JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN ELECTRONICS AND COMMUNICATION ENGINEERING

FABRICATION AND ELECTRICAL PROPERTIES CHARACTERIZATION OF SOL-GEL PREPARED PVA THIN FILM USING AS A DIELECTRIC FOR THIN FILM TRANSISTORS

Pratik N Kargatiya[1], Nirav Joshi[2], Nikhil Joshi[2],Utpal s. joshi[2],Naresh P.Patel[1]

[1]Electronics and communication Department, VGEC Chandkheda, Gandhinagar, Gujarat
[2]Department of physics, School of science, Gujarat University, Ahmedabad, Gujarat

pratikkargatiya@ymail.com

ABSTRACT*: Polyvinyl alcohol (PVA) is highly transparent organic material can be used as dielectric material for thin film transistors. Al (metal)/PVA (Organic)/ITO (inorganic) capacitor structure is implemented. Sol-gel technique is used for deposition of PVA thin film. The dielectric constant is derived for thin film of PVA which is used as dielectric material of thickness of 1000nm and area is 2mm^2. C-V graph is also plotted for the different frequencies. AFM image is taken for surface topography..

Keywords—PVA, ITO, Sol-gel, Organic dielectric

I: INTRODUCTION

Today transparent thin film transistor is become very popular. For this transparent materials are very useful. Organic and inorganic materials are very cost effective compare to conventional silicon material. The different dielectric materials for thin film transistors are inorganic: SiO_2, HfO_2, ZrO_2, BST and organic: PVA, PVP. The high-K dielectric materials are used in thin film transistors. The sol-gel technique is very cost effective than other physical deposition techniques. Here using sol-gel technique the capacitor structure is implemented with the PVA dielectric material and finds the dielectric constant for the PVA material.

II: EXPERIMENTAL

As shown in figure (a), capacitor structure is implemented using the following steps. The PVA solution is prepared by a dissolving the PVA of quantity 0.5gm in 20ml double distilled water (DDW). This solution is starring on the starrier equipment for the 1hr for complete dissolving of PVA in the DDW. After that this solution is deposited on the ITO/PET using a spin coating unit Model SCU 2005 of APEX Instrument Co. Required amount of PVA solution is put on the ITO/PET substrate and then rotating at the 2500rpm/min for 30sec for uniform deposition of the PVA layer. Then sample is put on the preheated hot plate at 130°C for remove the residuals of the solution for 1hr. To get desired thickness of PVA layer, same process is followed as given above for deposition of PVA layers.

Then Al as top electrode is deposited using a Thermal evaporation technique at the room temperature in the vacuum of 2×10^{-5} milli-torr. The thermal evaporation unit is of company Vacuum Techniques Pvt. Ltd., Bangalore of model 12" coating unit is used.

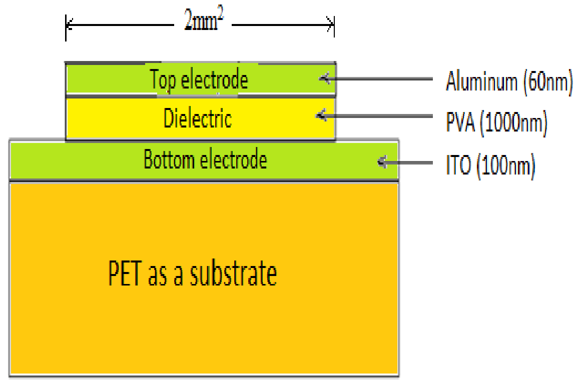

Figure (a) schematic of capacitor structure

III: RESULTS AND DISCUSSION

The surface topography is uniformed which can be seen from the AFM image of the PVA layer over the ITO/PET. AFM is the method used to know surface topography and can measure the surface roughness. AFM is used of company NanoSurf, model NanosurfEasy Scan 2.

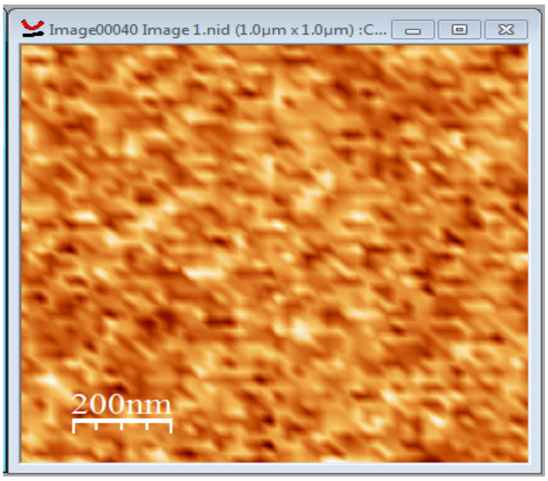

Figure (b) surface topography of PVA layer 2d view (AFM image)

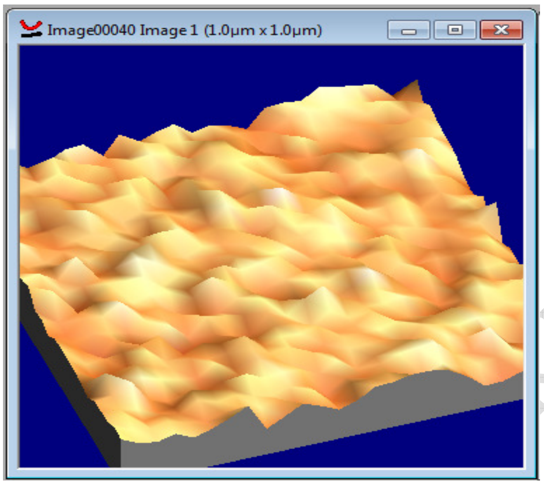

Figure (c) surface topography of PVA layer 3d view (AFM image)

Now prepared capacitor structure is put under the measurement of the capacitance. For this the Agilent's E4980A Precision LCR Meter 20 Hz to 2 MHz equipment is used. Capacitor vs voltage graph is shown in the figure (d) for the different frequency. As shown in the figure (d) graph, the capacitance value is decreases when the frequency is increases. For particular frequency the capacitance becomes constant. Using a profile-meter equipment, the PVA dielectric layer thickness measure is 1000nm. From the graph, the capacitor value for the 1 KHz, 10 KHz, 100 KHz, 1 MHz, 2 MHz is 421pf, 380pf, 342pf, 16.8pf, 0.16pf respectively.

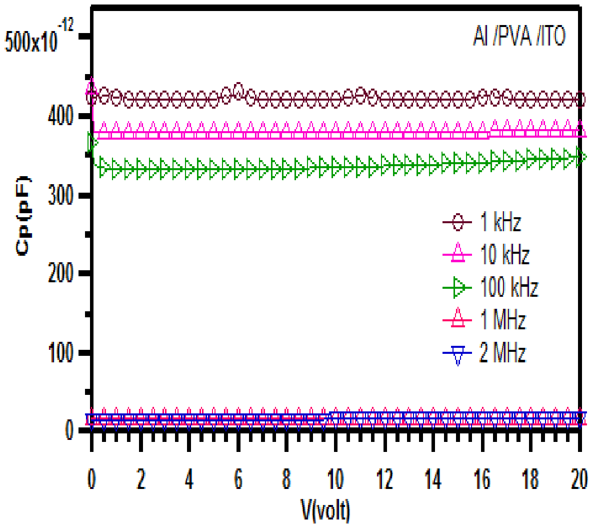

Figure (d) C-V graph for different frequency

Relative Dielectric constant:

$$\varepsilon_r = \frac{Cp.d}{\varepsilon_0.A} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where,
Cp= parallel plate capacitance= 421pf for 1 KHz
d= thickness of the dielectric material PVA= 1000nm
A= Area cross sectional of the dielectric material PVA= 2×2 mm^2
ε_r= relative dielectric constant
ε_o= permittivity of the air=8.85×10^{-12} F/m

The relative dielectric constant is 11.89 and it is unit less quantity.

IV: CONCLUSION

PVA can be used as dielectric material in the thin film transistors. The surface topography of AFM images gives a result that the PVA material has highly uniformly deposited on the ITO by spin coating unit. The dielectric constant of PVA layer is 10.73 for the frequency at 10 KHz. As the frequency increases the capacitance decreases.

REFRENCES

[1] Dalong Zhao, Devin A. Mourey, *Member, IEEE*, and Thomas N. Jackson, *Fellow, IEEE*, "*Fast Flexible Plastic Substrate ZnO Circuits*," IEEE ELECTRON DEVICE LETTERS, VOL. 31, NO. 4, APRIL [2010]

[2] Mallory Mativenga, Min Hyuk Choi, Jae Won Choi, and Jin Jang, *Member, IEEE*, "*Transparent Flexible Circuits Based on Amorphous-Indium–Gallium–Zinc–Oxide Thin-Film Transistors*," IEEE ELECTRON DEVICE LETTERS, VOL. 32, NO. 2, FEBRUARY [2011]

[3] Shinhyuk Yang, Jun Yong Bak, Sung-Min Yoon, Min Ki Ryu, Himchan Oh, Chi-Sun Hwang, GiHeon Kim, Sang-HeeKo Park, and Jin Jang, "*Low-Temperature Processed Flexible In–Ga–Zn–O Thin-Film Transistors Exhibiting High Electrical Performance*," IEEE ELECTRON DEVICE LETTERS, VOL. 32, NO. 12, DECEMBER [2011]
[4] Chien Cheng Liu, MengLun Wu, Kuang Chung Liu, Shih-Hua Hsiao, Yu Sheng Chen, Gong-Ru Lin, and Jian Jang Huang,"*TransparentZnO Thin-Film Transistors on Glass and Plastic Substrates Using Post-Sputtering Oxygen Passivation*," JOURNAL OF DISPLAY TECHNOLOGY, VOL. 5, NO. 6, JUNE [2009]
[5] Kenji NOMURA, Akihiro TAKAGI2, Toshio KAMIYA, Hiromichi OHTA, Masahiro HIRANO, Hideo HOSONO," *Amorphous Oxide Semiconductors for High-Performance Flexible Thin-Film Transistors*," Japanese Journal of Applied Physics Vol. 45, No. 5B,pp. 4303–4308, [2006]
[6] J. Y. Kao, C. Y. Hsu , G. C. Chen, D. C. Wen," *The characteristics of transparent conducting Al-doped zinc oxide thin films deposited on polymer substrates*," J Mater Sci: Mater Electron 23:1352–1360 DOI 10.1007/s10854-011-0598-0, [2012]
[7] Pedro Migual Candido Barquinha, Ph.D. thesis, "*Transparent Oxide Thin Film Transistors: production, characterization and integration*", [2010]
[8] Saji K. J., Ph.D. thesis, "*Amorphous Oxide Transparent Thin Films: Growth, and characterization Application to Thin Film Transistors*", [2008]