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Optical Properties of Carbon Nano Layer Prepared by Plasma Sputtering from Wasted Batteries

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Abstract- Carbon nano layers with thickness 63, 81 and 102 nm are deposited from graphite rods that within wasted or damaged 1.5 Volt batteries on a glass substrates. The deposition is done using sputtering technique by plasma in Argon gas atmosphere. The carbon layers imaged by optical microscope at zooming 100 xs and by scanning electron microscope SEM, all images shows the aggregation of carbon atoms in clusters. The transmittance and absorption measurements of these nano layers have been performed, we observed a continuous increase in transmittance values with each increment of incident wavelength within wavelength range (400-800nm), also, and the extinction coefficient and refractive index increases with incident photon energy .The calculated energy gaps for those layers 2.65, 2.675 and 2.7 eV respectively.

Keywords- Carbon clusters, carbon nano particles, optical properties of carbon nano particles.

I. INTRODUCTION

Carbon is listed at the top of the fourth column. Each individual carbon atom has six electrons distributed in the ground state at the lowest energy levels of the carbon atom as 1s2 $2s^2$ sp^2 [1-2]. When carbon atoms combine to form a solid, the distribution of electrons in their outer shell changes in three cases depending on the number of bonds formed with neighboring atoms [3].

In the hybridization of type 2sp, the s orbital interferes with a one of the p orbital compounds and result in a linear molecule in a chain, while in hybridization of type $2sp^2$, s Orbital interferes with two orbital compounds p, each hybrid carbon atom combines with three other hybrid carbon atoms to form a hexagon within parallel planes and finally in hybridization $2sp^3$, the s Orbital interferes with all p orbital compounds and these orbitals generate a regular quadratic shape [4]. In this study, the transmittance and absorbance were measured for carbon layer that deposited with difference thicknesses on glass substrate; the absorption coefficient was calculated to determined The energy gap for each layer.

II. EXPERIMENTAL METHOD

Plasma coating was used to deposit different thicknesses of carbon layers on glass substrate in the presence of argon gas as shown in figure (1). The automatic system (Q150R S/E/ES Sample Preparation System) was used in the deposition of carbon figure (2).

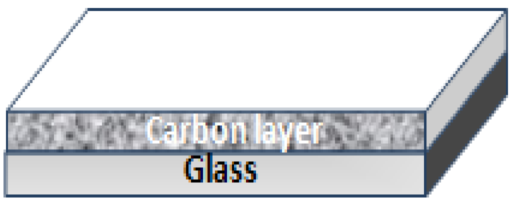

Fig 1. Show the sample structure**.**

The Glass slides are cleaned using a suitable solutions and acids then ultrasonically cleaned to remove any contamination or native oxide. Graphite rods that extracted from wasted or damaged 1.5 Volt batteries have been used as a source of Carbon.

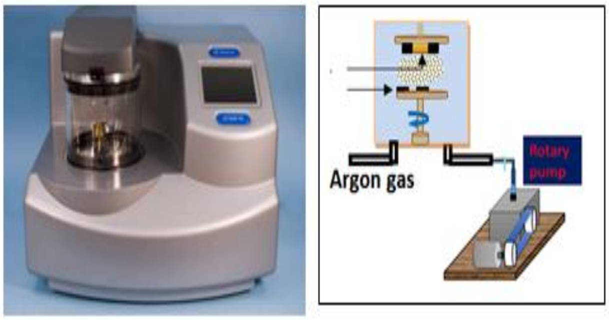

Fig 2. Show Q150R S/E/ES Sample Preparation System.

The software parameters for carbon deposition shown in table (1) [5].

Table 1. Software parameters for carbon deposition.

Parameter	Value	
Material	Carbon	Specify here the type of material to be sprayed.
Pulse current	80 A	The amount of current passing through the carbon column ranges between(10-90)Amp
Pulses Length	10 sec	The Time between two Pluses
Number of Pulses	5	The number of pluses ranges from (1-5)
Out Gas Time	60 sec	The discharging process time ranges from (10-60)sec
Out Gas Current	50 A	The current used for discharge ranges from (10-60)Amp

III. RESULTS AND DISCUSSION

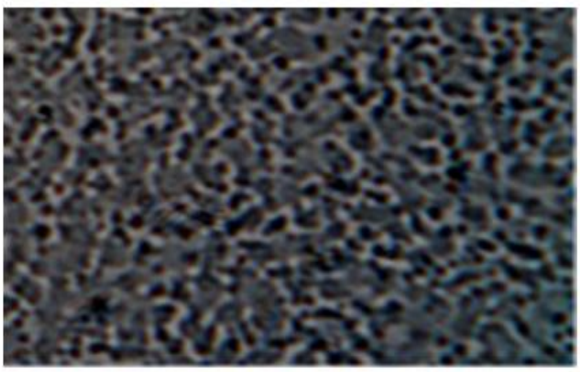

Fig 3. Optical image for 81nm layer at 100x.

The layers have been imaged using optical microscope and scanning electron microscope. The images show the aggregation of carbon atoms to form carbon clusters within the layers as shown in figure (3) and figure (4).

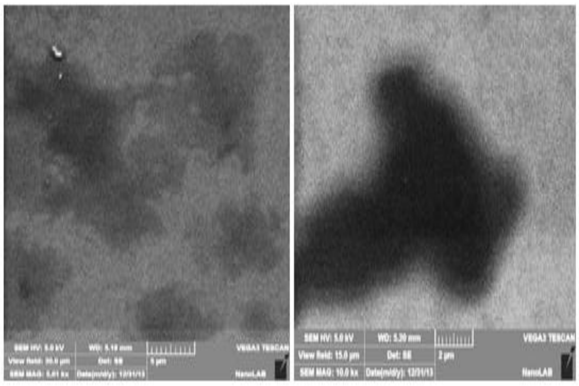

Fig 4. Show SEM images of 63 carbon layer.

The optical properties have been studied for carbon layer with nano thickness. These properties include transmittance absorbance were measured for each layer as shown in the figure (3).

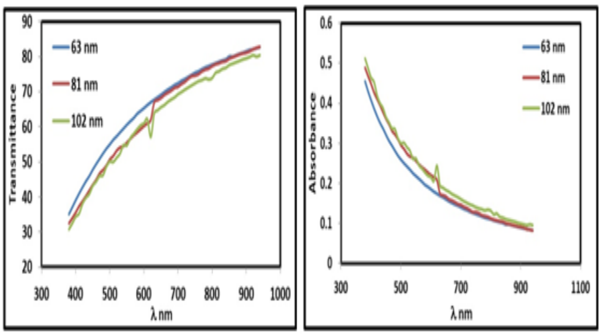

Fig 5. Transmittance abd Absorbance of carbon layers with different thicknesses (63, 81 and 102 nm).

Figure (3) show that the thickness within the nano scale (less than 110 nm) have a close values in the transmittance and absorbance which is reflected on the calculated value of energy gap for all layers.

The energy gap for each layer has been calculated which were within the range (2.65, 2.75 and 2.7 eV) as shown in figure (4) [6] [7] [8]. The calculated energy gaps values give us an indication that these layers act as semiconductors [9].The energy gap increases with carbon layer thickness due to the increase in the resistivity of layers as a result of carbon density increase as shown in figure (5).

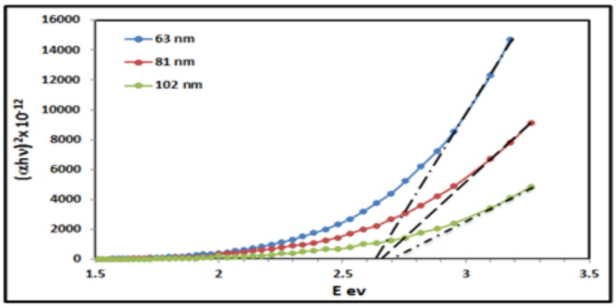

Fig 6. Absorption coefficient as a function of energy for carbon layers with different thicknesses (63, 81 and 102 nm).

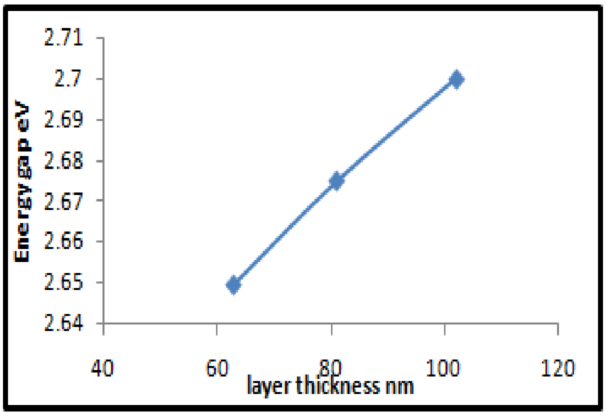

Fig 7. Energy gap variation with carbon layer thickness.

The refractive index increases with increasing energy of the incident photons, as it is influenced by the density of the medium. This appears clearly from the curves, the layers that have a thickness of 103nm have a higher refractive index than the others as shown in figure (6).

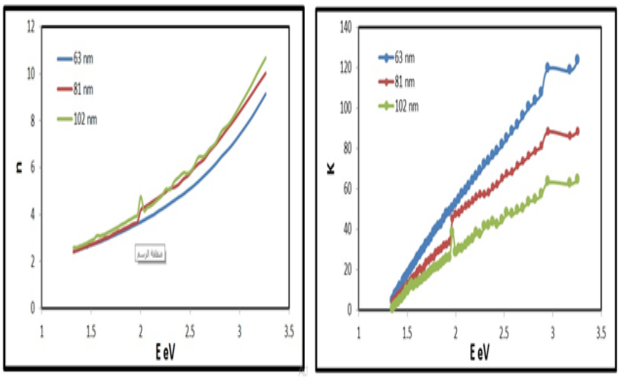

Fig 8. Refractive index and extinction coefficient as a function of energy for carbon layers with different thicknesses (63, 81 and 102 nm).

IV. ACKNOWLEDGMENT

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V. CONCLUSIONS

The energy gap changes with the thickness of the carbon layer. The calculated energy gaps for carbon layers are 2.65, 2.675 and 2.7 eV respectively.The layers that have a thickness of 102nm have a higher refractive index than the others. The extinction coefficient increases with incident photon energy, and the layers with 63nm thickness have a higher values of extinction coefficients.

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