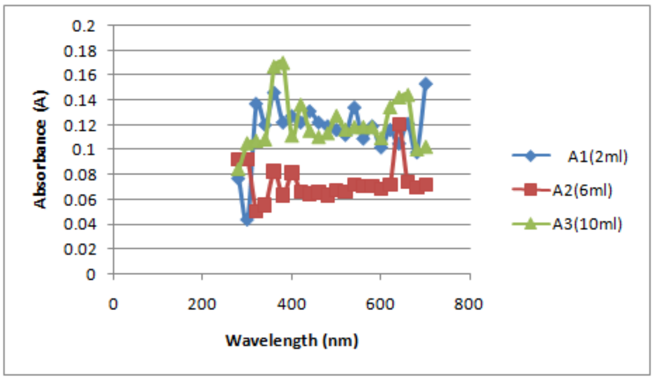

Figure 1: Plot of Absorbance against Wavelength for the films deposited at different concentrations of TEA

The transmittance spectra of the deposited films were illustrated in figure 2. From figure 2, the transmittance of the films to incident radiation was found to be generally high with the films deposited at 2ml and 6ml concentrations of TEA having peak transmittance values of 0.9036 (90.36%) and 0.8913 (89.13%) respectively within the wavelength interval of 300-320nm. This high transmittance value made the material a good candidate for application in photovoltaic devices.

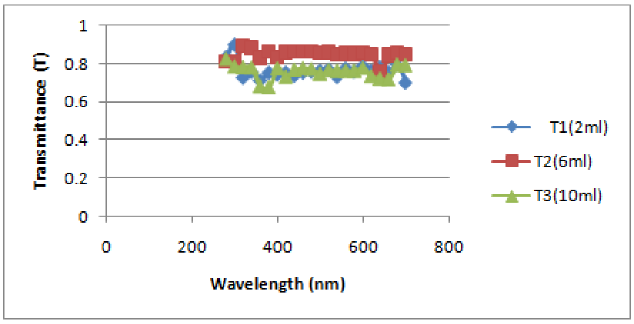

Figure 2: The transmittance spectra of the deposited films at different concentrations of TEA

The reflectance property of the films to incident radiation is shown in figure 3. The reflectance of the films to incident light energy was found to be generally low with film deposited at 10ml concentration of complexing agent (TEA) exhibiting highest peak value of 0.1539 (15.39%) at a wavelength of 380nm. This shows that Bismuth Sulphide semiconductor material can serve as anti-reflectance coating for fabrication of solar cells.

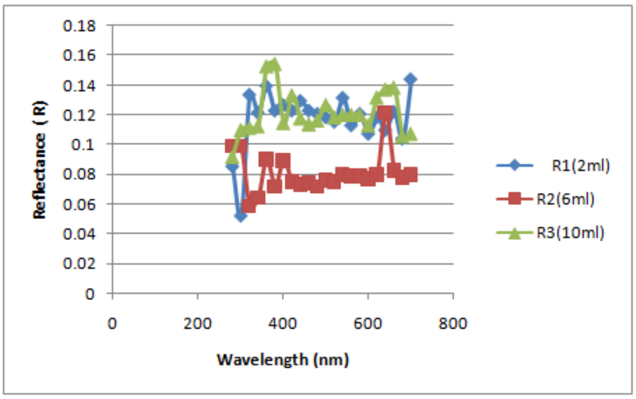

Figure 3: The plot of Reflectance against Wavelength for the deposited films at different concentrations of TEA

Figure 4 shows the plot of refractive index against photon energy for the films deposited at different concentrations of Complexing agent (TEA). The films were observed to possess moderate refractive index value range of 1.59-2.29. The film deposited at 10ml concentration of TEA was found to exhibit highest refractive index value of 2.29. This high refractive index value is an indicative that the thin film of Bismuth Sulphide can be used in fabricating photonic devices.

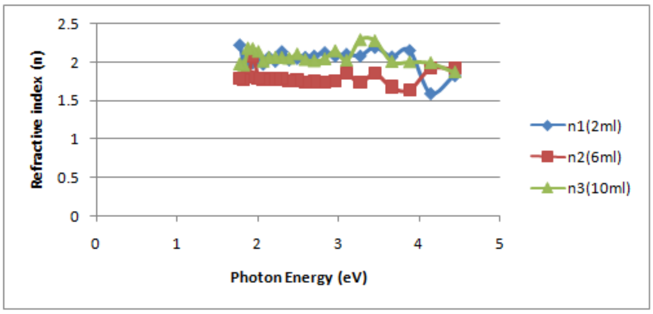

Figure 4: The variation of Refractive index with Photon Energy for the deposited Films at different concentrations of TEA

The optical conductivity spectra of the deposited films at different concentrations of complexing agent (TEA) are illustrated in figure 5. The films were observed to exhibit high optical conductivity of incident electromagnetic radiation which increases as the photon energy increases. From figure 5, the film deposited at 10ml concentration of complexing agent (TEA) was found to possess highest optical conductivity value of 2.52 x $10^{13}S^{-1}$ at photon energy of 3.45eV. This high optical conductivity value suggests that the Bismuth Sulphide semiconductor material can be used as window layer in solar cells devices.

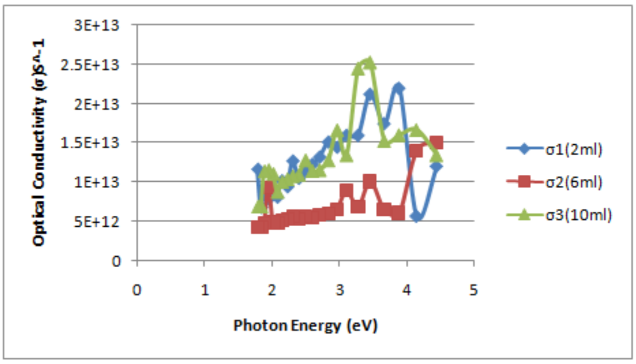

Figure 5: The optical conductivity spectra of the deposited films at different concentrations of TEA

The extinction coefficient spectra of the deposited films are illustrated in figure 6. From figure 6, the films were found to exhibit low extinction coefficient values with the maximum value of 0.013528 observed for film deposited at 10ml concentration of complexing agent (TEA) at photon energy of 3.27eV.

ISSN (Online): 2347-3878, Impact Factor (2015): 3.791

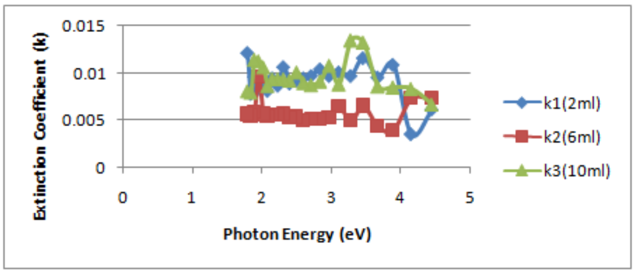

Figure 6: The extinction coefficient spectra of the deposited films at different concentrations of TEA

The real part dielectric function spectra of the deposited films are shown in figure 7. From figure 7, the films were observed to exhibit high real part dielectric function values with the film deposited at 10ml concentration of complexing agent (TEA) possessing highest peak value of 5.249506 at photon energy of 3.27eV.

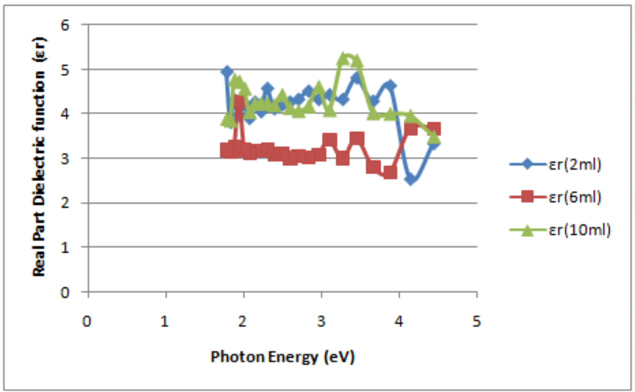

Figure 7: Real part dielectric function spectra of the films deposited at different concentrations of TEA

The imaginary part dielectric function spectra of the deposited films are depicted in figure 8. From figure 8, the imaginary dielectric function of the films were found to be of low values with the film deposited at 10ml concentration of TEA having the maximum value of 0.061992 at the photon energy of 3.27.

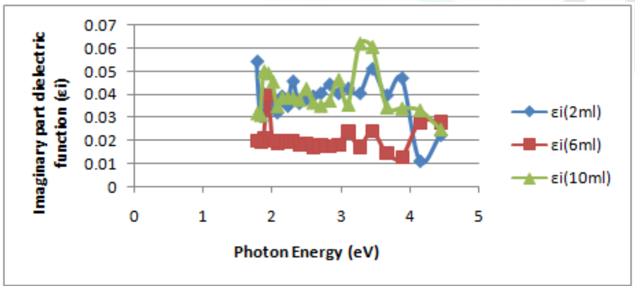

Figure 8: Imaginary part dielectric function spectra of the deposited films at different concentrations of TEA

Figures 9-11 show the plot of absorption coefficient squared against photon energy for the deposited films at different concentrations of complexing agent (TEA). Fromfigures 9-11, the band gap energies of the films were obtained at the point where the straight part of the graph meets the photon energy axis. The films exhibited band gap energy range of 1.95eV – 2.60eV with the film deposited at 6ml concentration of complexing agent possessing the highest band gap energy of 2.60eV.

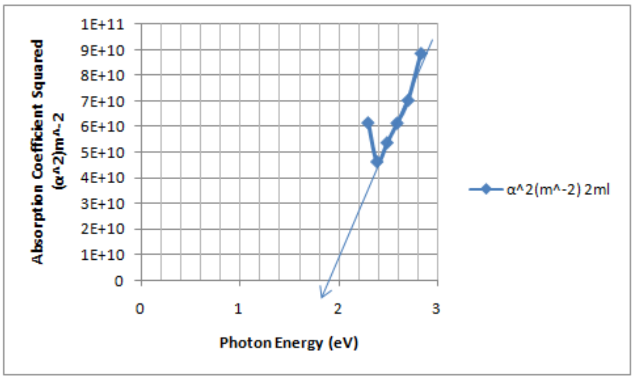

Figure 9: Plot of Absorption coefficient Squared against photon energy for film deposited at 2ml concentration of TEA

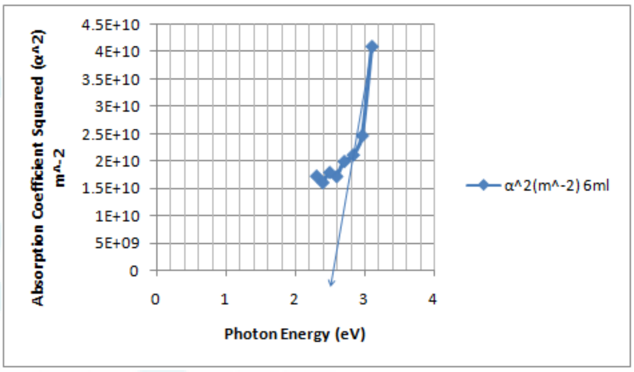

Figure 10: The plot of Absorption Coefficient Squared against Photon energy for the film deposited at 6ml concentration of TEA

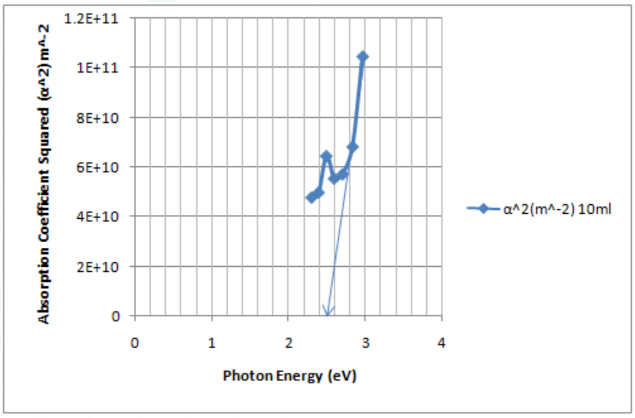

Figure 11: Plot of Absorption Coefficient Squared against Photon Energy for film deposited at 10ml concentration of TEA

4. Conclusion

Thin films of Bismuth Sulphide were successfully deposited on glass substrate using a Chemical Bath Deposition Technique which has been adjudged to be most cost effective way of depositing thin films. The technique is reproducible and with it large area of an object can be coated with thin films of desirable semiconductor materials. From the work it was observed that the concentration of complexing agent (TEA) has potential effect on the optical properties of the deposited films. The film deposited at 10ml concentration of TEA was found to be affected most and this goes to illustrate that high concentration of complexing agent has substantial effect on optical properties of semiconductor material. All these desirable properties of Bismuth Sulphide semiconductor material confirmed in this research show that the material is a good candidate for applications in photonics, opto-electronic and photovoltaic devices.

References

[1] Lokhande, C.D. (1991): Chemical deposition of metal chalcogenide thin films. Mater. Chem. Phys; 27:1-43
[2] Miller B. and Heller A. (1976): Nature 262, 680
[3] Robin O., Grimm J.M., Wojtkiewicz G., and Weissleder R., (2006): Nat. Mater. 5, 118
[4] Bube R.H., (1978): Photoconductivity of solids, Krieger Publ. Co, New York
[5] Mahmoud S. (1996): Studies on chemically deposited films of Bismuth-Sulfide (Bi_2S_3). Fizika A, 5: 153-162
[6] Killedar V.V., Lokhande C.D and Bhosale C.H., (1996): Preparation and Characterization of Bi_2S_3 thin films spray deposited from non-aqueous media. Thin Solid Films, 289: 14-16
[7] Wang S.Y., and Du Y.W., (2002) J. Crystal Growth 236, 627
[8] Shao M.W, Mo M.S, Cui Y., Chen G., and Qian Y.T. , (2001): J. Crystal Growth 233, 799
[9] Lokhande C.D and Bhosale C.H., (1990): Electrodeposition of CdS, Bi2S3 and Cd-Bi-S thin films and photoelectrochemical properties. Bull. Electrochem; 6: 622-622
[10] Hussain A., Begum A., andRahman A., (2012): Studies on Electrical and Optical Properties of Annealed and Unannealed Nano-crystalline Bismuth Sulphide Thin Films Prepared by Chemical Bath Deposition. Asian Journal of Materials Science 4: 28-33