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# AC Electrical and Dielectric properties of PVA-MWCNT nanocomposites under different Stress conditions

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## Abstract:
AC electrical and dielectric properties of PVA with MWCNTnanocomposites for different concentrations by weight percentages and for different stress conditions were investigated. The capacitance versus stress on the samples were studied.This finding can throw some light in designing MWCNT doped polymer sensors which can measure pressure and stress.
Keywords------ Carbon nano tubes, PVA, nanocomposites, electrical properties, capacitance, weights, sensors

# INTRODUCTION

Since the discovery by Iijim's in1991 (Cassell etal.,1999) of carbon nanotubes (CNTs) in arc-discharge soot materials, nanotubes have simulated intensive studies for their high strength and adsorbents properties in many potential applications which include mechanical, electronic,catalysis, sensors (Qian etal., 2002; Cline,2004; Height etal.,2004; Komarov&Mironov, 2004; Lohletal., 2007).

It was recognised that nano-dopants, microscopic structure, and environmental conditions contributed to unique physical properties of these material systems. Our rationale originates from the fact that a functional understanding of both conduction and insulation properties are needed for the efficient use of dielectric materials in electronic devices, such as in printed circuit boards (PCBs), charge coupling devices (CCDs), and digital images[1-3]. These systems require electric currents to exist only along specific conduction paths, while travelling between electrical components, and not to occur in an undesignated manner. The CNTs were found in two general morphologies, single-walled (SWCNTs) and multi-walled (MWCNTs). SWCNTs are hollow single cylinders of a graphene sheet, which were defined by their diameter and their chirality, while the MWCNTs are a group of concentric SWCNTs often capped at both ends, with diameters reaching tens of nanometres depending on the physical properties and their applications. These studies show that the polymer/CNT composites are

In the last decade, many researches were interested in polymer/CNT composites and so continuous studies are needed to improve their physical properties and their applications. These studies show that the polymer/CNT composites are better than composites filled with metallic particles consisting electrical and thermal transfer mechanisms, even a small amount of CNT added to the composites will enhance these properties. The most important polymer that has CNT nanocomposites is Polyvinyl Alcohol (PVA). Matthew Edwards etal. 2015 [4] studied the dielectric surface currents and dielectric constant measurements of pure and multi-walled carbon nanotubes (MWCNTs) doped with polyvinyl Alcohol (PVA) thin films. They found that the dielectric constant and the dielectric loss were observed to be highest for MWCNT doped PVA compared to pure PVA.Estabrak. T. Abdullah and Asama etal., 2011 [5] showed that electrical conductivity measurements increase with the increase of the amount of MWCNTs. OmedGh. Abdullah, Sarkawt et al. 2011 [6] showed that as NaI content and temperature increases, the dielectric permittivity, dielectric loss ac conductivity of PVA host increases. Shi etal. (2009) studied the electrical and dielectric properties of MWCNT/PANI composite.They showed that the dielectric constant for the nanocomposite increase as the amount of MWCNT increase. The present work is focused on the study of the capacitance for PVA/MWCNT nanocomposites, to show the effects of MWCNTs concentrations on weights or stress on these nanocomposites.

## II. EXPERIMENTAL PROCEDURE

Different samples of different concentrations by weight percentages (0.5% CNT + PVA, 1%CNT + PVA, 2% CNT + PVA) and of thickness 60 micron and 120 microns were prepared by solution casting method. These samples were shaped as discs of diameters 5cm.The samplewas sandwiched between two similar copper electrodes attached to the glass plates of same or somewhat more diameter. The whole assembly was shown in Figure.1.

Figure.1 Arrangement of sample holder

Here we have investigated the capacitance of the above said samples by increasing the stress in the order of 50g varying from 50g to 400g on the above said samples by means of LCR bridge.

Figure2 represents the experimental setup used for carrying out the work.

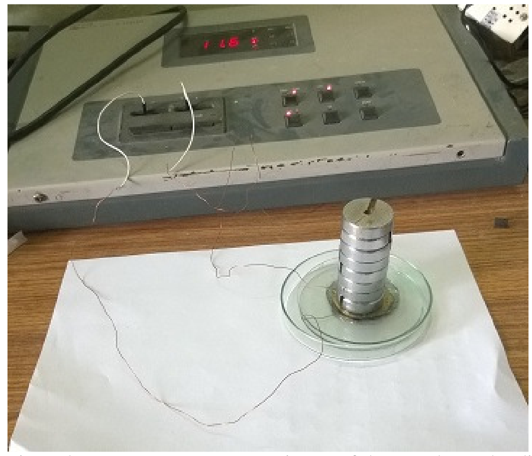

Figure.2 set up to measure capacitance of the samples under different stress conditions

## AC ELECTRICAL MEASUREMENTS:

The electrical measurements such as capacitance in (Pico Farads) of different PVA mixed CNT composites for the thicknesses of 60 micron and 120 micronsat room temperature for different weights or stress was observed. Samples used for electrical measurements were shaped as discs of diameter 5cm. The electrical properties were investigated at the frequency of 1KHz and at room temperature by means of LCR bridge. The sample was placed in the glass bowl in between the copper electrodes attached to the glass plates. By increasing the stress by 50g starting from 50g to 400g, the capacitance of different samples was noted down and the corresponding graphs were plotted taking weights on X-axis and Capacitance in picoFarads on Y-axis. Fig.3 and Fig.4 represents the variation of capacitance with stress for different composites of thickness 60 micron and 120 microns at room temperature and at frequency 1KHz.

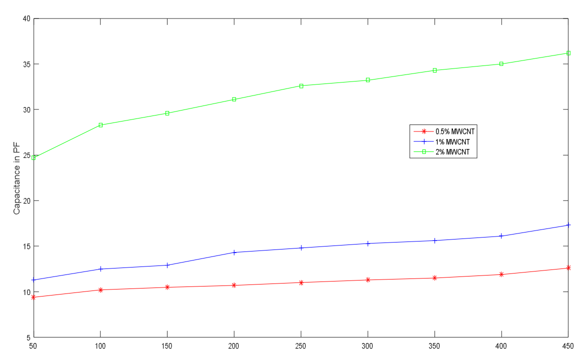


**Fig.3.Variation of Capacitance with Weights or stress for different**

**composites of thickness 60 micron at room temperature and at 1 KHz frequency**

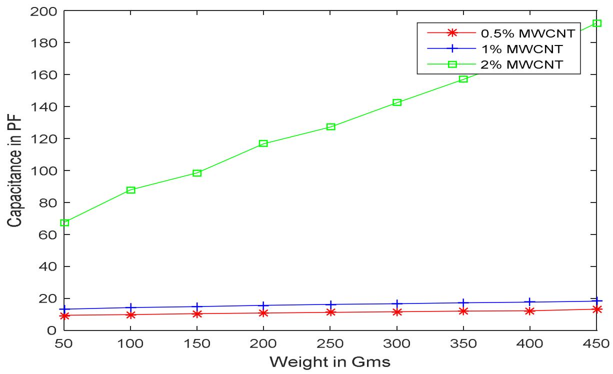


**Fig.4. Variation of Capacitance with Weights or stress for different composites of thickness 120 micron at room temperature and at 1 KHz frequency**

It was observed from Fig.3 and Fig.4 that for 60 and 120 micron nanocomposite samples, the capacitance is increasing gradually as the stress on the samples increases. And we have also observed from Fig.3 and Fig.4that for both 60 micron and 120 micron samples, the capacitance is more for 2% CNT + PVA samples. So, the sample with high concentrated MWCNT has got high capacitance. It may be due to the amount of increased interstitial dopant in the sample. This may be attributed to the increase of electronic, ionic and orientationalpolarizability. Based on preliminary results, it is evident that all the samples are functional and variation in molecular mass PVA powder yielded changes to the capacitance. The addition of MWCNT dopants enhanced the capacitance, which can be attributed to the amount of the interstitial dopant being deposited in the nanocomposites.

## CONCLUSION

PVA/MWCNT samples were prepared by solution casting method. The capacitance of these nanocomposites was studied. It showed that adding a small amount of MWCNT to the PVA polymer, will enhance the electrical capacitance. Further by increasing the stress on the samples irrespective of the thickness of the sample, the capacitance was also increasing. These observations were done at constant room temperature and at frequency of 1KHz. Additionally, highly doped MNCNT combined with PVA nanocomposites showed the highest capacitance when compared to other samples. This study reveals that the relaxation process at high CNT content is due to the ionic conductivity relaxation. Further studies can be carried out in the direction to validate the possibility of making polymer based stress, strain and load cell sensors.

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