Growth and Optical Properties of Un-Doped and Oil Bean Doped Tin (II) Oxide

Iwueze Tochi Malachy, Okpala Uchechukwu Vincent, Onuchukwu Chika Christian

***Abstract*— Here, we studied growth and characterization of Tin (II) oxide doped with oil bean seed extracts. Tin (II) oxide was grown by reacting some quantities of aqueous Tin chloride and aqueous sodium hydroxide. Oil bean seeds were grinded, dissolved in distilled water, stirred, and sieved to remove the undissolved parts. Analytical grade glass slides were inserted in the beaker.Samples B6 was un-doped, B7 was doped with 0.2 ml of oil bean extract, B8 was doped with 0.3 ml of oil bean extract, B9 was doped with 0.4 ml ofoil bean extract and B10 was doped with 0.5 ml of oil bean extract.Optical characterization showed that oil bean seed extract decreased the transmittance with peak 50% at wavelength of 800 nm, but improved the absorbance of Tin (II) Oxide with peak above 0.5 at wavelength of 300 nm. The reflectance was too low with maximum peak of 0.2 at wavelength of 800 nm. Samples B7, B8 and B9 have no band gaps but samples B6 and B10 have band gaps of 3.8 and 3.9 respectively and as such can be used as refractory materials.**

***Index Terms*— Tin II Oxide, Optical Properties, Oil Bean and Band gap.**

I. INTRODUCTION

Thin film technology is one of the most thriving industry today because it plays a vital role in nearly all electronic and optical devices. It has been used as electroplated films for decoration and protection (Heaven 1970). An interesting thing in thin film technology is the changes that take place in the structural, morphological and optical properties of the material whenever impurity is introduced.

In this work, we studied the optical properties of un-doped and oil bean doped Tin II oxide using chemical bath method.Tin (II) oxide or stannous oxide (SnO) is composed of tin and oxygen where tin has the oxidation state of +2. It is of two forms; stable blue-black and metastable red (Zumdahl, 2009; World Health Organization, 2005). It has a tetragonal structure. It is predominantly used as a precursor in the manufacturing of other tin compounds or salts and as a reducing agent and in the creation of ruby glass. Cerium (III) oxide in ceramic form, together with Tin (II) oxide (SnO) are used for illumination with UV light, (Peplinski D.R. et-al., 1980).

II. OIL BEAN SEED

Oil bean is popular in Nigeria. It has several names such as Apara in Yoruba, Ugba (Igbo) and Ukana in Efik. It is a popular condiment and meat analogue among consuming populations, (Enujiugha and Akanbi, 2005). The seeds are dorso-ventrally flattered, hard, brown in colour and about 6 cm long and 3 cm wide (Achinewhu et al., 1998). It is a nutritious seed. When unfermented it contains traces such as poisonous alkaloid known as pauvine, small amount of caffexylpectrecine, a growth depressant bacteria such as E. coli and Staphylococcus aureus, as well as molds that produce mycotoxins in food. Therefore, it must undergo fermentation process to eradicate any unwanted toxins before consumption. It contains protein, annino acids (44% protein with all twenty essential amino acids), phosphorus, magnesium iron, vitamins, calcium, manganese and copper. It is an excellent source of phyto nutrients such as tannins, alkaloids, flavonoids, sterols, glycosides and saponins. The process of fermentation removes most of these mineral and vitamins such as phosphorus that have harmful effect, (Achinewhu *et al.*, 1998). African oil bean has medicinal value. Neuro logical disorder and other ailments can be corrected with oil bean seed (Akintayo and Bayer, 2002).

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III. EXPERIMENTAL DETAILS

Preparation of Oil Bean Seed Extract

Hard shells of some quantities of oil bean were removed from the main seed, dried and crushed with manual grinding machine. After grinding, the particles were dissolved in 100 cm^3 of distilled water and later sieved to allow the mixture to be in aqueous form.

40 ml of hydrated tin (II) oxide chloridewas mixed with 20 ml of sodium hydroxide to produce tin oxide as a byproduct.

$$SnCl_2(aq) + 2NaOH(aq) \rightarrow SnO(aq) + 2NaCl\ (aq) + H_2O\ (l) \quad (1.1)$$

The mixture was placed in a magnetic stirrer at temperature of 60^{o}C for 20 minutes.After which glass slides were immersed into the beaker containing the sample for 24 hours to allow deposition of tin (II) oxide to take place. 0.2 ml, 0.3 ml, 0.4, ml and 0.5 ml of oil bean seed extract were added to the samples; B7, B8, B9 and B10 respectively. Sample B6 was un-doped.

Table 1.1: The Summary of Experiment Conducted with Tin (II) Oxide Doped with Oil Bean Seed Extract

Sample	$SnCl_2$ (aq)	NaOH (aq)	Oil bean seed extract
B_6	40 ml	20 ml	Un-doped
B_7	40 ml	20 ml	0.2 ml
B_8	40 ml	20 ml	0.3 ml
B_9	40 ml	20 ml	0.4 ml
B_{10}	40ml	20ml	0.5 ml

IV. Optical Analysis

Here, optical properties of un-doped and oil bean doped tin II oxide were discussed. Samples B6 was un-doped, B7 was doped with 0.2ml of oil bean extract, B8 was 0.3 ml of oil bean extract, B9 was 0.4 ml of oil bean extract and B10 was 0.5 ml of oil bean extract.

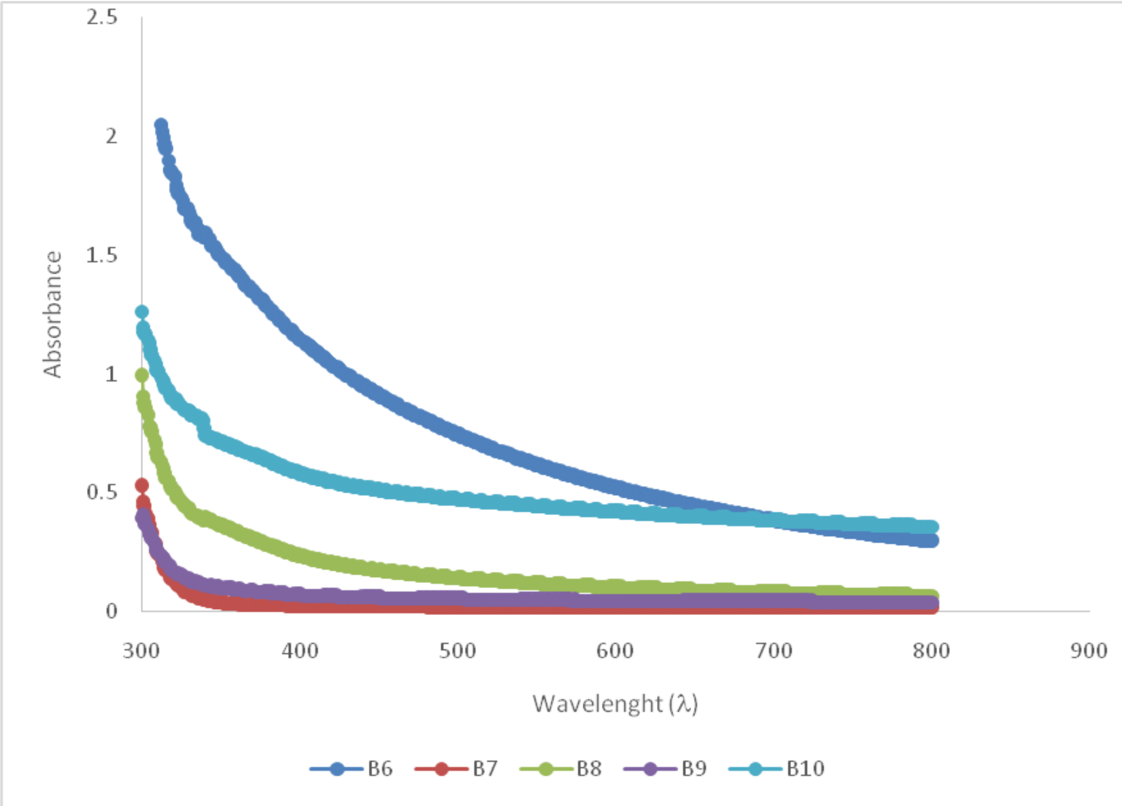

Figure 1: Absorbance versus Wavelength

It was observed that the samples rate of absorption decreased with increased wavelength for samples B6, B8 and B10. Samples B7 decreased from 0.5 at 300 nm to 0 at 350 nm and could not absorb again towards 800 nm. In sample B9, absorbance decreased from 0.6 at 300 nm to 0.05 at 600 nm and became steady towards 800 nm.

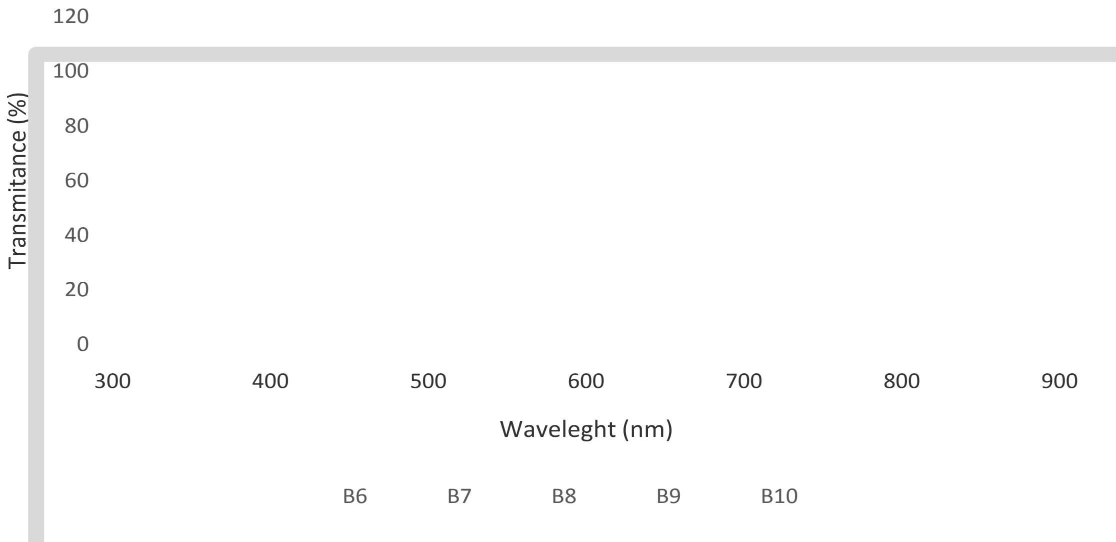

Figure 2: Transmittance versus wavelength

In figure 2 ,all the samples were highly transmitting. Sample B6 had the least transmittance. It transmitted lowly from 300-400 nm and increased progressively to 800 nm. Sample B10, transmitted from 5% at 300nm and increased to 30% at 640 nm and remained steady up to 800 nm. Sample B8 transmitted from 10% at 300 nm and increased to 800 nm. Sample B9 transmitted from 40% at 300 nm and increased to 80% at 400 nm and remained steady up to 800 nm. Finally, sample B7 had the highest transmittance. It transmitted from 30% at 300 nm and increased to 90% at 350 nm and remained steady to 800 nm. The samples are highly transmitting from the visible region towards the near infra-red regions and as such can be applied in poultry and solar energy applications,(Okpala V. Uche., et-al., 2012).

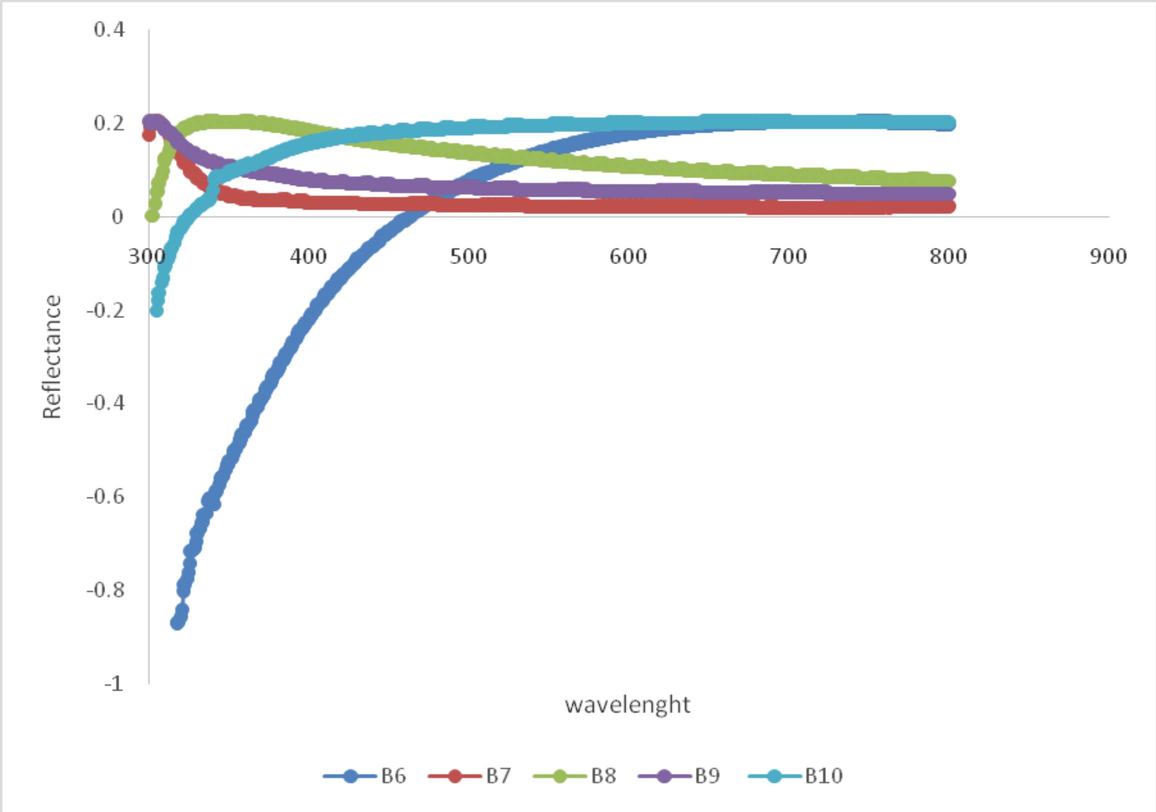

Figure 3: Reflectance for Samples B6 to B10

All the samples were poorly reflecting. Samples B6 has negative reflectance from -0.9 at 340 nm to 0 at 470 nm and increased positively up to 600 nm and remained steadily towards 800 nm. Sample B10 also had negative reflectance of -0.2 at 300 nm and increased to 0.18 at 400 nm before it reflected steadily towards 800 nm. The negative value may be due to presence of impurities (dirt) in the process of deposition. Sample B7 had 0.2 reflectance at 300 nm and decreased to 0 at 680 nm before it became steady towards 800 nm. B8 had 0 reflectance at 300 nm and increased to 0.2 at 320 nm and had a sharp decrease towards 800 nm. Sample B9 had reflectance of 0.2 at 300 nm and decreased toward 800 nm. The reflectance was too low so it can be applied in making of an antireflection coating of materials, (Edmund, 2007).

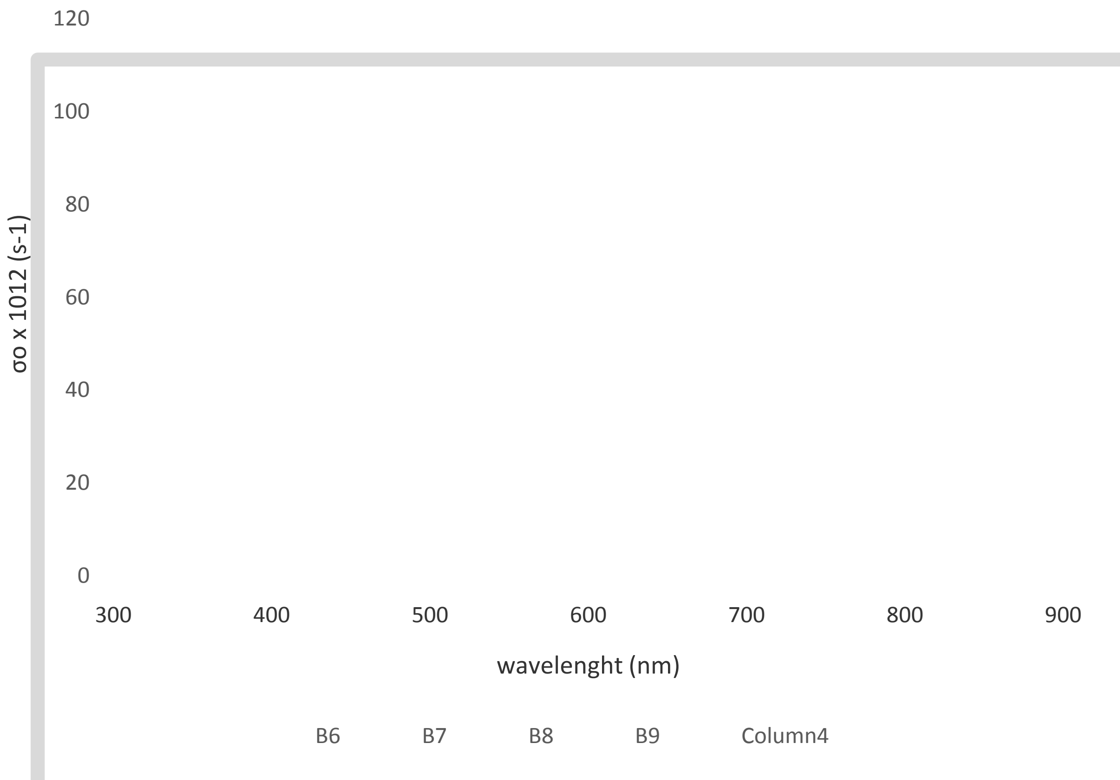

Figure 4: Optical Conductivity for Samples B_6 to B_{10}

Sample B6 had optical conductivity of 70 at 480 nm decreased to 50 at 680 nm. Sample B7 had optical conductivity of 45 at 330 nm and decreased towards 800 nm. Sample B8 had the highest conductivity of 108 at about 320 nm and decreased towards 800 nm. Sample B9 had optical conductivity of 45 at 330 nm and decreased towards 800 nm. Sample B10 had optical conductivity of 93 at 360 nm and decreased towards 800 nm.

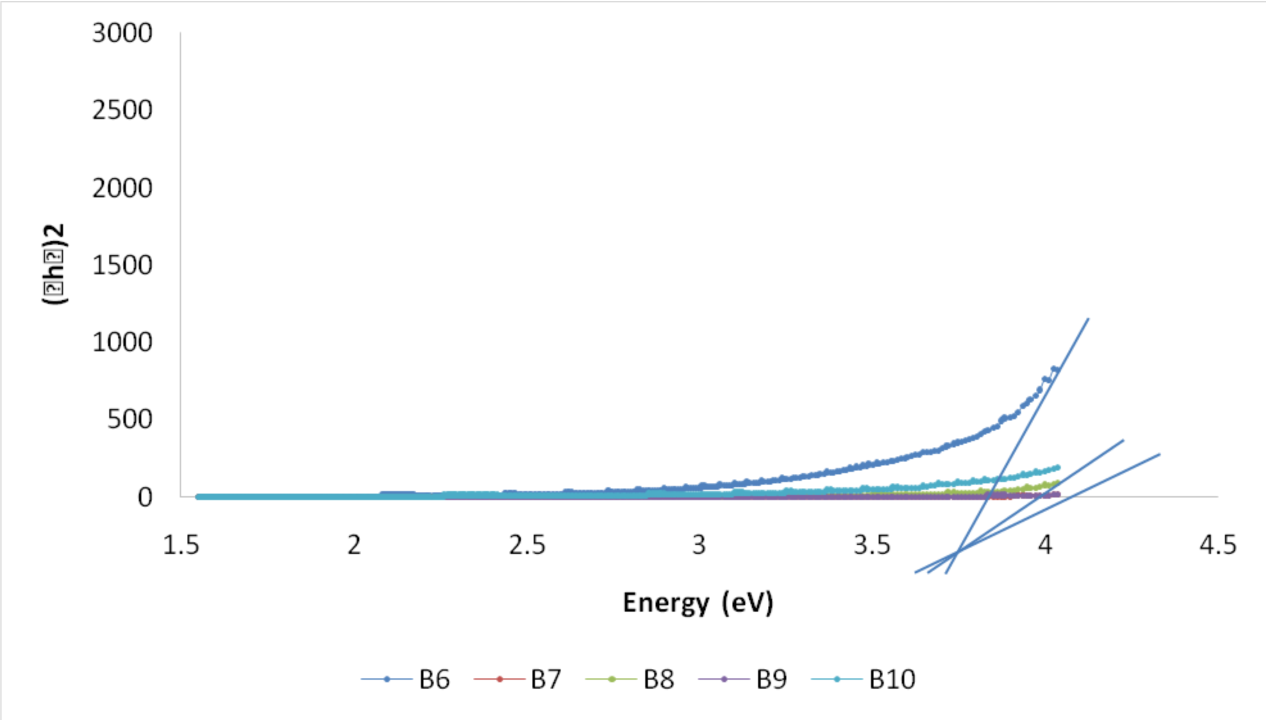

Figure 5: Energy Band Gap for Samples B_6 to B_{10}

The films grown were wide band gap materials except for samples B7 and B9 that have no band gaps and as such are not semiconductor materials. This implied that they were metals and can be applied in the production of cooking utensils, electrical wires, pressing irons etc., (Yoshikawa, 2007). Sample B6 has band gap of 3.8 and sample B10 has a bang gap of 3.9 which indicate that they are wide band gap semiconductors and can be used as refractory materials and as heat sink, (Okpala et-al., 2012, E.N. Ufere et-al., 2016and Yacobi B.G., 2004).

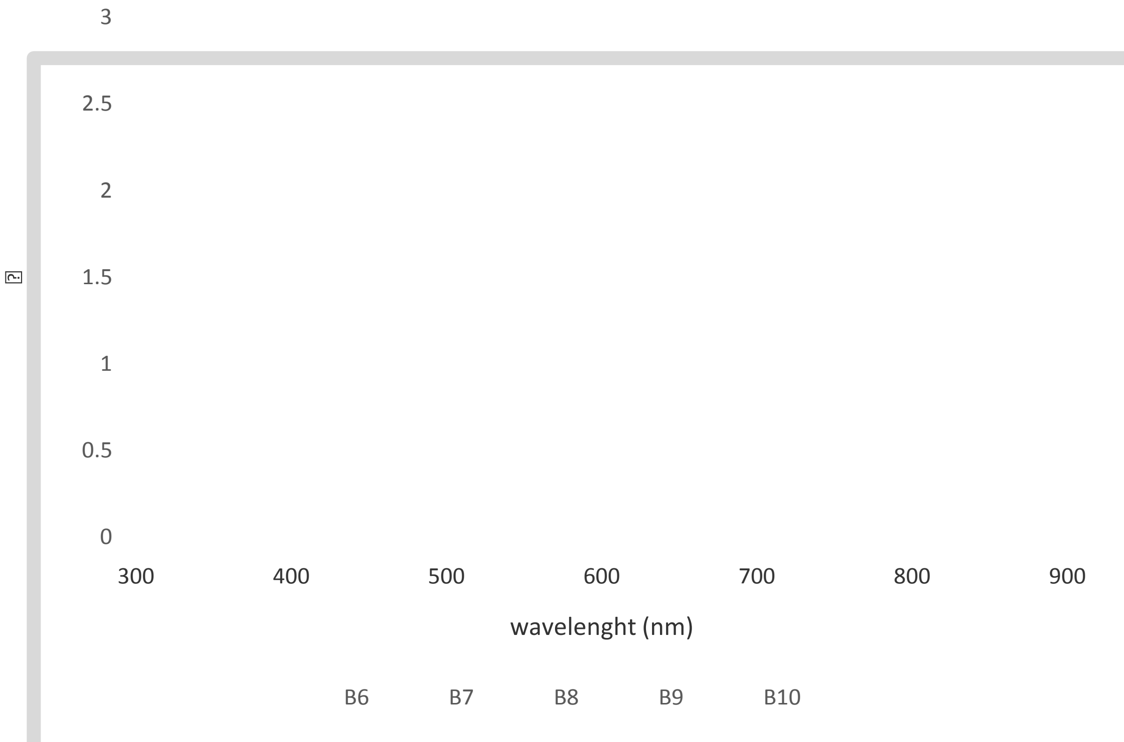

Figure 6 : Refractive Index for Samples B6 to B10

In Figure 6 , sample B6 had refractive index of I.2 at a wavelength of 460 nm and increased to 2.8 at a wavelength of 450 nm before it became steady towards 800 nm.Sample B7 had refractive index of 2.7 at a wavelength of 300 nm before it decreased towards 800 nm. Sample B8 had refractive index 2.2 at a wavelength of 310 nm and increased to 2.7 before it decreased towards 800 nm. Sample B9 had refractive index of 2.7 at 300 nm and decreased towards 800 nm. Sample BI0 had refractive index of 1.75 at 340 nm and increased to 2.7 towards 800 nm. Materials with high refractive index above 1.8 are good in making lens, optical circuit, optical fibre, antireflective films and coating, optical adhesive, LCD display, waveguide (Hun-Ju Yen and Guey-Sheng Liou, 2010).

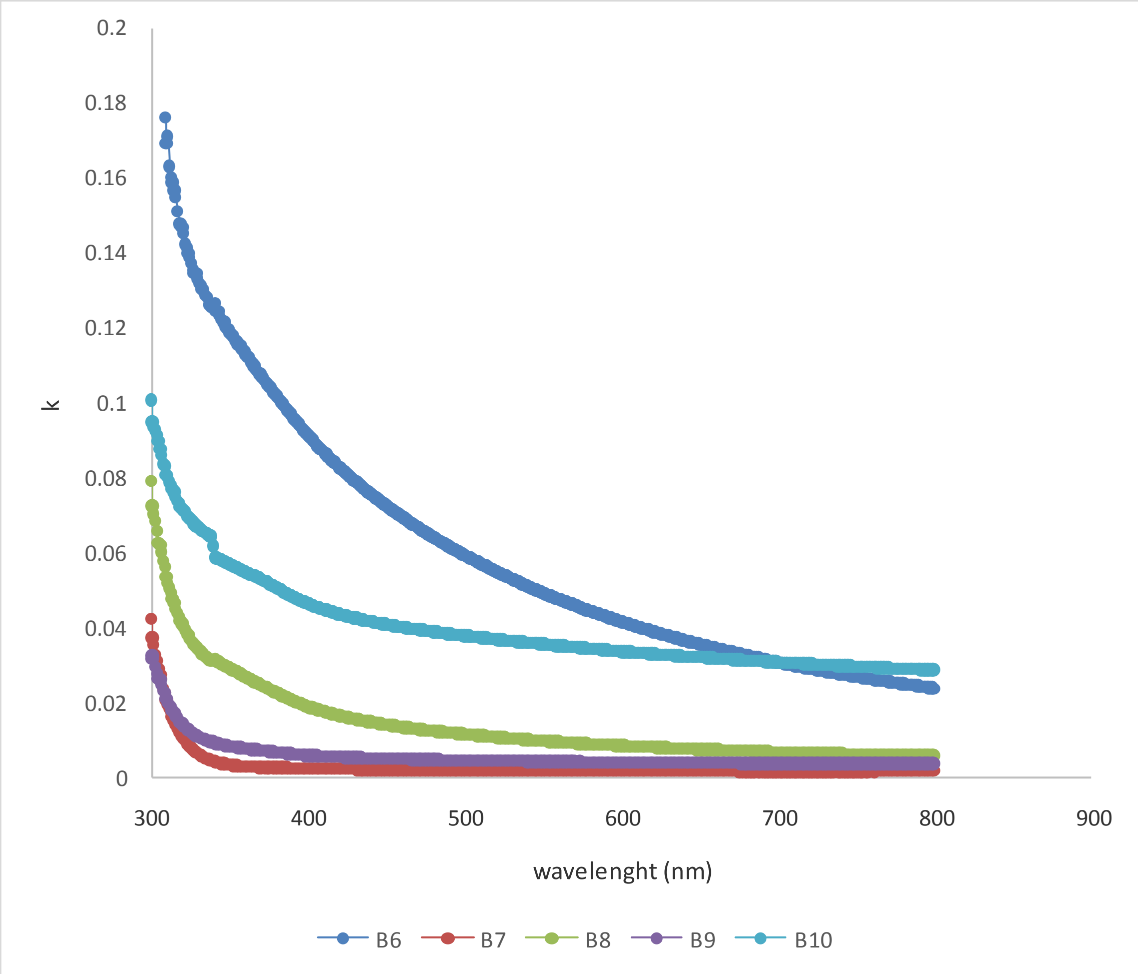

Figure 7 : Extinction Coefficient for Samples B_6 to B_{10}

In figure 7, sample B6 had peak at 0.I75 extinction coefficient at wavelength of 310 nm and decreased towards 800 nm. Sample B7 had extinction coefficient of 0.04 at 300 nm and decreased towards 800 nm. Sample B8 had refractive index of 0.08 at a wavelength of 300nm and decreased towards 800 nm. Sample B9 had refractive index of 0.03 at 300 nm and decreased towards 800 nm. Sample B10 had refractive index of 0.1 and decreased towards 800 nm.

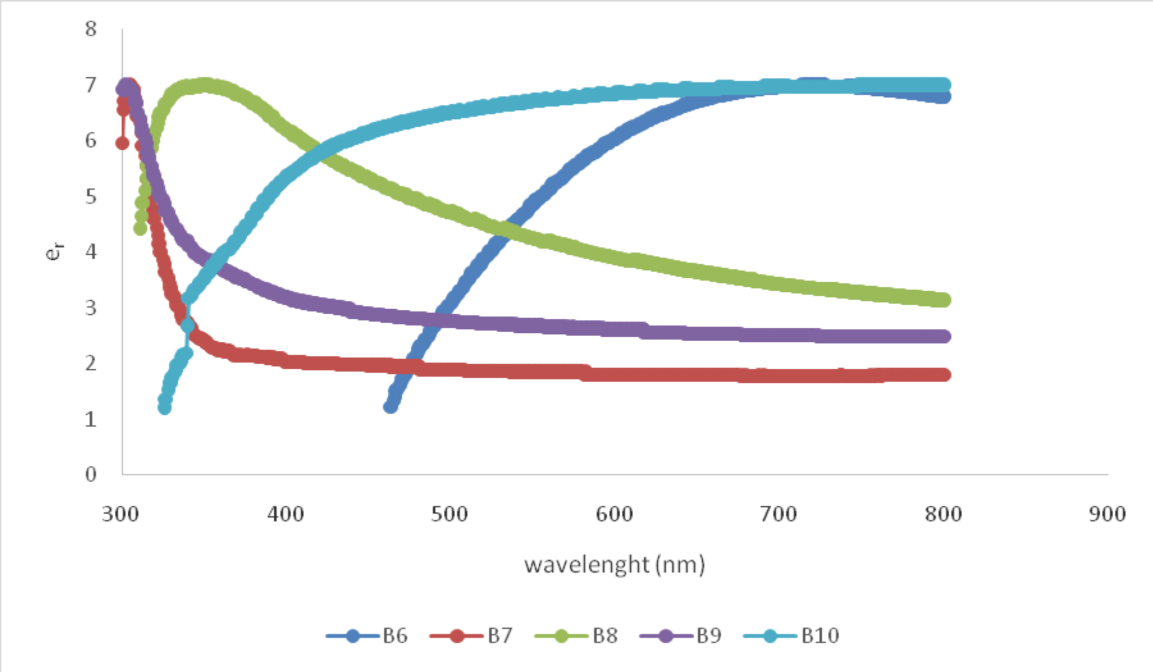

Figure 8 : Real Dielectric Constant for Samples B_5 to B_{10}

Figure 8 shows that sample B6 increased from 1 at a wavelength of 320 nm and increased towards 800 nm. Sample B7 started increasing from 6 at a wavelength of 300 nm increased to 7 and had a sharp decrease towards 800 nm. Sample B8 started from refractive index of 4 at 320 nm and increased to 7 before it decreased towards 800 nm. Sample B9 dielectric constant of 7 at a wavelength of 300 nm and decreased towards 800 nm. Sample BI0 increased from 1 to 6.5 before it became steady towards 800 nm. Materials with high dielectric constant are good for making capacitors while low dielectric constants are good in providing insulations between conductors to minimize lost. (Alfredo, 2005).

V. Conclusion

Tin (II) Oxide (SnO) doped with oil bean seed extracts showed high transmittance from the visible to near infra-red regions and as such are good for poultry and solar energy applications, (Okpala V. Uche., et-al., 2012).Thehave very low reflectance and as such are good for anti-reflective coating of materials (Edmund, 2001). The sample showed high refractive index in some cases, those with high refractive index above 1.8 can be used for making lenses, optical fibre, antireflective films and coatings, wave guide (Hung-Ju Yen and Guey-Shenglion, 2010).

Energy band gap showed high range between 3.8 to 3.9eV which is under the range of a semiconductor and can be useful in making of electronic components such as diodes, transistors and building block of logic gate (Yoshikawa, 2007). They are wide band gap materials and as such can be employed in high temperature, high power, high frequency, optoelectronic devices and as heat sink, (Okpala, et-al, 2012;E.N. Ufere et-al., 2016). The samples with zero band gap are metals and can be useful in making of electrical cables, cooking utensils, pressing iron etc., (Pillai, 2009).

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