Available online www.ejaet.com

European Journal of Advances in Engineering and Technology, 2018, 5(3): 214-217

Research Article ISSN: 2394 - 658X

Similar Properties of Selenium and Tellurium as Semiconductor

Swati Arora[1], YK Vijay[2] and YC Sharma[2]

[1] *Department of Electronics & Communication, Swami Keshvanand Institute of Technology, Jaipur, India*
[2]*Department of Physics, Vivekananda Global University, Jaipur, India*
aroraswati14@gmail.com

ABSTRACT

Thin films deposition increased with the contact area of the cell components, which results in high fraction reactants. Thin films have high current density and cell efficiency obtained due to the transportation of ions throughout thin-film layers as compared to bulk materials. We have investigated the drain characteristics of metal-semiconductor thin film transistors. It consists of a metal contact layer and a semiconducting layer, which forms metal-semiconductor junction. The top gated metal layer is deposited for conduction of charge carriers which flows from source to drain and controlled with Schottky metal gate. The channel control has been obtained by varying the width of depletion layer by depositing different thickness of conducting channel of selenium and Tellurium layer and the flow of current between source and drain. The metal gate electrodes have been directly deposited on the selenium and Tellurium channel without any insulating layer, because of the formation of Schottky barrier at the interface of metal and semiconductor. It has also investigated that observed drain characteristics shows similar behaviour for both semiconductor materials.

Keywords: Metal Semiconductor Field Effect, Thermal evaporation, schottky metal gate

INTRODUCTION

Metal-semiconductor thin film deposition is interesting property in the era of miniaturization of electronic and chemical components. Materials of different thicknesses have been used to vary the physical and electrical properties which depend on the nature of the material which gives considerable functional applications of electronic device application and different physical properties, when it combines with different materials [1]. The metals show high conductivity and being used to increase the electrical resistivity and sheet resistance with a decrease in thickness by highly scattered free electrons, so conductivity has increased with increased thicknesses of thin film [2]. These results have been used for electronic devices and microelectronic industry applications. Thickness plays a very important role to observe the properties of metals [3]. Selenium and Tellurium are metalloid and having some characteristics of metal & some characteristics of non-metal so also called as semiconductor. dissimilar metal-semiconductor-metal ratios results by evaporation of after heating in a vacuum chamber, resting on the confidence of size of crystallite, orientation preferential, unevenness, have been studied, in metal semiconductor interface gate made by metal forms a schottky barrier will be formed [4]. The free electrons are able to cross the depletion region with effect of energy source from one side to other. Source and drain are directly connected to semiconductor, determine transistor dimensions. Aluminum is used as contact material in IC's exhibits good corrosion resistance. As voltage which has been applied to gate electrode bulk charge is involved with electric field applied which structure conducting channel [5]. Glass plate is used as a substrate on which active layer is grown to make it partially insulating substrate. The higher transit frequency of the FET has common application in microwave circuits [6].

EXPERIMENTAL

The samples had equipped by thermal evaporation at a pressure of 10^{-5} torr. High purity of Aluminium sheet about 99×999% pure, and selenium and Tellurium powder have purchased from Koch-Light laboratories LTD, colnbrook Berks England [7]. The properly cleaned glass substrate of 1x1 cm^2 dimension, substrate cleaning is done using soap solution and keeps it in hot chromic acid and then cleaning done by deionized water then rinse in acetone, were placed in the holder situated above the tungsten boat which carrying materials. After reaching the high vacuum (10^{-}

[5]torr) in the chamber the metal and Semiconductor heated by transient the current slowly to the electrodes [8]. Metal layer having thicknesses 500 Å in form of source and drain firstly deposited on substrate using mask after that Selenium or Tellurium having thicknesses 800 Å was evaporated and form sandwich structure and at last metal of constant thickness (500 Å) deposited over these films to get metal gate contact for thin film structure. Thickness of the material on substrate was controlled using quartz crystal monitor ('Hind Hivac' Digital Thickness Monitor Model–DTM–101) [9]. The total thickness of the Metal-Semiconductor-Metal thin film is about 200 nm.

The Schottky contact is formed when a metal and semiconductor are in intimate contact and the work function of the metal Φm is larger than the work function of the semiconductors [10]. When there is a contact, a potential barrier of height Φm has been formed between the metal and the semiconductor, which equals to the work function of the metal minus the electron affinity (χ) of the semiconductor [11]. A built-in potential V_{bi}, has been created at a Schottky contact due to a misalignment in the Fermi energies of metal and the semiconductor. Typically, the work function of the metal is greater than that of an n-type semiconductor, and the semiconductor valence and conduction bands will bend upward at the inference in order to align the Fermi levels [12]. The amount that the energy bands bend upwards at the interface is known as the built-in potential V_{bi}. The relation of these parameters is shown in Fig.1[13].

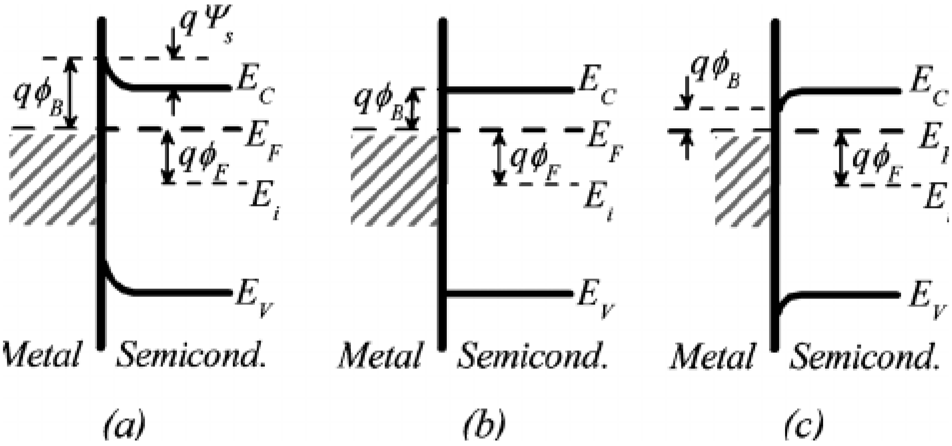


Fig.1 The energy band diagram of Schottky contact

RESULTS AND DISCUSSION

Electrical Properties

It has observed that the fabricated FET is gives the increase of the drain current at negative gate voltages of a MESFET (between 1 V to 5 V) and which has compared to quadratic expression [13].

$$I_{D,sat} = \mu_n \frac{\varepsilon_s}{w} \frac{W}{L} \frac{(V_G - V_T)^2}{2} \tag{1}$$

Where w is the width of depletion layer in channel layer [8]. The quadratic expression given as

$$V_G = \emptyset_i \text{ for } w = 3d/8 \tag{2}$$

The gate – channel built in potential is given by

$$V_{bi} = \emptyset_m - [\chi + \frac{t_g}{2q} - \frac{k_B T}{q} \ln\left(\frac{N_D}{n_i}\right)] \tag{3}$$

The metal semiconductor junction at the gate is sufficient to deplete the entire channel region [14]. Hence the conduction channel is absent at Vgs =0 V. So such devices are constructed by incorporating a very thin epitaxial layer on semi-insulating substrate, using a semiconductor like selenium or Tellurium [11].

Drain characteristics for the typical Field Effect Transistor is shown in Fig 2 at various gate to source fixed voltages. Fabricated MESFET using metal contact of aluminum and selenium semiconductor is shown in Fig 3. The basic shape of curve is similar for the normal field effect transistor. MESFET requires positive gate voltages to allow reasonable gate currents. To an extent, the channel conductivity can be increased by increasing the channel carrier concentration [7,14]. The individual graphs between drain current and drain voltage for selenium as semiconductor are shown in fig. 3 at (a) VGS =1V (b) VGS=3V(C) VGS=5V as the Drain characteristics of MESFET using Aluminum as Metal contact.

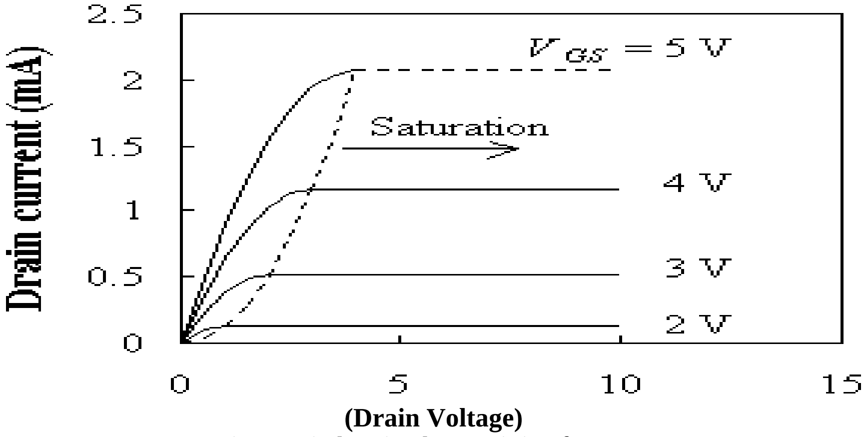
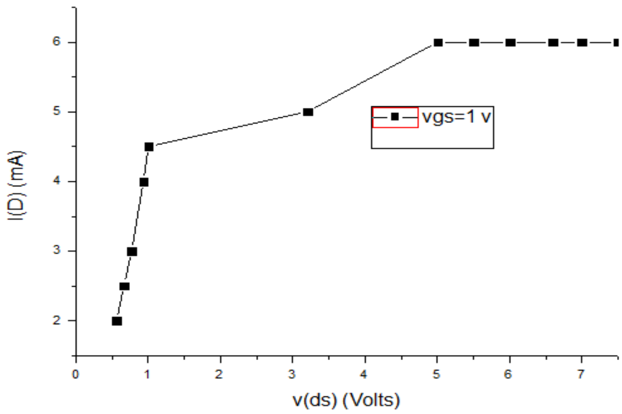
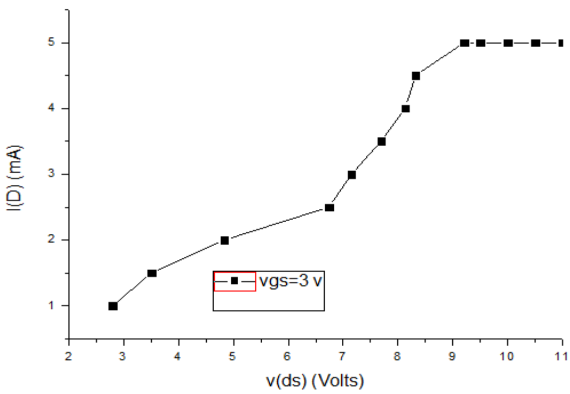


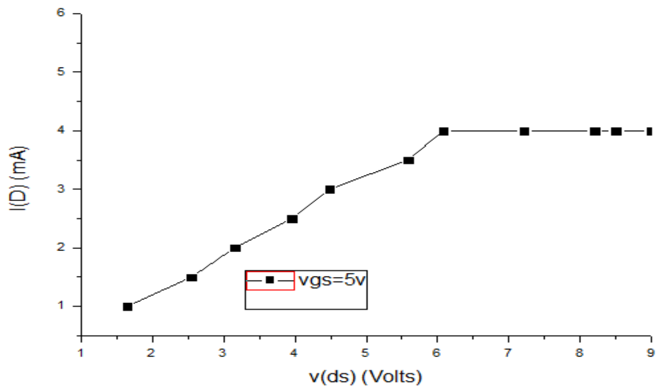
Fig. 2 Typical Drain Characteristics of FET



(a)

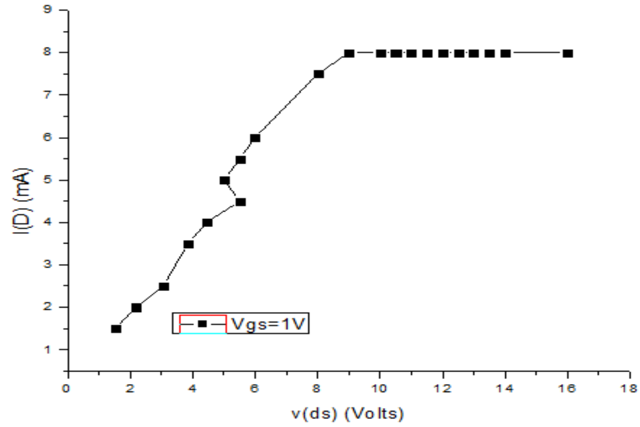


(b)

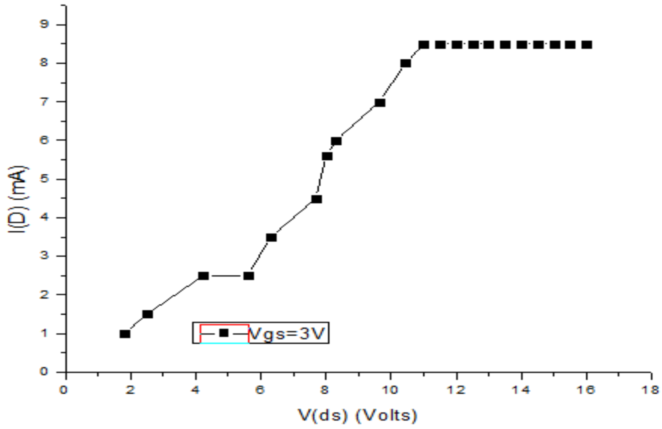


(c)

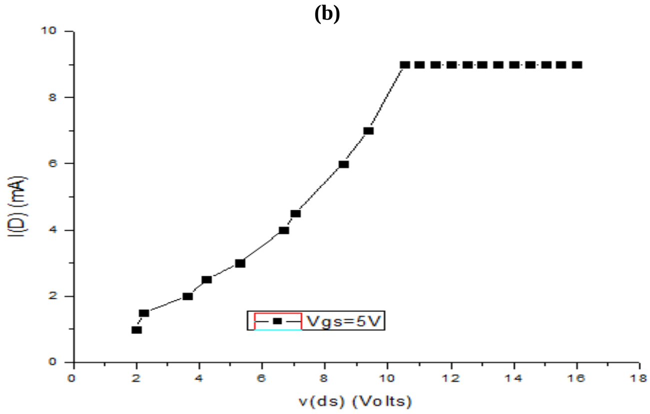
Fig. 3 Graph between drain current and drain voltage at (a) V_{GS} =1V (b) V_{GS}=3V(C) V_{GS}=5V as the Drain characteristics of MESFET using Selenium as semiconductor



(a)



(b)



(c)

Fig. 4 Graph between drain current and drain voltage at (a) V_{GS} =2V (b) V_{GS}=3V(C) V_{GS}=4V as the Drain characteristics of MESFET using Tellurium as semiconductor

Fig. 4 gives the graph between drain current and drain voltage as the Drain characteristics of MESFET using Tellurium as semiconductor material for the individual graphs of drain characteristics at different V_{GS}. The investigation shows FET characteristics for selenium and Tellurium channel are same [15].

Investigation gives results that the flow of charge carrier is from source to drain which is control by Schottky metal gate. By the depletion layer variation, channel width has controlled by the metal contact and thickness of the conducting channel (selenium or Tellurium channel) controlled by current from source to drain.

CONCLUSION

This research has been done for obtaining the better device performance by using the selenium or Tellurium material as semiconductor in MESFET. By using different device parameters better results have been obtained for threshold voltage. To enhance and optimize the performance sustainable and alternative semiconductors have been used of TFT in terms of composition and structure of materials. The additional important parameter is methods of deposition.TFT are also fabricated by using different stacked structure by depositing the different layer of materials on the substrate. We demonstrate the experimental research investigations on a Thin Film Transistor for the application of Metal semiconductor field-effect transistor. The obtained characteristics for selenium and Tellurium channel are same. The majority carriers flow from source to drain with the conducting semiconductor layer of selenium and control of charge has been done by schottky metal gate formed at metal semiconductor junction. Metal (Al/Cu) contact and metalloid (Se) channel has been used as a Field Effect Transistor on a glass substrate by depositing the source, drain and top-gate metal contacts.

REFERENCES

[1] J Kavalieros, BS Doyle, S Datta, G Dewey and R Chau, Tri-Gate Transistor Architecture with High-k Gate Dielectrics, Metal Gates and Strain Engineering, *Digest of Technical Papers VLSI Technology Symposium*, **2006**, 62-63.

[1] Y Wang, SW Liu, XW Sun, JL Zhao, GKL Goh, QV Vu and HY Yu, Highly Transparent Solution Processed In-Ga-Zn Oxide Thin Films and Thin Film Transistors, *The Journal of Sol-Gel* Science *and* Technology, **2010**, 55(3), 322–327.

[2] TS Pan, D De, J Manongdo, AM Guloy, VG Hadjiev,Y Lin and HB Peng, Field Effect Transistors with Layered Two-Dimensional Sns2− Xsex Conduction Channels: Effects of Selenium Substitution, *Applied Physics Letters*, **2013**,103, 93-108.

[3] E Elangovan, KJ Saji, S Parthiban, G Goncalves, P Barquinha, R Martins and E Fortunato,Thin-Film Transistors Based on Indium Molybdenum Oxide Semiconductor Layers Sputtered at Room Temperature, *IEEE Transcation on Electronics Devices*, **2011,** 32(10), 1391–1393.

[4] Kyratsi, K Chrissafis, J Wachter, KM Paraskevopoulos and MG Kanatzidis, Advanced. Materarial ,SG Hur, ET Kim, JH Lee, GH Kim and SG Yoon, *Journal of Vacuum Science and Technology*, **2008**, B 26, 1334 – 1336

[5] B Li, J Liu, G Xu, R Lu, L Feng and J Wu, Development of pulsed laser deposition for CdS/CdTe thin film solar cells, *Applied Physics Letters*, **2012**, 101,153903-04

[6] D De, J Manongdo, S See, V Zhang, A Guloy and H Peng, Field Effect Transistors with Layered Two-Dimensional Sns2− Xsex Conduction Channels: Effects of Selenium Substitution, *Nanotechnology*, **2013**, 24 (2), 025202– 204

[7] Y Lin, DJ Gundlach, SF Nelson and TN Jackson, Stacked Pentacene Layer Organic Thin-Film Transistors with Improved Characteristics, *IEEE Transaction on Electron Devices*, **1997**, 18, 606 – 608.

[8] NJ Watkins, L Yan, and YL Gao, Nature of Electrical Contacts in a Metal–Molecule–Semiconductor System, *Journal of Vacuum Science & Technology B, Nanotechnology and Microelectronics: Materials, Processing, Measurement, and Phenomena*, **2002**, 80, 4384– 93.

[9] M Shtein, J Mapei, JB Benziger and SR Forrest, Effects of Film Morphology and Gate Dielectric Surface Preparation on the Electrical Characteristics of Organic-Vapor-Phase-Deposited Pentacene Thin-Film Transistors, *Applied Physics Letters*, **2002**, 81, 268– 272.

[10] NJ Watkins, L Yan and YL Gao, Electronic Structure Symmetry of Interfaces Between Pentacene and Metals, *Applied Physics Letters*, **2002**, 80, 4384– 4386.

[11] Colin Reese, Mark Roberts, Mang-mang Ling and Zhenan Bao, Organic Thin Film Transistors, *Elsvier Materials Today*, **2004,** 7 (9), 20–27.

[12] Chaeho Kim and Dongryul Jeon, Organic Metal-semiconductor Field-effect Transistors using Aluminum-pentacene Schottky Junctions, *Journal of the Korean Physical Society*, **2010,** 57 (6), 1702-1706.

[13] Swati Arora, Vivek Jaimini, Subodh Srivastava, and YK Vijay, Properties of Nanostructure Bismuth Telluride Thin Films Using Thermal Evaporation, Journal of Nanotechnology, **2017,** Article ID 4276506,4 pages.