is consuming onions in his daily eatables in different forms and people use to through the precious peels before its consumption. The same thing is happening with peels of garlic also. Here is an effort to make these useless peels of Allium sativa and Allium Cepa, a very useful and revolutionary application in the field of charge storage devices.

Now a day, safe dumping and risk free decomposition of electric and electronic gadgets is a major issue of modern era. Although people are trying to overcome the problems, still the problem of e- waste is persisting day to day. In the present work, an effort is made to produce bio-degradable dielectric materials which may be widely used in some electric and electronic gadgets and decomposition and destroying process will be also easy. The allium cepa (AC) and allium sativa (AS). In my present work a substitute of traditional barium based dielectric is presented here.

The work has been finished in three main steps-

(I) Sample of peels of pure allium sativa (AS), common name garlic has been prepared and electrical properties have been observed.

(II) Sample of peels of pure allium cepa (AC), common name onion has been prepared and studied all electrical properties 0f it.

(III) A mixture of AS and AC in equal ratio has been prepared and studied the electrical properties at different loads.

Samples Preparation

Dry peels of AS and AC have been collected from a vegetable market. These peels are stored separately and washed at least four times in distilled water. Both the samples are dried in shadow to avoid water droplets. Now20 g of each AS and AC have been stored separately and marked the container as AS and AC, 20 g of AS and 20 g of AC are taken and mixed it and marked as ACS. All the samples are grinded for two hours in domestic grinder. Four drops of glycerin was added as binder and hand milled for two hours each. Now samples are heated in muffle furnace for two hours at 200 degree Celsius to vaporize the binder and other volatile impurities. One pellet of each samples has been prepared at load 2 ton. Three more pellets of ACS have been prepared at load 3 ton, 4 ton and 5 ton and symbolized as ACS-3, ACS-4 and ACS-5 respectively.

Sample NO.	Allium Cepa	Allium Sativa	Load	Sample Code
-1	NIL	100%	2 ton	AS
2	100%	NIL	2 ton	AC
3	50%	50%	3 ton	ACS- 3
4	50%	50%	4 ton	ACS- 4
5	50%	50%	5 ton	ACS- 5

Table-1

Thickness and diameter of the pellets are measured and then gold plated for the purpose of dielectric measurement.

II. RESULT AND DISCUSSION

The gold plated samples have been placed between the terminals of the sample holder of impedance analyzer one by one and data is recorded at different frequencies and temperatures. Analyzer measures the impedance of samples which is a function of resistance used in series, inductive reactance (**X_L**) and capacitive reactance **(X_C).** The impedance of a LCR circuit is the square root of the sum of the squares of inductive reactance and capacitive reactance i.e.**Z^2= [R^2 + (X_L +X_C) ^{2}]**

By matching of R and X_L, X_C can be determined. Capacitative reactance X_C is reciprocal of the product of angular frequency and capacitance i.e. $X_C = \frac{1}{\omega C}$. In this way C_m is known and C_0 is the value of capacitance with empty space can be determined as $C_0 = \frac{\varepsilon 0 \ A}{d}$

The ratio of capacitance in given dielectric medium to the vacuum gives relative permittivity. The temperature dependence of dielectric constant has been studied at variable temperature range from 20 ^{0}C to 250 ^{0} and also at definite frequency 2kHz. At the same time frequency dependence of relative permittivity is another aspect of the present work. The reciprocal of tan loos justifies the quality factor of the sample. Analysis of the polarizing capacity of the samples has been further observed by applying electric field of specified range.In first step of observation dielectric properties as a function of temperature and frequency were studied using Wayne Kerr LCR meter.

The pattern of graph in Fig.2 depicts,the material has gained dielectric responses with compactness. The gradual decreasing trend of dielectric constant (**ε_r**)has been noticed at increasing temperature [11].

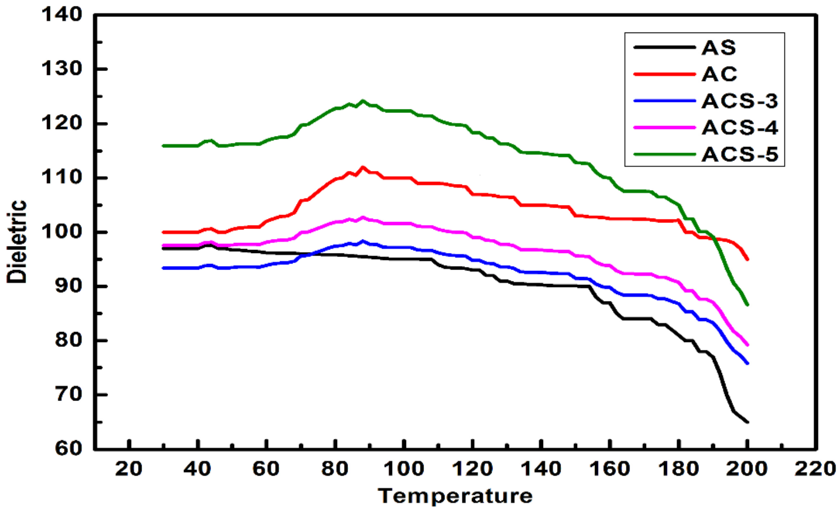

Fig. 2. Temperature vs Relative permittivity

The decline in dielectric value follows different pattern in case of individual sample whereas dielectric constant of AS remains even up to 42^{0}C, after this critical temperature starts to decrease slowly up to 160^{0}C fast decline is noticed after 154^{0}C. In case of second sample AC, the pattern of the dielectric is quite different. Sudden change in relative permittivity has been observed at 78^{0}C, it remains almost unchanged up to 150^{0}C after that rapid fall has been noticed.Third sample i.e. ACS shows mixed response of AS and AC but growth in critical temperature is noticed. Increase in compactness is considered the cause of enhancement in the dielectric value [12]. The pattern of this sample shows mixed response of AC and AS with increasing value of dielectrics. In case of sample fourth (ACS-4) and fifth (ACS-5), dielectric constant is once again observed higher than previous samples. It is assumed that compactness of the samples increases the number density of the polarized domain [13] which contributed in growth of dielectric constant [14]. The critical temperature for ACS-4 and ACS-5 has been recorded 92^{0}C and 94^{0}C respectively. The mild decline is reported due the change in hygroscopic state into anhygroscopic state of the samples [15]at lower temperature as depicted in the graph. The gradual increase in dielectric value of ACS-5 is also due change in diffusion rate of ACS material, ultimately the porosity changes and shows its reflection on dielectric value.

Sample	Critical temperature
AS	42^{0}C
AC	78^{0}C
ACS-3	88^{0}C
ACS-4	92^{0}C
ACS-5	94^{0}C

Table-2

Dielectric behavior of these samples has been observed in the frequency range 1 kHz to 2.0MHz. Dielectric constant has been found to be in close vicinity at lower frequencies while better at higher frequencies. The polarization exists in all samples although sharp rise is observed with the sample ACS-5 with high compactness [16]. At lower frequencies up to 1.5 kHz the dielectric value is erraticdue to annihilation of domains after application of electric field [17]. Between frequency ranges 5 kHz to 2 MHz dielectric value is almost linear for all the samples. Fifth sample ACS-5 has highest value of dielectric for a long range of frequencies which is making the samples useful and best among all the samples. The performance of ACS-5 is once again best among all samples as shown in figure-3.

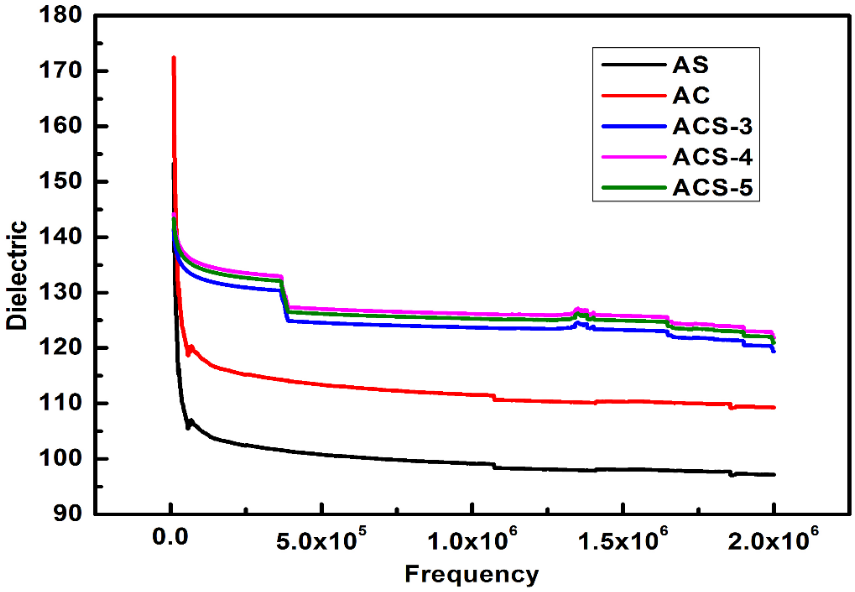

Fig. 3. Frequency vs relative permittivity

As shown in Fig.4, the AC resistivity falls initially for all samples but soon after 200Hz it remains constant. Resistivity of the fourth sample ACS-4 exhibits better resistivity which is signal of having better value of relative permittivity. Although resistivity has been noticed in increasing order with increase in compactness. Higher the compactnessof sample increases the domain density and consequently number density of free electrons increases. When external electric field is applied the relaxation time of electrons decreases which leads to increasing resistivity with high compactness. The sample synthesize at highest load ACS-5 is proven the best dielectric material at room temperature as well as higher temperature. Increasingvalue of resistivitysupports rise in polarization. The rise in resistivity shows decrease in conductivity as the load is increased.

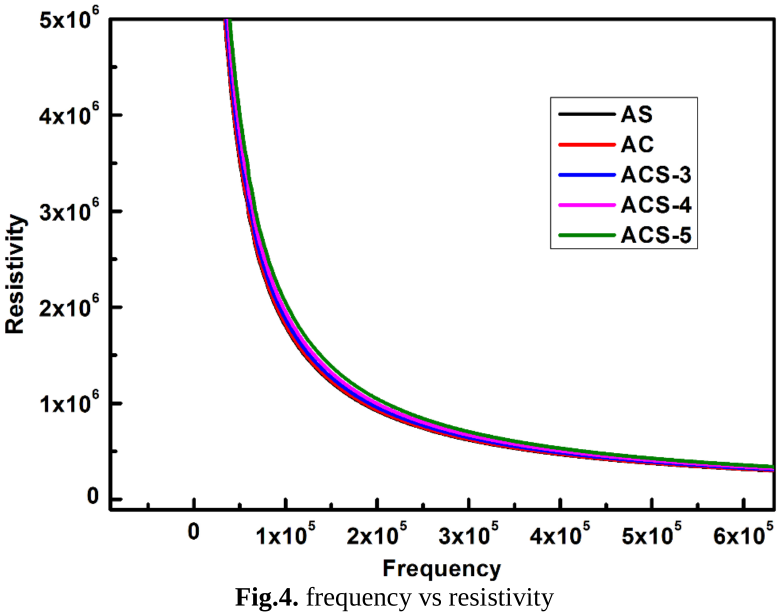

Fig.4. frequency vs resistivity

Fig. 5 shows the response of samples to AC flow operated under 100Hz of frequency at room temperature. This is carried out to understand response of samples for being a bio dielectric materials.

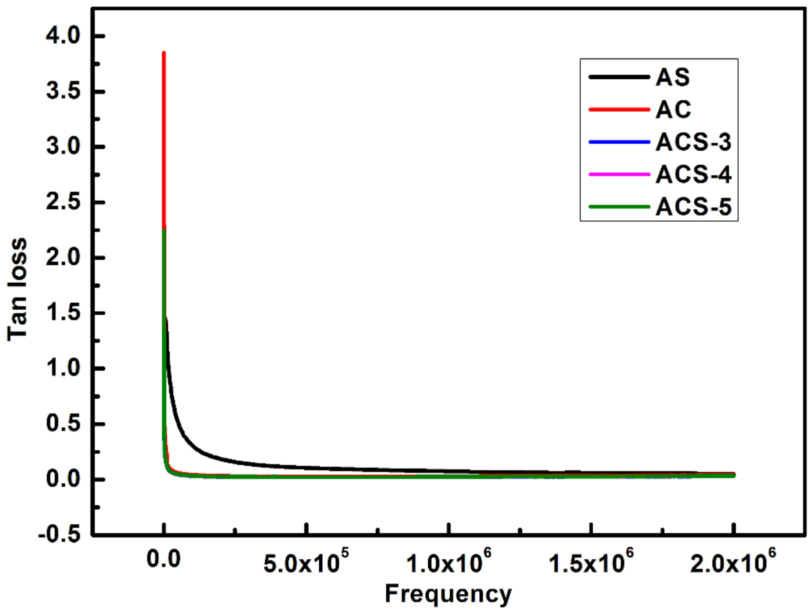

Fig. 5: tan loss vs frequency

The dielectric loss factor indicates the energy loss because of the retarding or friction forces due to alignment of dipoles during the movement of charges in an alternating electromagnetic field [18]. Tan-loss is predominantly high at lower frequency. At higher frequencies tan loss of each samples have been recorded decreasing very slow which depicts from less slope of the graph (Fig.5). It is found noticeable that tan loss of AS and AC is high but the composition of AC and AS indicates decrease in loss factor. Loss factors of the samples ACS-3, ACS-4 and ACS-5 have been observed in decreasing order. Due to being minimum tan loss of ACS-5, the sample is found best in all. The lower value of tan loss is once again enough to say the utility of the sample as dielectric materials.

Electric stress was provided to all the samples to study effects of electric field on any change in dipole orientations and overall polarization of the materials. The results are as shown in Figure 6.

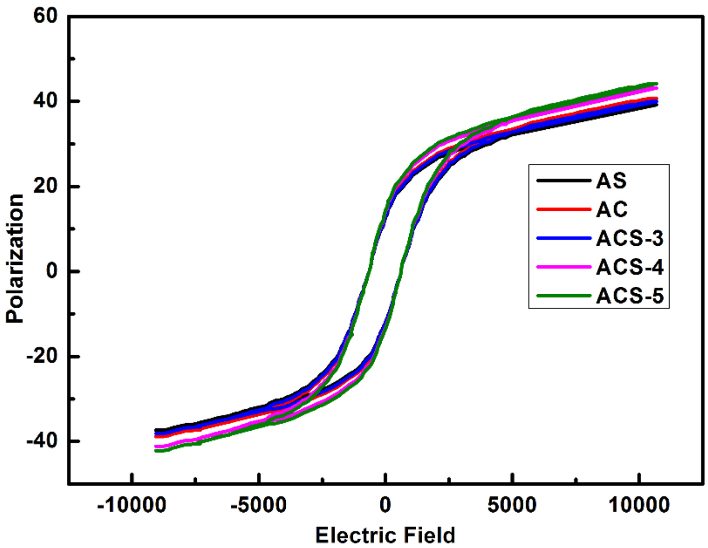

Fig. 6: P-E hysteresis curve

The saturation polarization has been observeddifferent with individualcomposition and compactness. The fragmental width of the graph has been noticed with average continuous rise which enables the samples for better results. The polarization index of the sample ACS is found better than AC and AS. At the same time settlement of domain continue to enhance further with ACS prepared at higher load. ACS-5 exhibited best polarizability.The horizontal stretch in the graph represents the consistent growth in polarization factor with enhancement of pressure on the samples ACS-3, ACS-4 and ACS-5. Saturation polarization for each sample AC, AS., ACS-3, ACS-4 and ACS-5 has been observed to be 2.332,2.383, 2.408, 2.45 and 2.471 μC/cm^2 respectively. The continuous horizontal stretch in P-E graph refers to rise in electric coercivity [19-21]. Study of overall electric properties of these samples reveals following facts at a glance as in Table 2.

Name of samples	Maximum dielectric constant at 2 kHz attemperature 40^{0}C	Critical temp. (^{o}C)	AC resistivity	Saturation Polarization(μ C/cm$^{2)}$	Quality Factor
AC	93.5	42^{0}C		2.332	Lower
AS	95	78^{0}C		2.383	Low
ACS-3	95.6	88^{0}C		2.408	Improving
ACS-4	101.23	92^{0}C		2.45	Improving
ACS-5	120.72	94^{0}C		2.471	Best

Table -3: Comparative study of electric properties

III. CONCLUSION

AC, AS, ACS (3-5) have been proven a bio-dielectric material having significant relative permittivity. Such materials may be proved a substitute of those dielectrics which are being used in devices working with medium frequency range.At the same time these can meet the challenge of e-garbage management. The kitchen waste peels of Allium cepa and Sativa gain the properties of good dielectric material when they are mixed in equal proportion and compressed at high load. The relative permittivity has been noticed maximum for the sample ACS-5. Gradual decline in relative permittivity is noticed with rise in temperature. For each sample there is a fixed temperature where relative permittivity has been recorded maximum, after that certain value, decline is noticed. This is due to different coefficient of thermal expansion of samples which effect porosity of the samples. In case of ACS-3, ACS-4 and ACS-5, dielectric value increases remarkably due to increasing number density of dipole domains. The critical temperature has been noticed to be increasing consistently with all samples.

For a long range of frequency the dielectric value is observed enough for some daily use electronic memory devices.The lowest value of tan loss factor of ACS-5is enough to declare it is most precious sample in comparison of others. At higher temperature resistivity of the samples is observed low but constant over a reasonable range of frequency making the samples better for resonator filters. The materials exhibited rise in saturation polarization and coercivity synthesized at higher pressure. These properties are making bio-degradable samples attractive for memory devices, resonator filters and multi-layered capacitors. The consistent rise of dielectric constant and decline of resistivity at lower frequencies indicate formation of samples to be suitable for tunable capacitor working within low frequency range.

ACKNOWLEDGEMENT

The author wishes to express gratitude to department of Physics,SantLongowal Institute of Engineering and Technology Longowal, Sangrur (PB.) India for experimental supports. I am also thankful to Wikipedia for having a lot of information about onion and garlic.

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