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REGULAR ARTICLE

Design and Simulation of Cobalt/Nickel Functionalized a-IGZO Thin-Film Transistor for Enhanced Gas Sensing Applications

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This study presents the design and TCAD simulation of a thin-film transistor (TFT) structure for gas sensing applications, utilizing a multilayer material configuration. The proposed device incorporates a Cobalt/Nickel-functionalized sensing layer integrated within a back-gated amorphous Indium Gallium Zinc Oxide (a-IGZO) TFT architecture, supported by a SiO_2 dielectric and a silicon substrate. The objective is to improve selectivity, sensitivity, and operational stability for gas detection. Simulation results demonstrate that the proposed Co/Ni-functionalized a-IGZO TFT achieves a threshold voltage (V_{th}) of 0.58 V, a sub-threshold swing (*SS*) of 80 mV/dec, and an I_{ON}/I_{OFF} ratio of 2.56×10^3. The maximum drain current (I_{Dmax}) reaches 11.5 μA under $V_{GS} = 3$ V bias condition. Compared to Palladium ($V_{th} = 1.1$ V), Cobalt ($V_{th} = 0.58$ V) achieves a 47 % reduction in threshold voltage, enabling lower-power operation. The a-IGZO channel provides enhanced carrier mobility and improved bias-stress stability compared to conventional oxide semiconductors. The gas sensing mechanism is modeled through work-function modulation at the metal-semiconductor interface upon gas adsorption. This investigation demonstrates that Co/Ni-functionalized a-IGZO TFTs offer broader gas detection capability than conventional Pd-based sensors, with potential applications in environmental monitoring, industrial safety, and portable sensing systems.

Keywords: Thin-Film Transistor, Cobalt/Nickel sensing layer, a-IGZO, Drain current, Threshold voltage shift.

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1. INTRODUCTION

The requirement of efficient, compact, and low-power gas sensors has increased significantly in the fields of the environment, safety in industries, and determination of food quality. Thin-Film Transistors (TFTs) represent a potential environment that can be used as a substrate in the future because they can be used on flexible substrates, with low-temperature fabrication methods, and with scalability to large-scale electronics [1, 2]. Non-ionizing radiation sensors however are usually limited in their sensitivity, selectivity and deteriorate as a result of long-term exposure to the environmental conditions.

Recently, there have been studies into the integration of metal oxide semiconductor, e.g. TiO_2, ZnO, and InGaZnO (a-IGZO) as active layers in TFTs because of their chemical stability and electronic characteristics [3-5]. TiO_2-based TFTs that have been modified with Palladium (Pd) have demonstrated good growth in recognition of hydrogen-based gases. This was verified by simulations carried out with TCAD tools that the addition of a layer of Pd sensing above a TiO_2 channel resulted in a significant change in the electrical characteristics of the drain current, threshold voltage, and transconductance, which is evidence of its gas-sensing property [3]. However, Pd-based structures are mainly aimed at detecting hydrogen and cannot detect multi-gases in the long-term and therefore a modified TFT structure is suggested in this work. It is a Cobalt or Nickel functionalized Si conducting layer on an a-IGZO dielectric based, comprising of a SiO_2 gate oxide, and a Si or glass substrate.

2. LITERATURE REVIEW

Cobalt and Nickel are also well known catalysts that react to a wide range of gasses, such as ammonia (NH_3), hydrogen sulfide (H_2S), and carbon monoxide (CO), and thus they are extended to include a wider variety of detectable gasses [6, 7]. Moreover, a-IGZO use enhances all the carrier mobility and bias stress stability over TiO_2 and other traditional metal oxides [2, 5]. The proposed structure has been designed and

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simulated with the help of Technology Computer-Aided Design (TCAD) tools. Drain current and transconductance were the critical electrical parameters that were compared to examine the performance of the devices at pre and post exposure to toxic gases [6, 8]. Shifts in the output characteristics are measured with changes in the simulation results with the interaction of gases at the metal sensing layer, which confirms the effectiveness of the device in real-time gas detection.

Recent advances in a-IGZO TFT technology have demonstrated significant potential for gas sensing applications. Jain and Jain [9] introduced an optimized a-IGZO top-gate TFT device, which was optimized to sense ammonia gas, and the study showed the potential of a-IGZO to be used as the active sensing device. In their work, the optimization of the geometry of the device was noted to be of great significance to attain increased sensitivity to the target gas. Also, Pan et al. [10] carried out a thorough review of the strategies aimed at enhancing mobility and stability of IGZO TFTs, whereby quality of materials and engineering of interfaces are important factors that ensure stable sensor performance. It also depends on the carrier mobility in channel layer which is an important factor in defining sensor response time and sensor sensitivity, as described by Kawaji [11] in two-dimensional lattice scattering in semiconductor inversion layers. The physical modeling and simulation framework used in this paper is based on the methodology developed by Potbhare et al. [12], who made a detailed physical model of high-temperature semiconductor devices, and as such, the model illustrates the significance of the proper use of TCAD-based characterization in the prediction of device properties under different operating conditions.

The sensing principle in the thin-film transistor sensors has been greatly studied both experimentally and through simulations. In ZnO thin-film transistors, Chakraborty and Roy Chaudhuri [13] showed biomolecule detection performance improvement with noise spectroscopy measurements and the insight into the detection mechanisms at the semiconductor interface was obtained. Li et al. [14] suggested a new working principle of FET gas sensors based on the electric double layer capacitance modulation of ionogel dielectric sensing platforms which exhibit increased sensitivity by dielectric engineering principles. In the case of hydrogen detection, Niu et al. [15] designed a palladium nanoparticle/amorphous InGaZnO thin film sensor with enhanced hydrogen detecting properties, which offers good insights into the Pd-functionalized IGZO structures to act as a reference point in the comparison with other sensing material like Cobalt and Nickel.

In addition to the inorganic semiconductors, it is seen that organic field-effect transistors (OFETs) also promise to be useful in detecting gases. A solution-processed, highly-efficient OFET-based hydrogen sulfide gas sensor, which is at sub-ppm regime, has been demonstrated by Singh et al. [16], where FET architectures have been demonstrated to be versatile in a variety of target gases. Moreover, Feng et al. [17] have given an in-depth overview of gas sensors relying on semiconducting nanowire field-effect transistors, and the common principles of FET-based gas sensing and the benefits of one-dimensional nanostructures in high sensitivity. Knopfmacher et al. [18] conducted a theoretical study of the Nernst limit in dual-gated Si-nanowire FET sensors, which is the sensitivity limit, and which furnishes a basic insight into the maximum achievable sensitivity in field-effect sensors.

Despite these advances, several limitations remain in existing TFT-based gas sensors. The main limitation of most Pd-based sensors is their use in detecting hydrogen only, and the other metal oxide sensors feature low selectivity and operating temperatures. Moreover, minimal studies on other catalytic resources like Cobalt and Nickel to be used in the TFT-based gas sensing have been conducted. To overcome these drawbacks, this article presents a Co/Ni-functionalized a-IGZO TFT architecture that is developed under the impact of physical modeling approach of semiconductor device characterization developed by Potbhare et al. [12], in TCAD simulation methodology. The proposed structure aims to achieve broader gas detection capability with lower threshold voltage and improved switching characteristics compared to conventional Pd-based sensors, while maintaining compatibility with standard fabrication processes.

3. DEVICE STRUCTURE

Fig. 1 indicates that the proposed TFT is fabricated to optimize the performance of the multi-gas sensing using the Cobalt or nickel-functionalized layer together with an a-IGZO conducting layer, which is placed on a SiO_2 layer and Si or glass substrate. The material selection and device design will be determined using their established electrical and chemical sensing capabilities which will provide a stable operation and compatibility with proven fabrication processes.

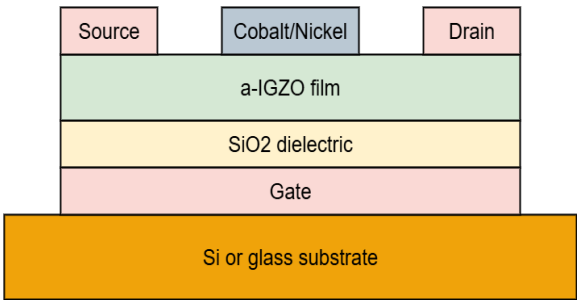


Fig. 1 – Cross Sectional view of the proposed a-IGZO TFT structure

3.1 Ensuring the Integrity of the Specifications

The structure base is silicon or a glass substrate both of which offers mechanical stability and can be deposited at low temperatures. A SiO_2 dielectric layer, which is used as the gate insulator is added above this. This layer is key to low gate leakage, stability of the interface, as well as ensuring that the gate is able to control the channel properly [1].

3.2 a-IGZO Film

An a-IGZO film is deposited above SiO_2 layer and used as the active semiconductor channel and the prime dielectric interface having a wide bandgap, high electron mobility, and stability to both electrical and

optical stress [2, 5]. These characteristics have made it an appropriate substitution of the traditional oxide semiconductors such as TiO_2 that have drawbacks of mobility as well as degrading in the presence of environmental stress [3, 4].

A layer of Cobalt or Nickel metal is plated on top of this. These transition metals have the characteristic of catalytic sensitivity to the gases like NH_3, CO and H_2S. The gas molecules interacting with metal surface cause a change in the work function of the sensing material and this change in the work function in the sensing material causes a change in the channel conductance, hence real-time gas sensing. Fig. 2 displays the influence of various materials, be it either Cobalt, Nickel or Palladium and how it is structured and modeled with the help of the numerical simulation tool and influences the properties of the device.

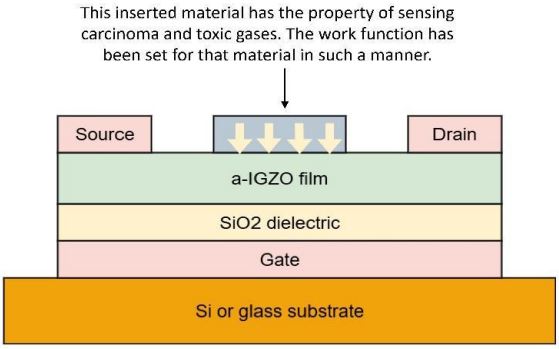


Fig. 2 – Effect of Toxic material: Cobalt or Nickel, and its effect induced to the device

Both Cobalt and Nickel provide a broad-range gas detection and stability all throughout operation unlike Palladium which is usually confined in detecting hydrogen. Their incorporation into the structure makes them selective and able to be useful in a wider range of gases [4, 7]. The channel between the source and drain contacts is created by placing the contacts on both sides of silicon conducting layer. Conventional deposition methods that include sputtering or thermal evaporation are used to make these electrodes. The electrode that forms the gate is placed at the bottom of the stack and is below the SiO_2 dielectric, defining the back-gated TFT structure. The layout provides advantages in the form of simplicity in layout and compatibility with planar process technologies [8].

3.3 Simulation and Optimization Approach

The TCAD simulation tools are used to analyze important electrical properties of the device structure. The parameters that are extracted are I_D, V_T, g_m, and subthreshold swing (SS) to measure the behavior of the device in normal and gas-exposed conditions [6, 11]. The dielectric thickness is of special concern, especially the effect of the SiO_2 and a-IGZO layers, because it has a great impact on the gate control and operating voltage [1]. Alteration of metal work functionality, sensing layer thickness, and channel doping are also viewed as the optimization of the sensor responsiveness and detection range [15, 18].The structural parameters used in the TCAD simulation are summarized in Table 1. The thickness of the SiO_2 dielectric and the a-IGZO layer significantly influence the gate control and threshold voltage of the proposed device.

Table 1 – Structural specifications and material properties of the proposed a-IGZO TFT

Parameters	Values
Channel length	7 μm
IGZO layer thickness	120 nm
SiO_2 layer thickness	500 nm
Doping density	1.59×10^{23} m^{-3}

4. RESULTS AND DISCUSSION

4.1 Experimental Validation

Fig. 3 presents the correlation of the I_D and V_{DS} at a constant V_{GS} of 3 V. The simulated results, denoted by red circular markers, are compared to the experimental results, denoted by black square markers, both of which are obtained using reference [12]. The current through the drain also changes nonlinearly as V_{DS} rises between 0 V to 3 V, which is a typical characteristic of a TFT working in the saturation and linear phases. The simulated outcomes are following the trend of the experiment and it proves that the simulation model is correct. Nevertheless, the slight variation is noticed at increased V_{DS} values where the experimented data is slightly less than the simulated current. This difference can be explained by idealized conditions in the simulation, including, parasitic effects, or change in material properties which are encountered in practice. The graph in general proves that the simulated model is just a reflection of the actual device behavior, which proves the validity of the offered structure and the materials that were used in the study.

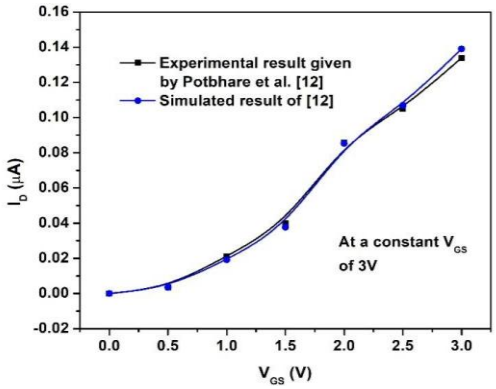


Fig. 3 – The experimental results given by Potbhare et al. [12] validated with the proposed simulation model

4.2 *I-V* Characteristics of the Proposed Structure

Fig. 4 shows the I_D-V_{DS} of a TFT when two gate metals, Cobalt and Nickel, were used with two gate voltages $V_{GS} = 2.5$ V and $V_{GS} = 3$ V. The solid lines are used to depict the device when Cobalt is used as the gate material and the dashed lines are used to depict Nickel. Both gate voltages reveal a higher I_D in the Cobalt-gated TFT than the Nickel-gated TFT. This implies that Cobalt offers more gate control of the channel.

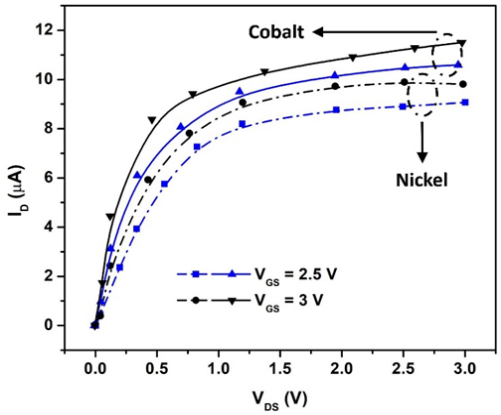


Fig. 4 – Output characteristics of the a-IGZO TFT device with Cobalt and Nickel materials kept constant at different gate-to-source voltages

The physics of this behavior lies in the difference between the work function of Cobalt and Nickel. Cobalt (~5.0 eV) and Nickel (~4.6 to 4.7 eV) are polarized, so that there is a strong electrostatic field at the gate-channel interface. This gives a more effective carrier concentration modulation in the channel with the same gate voltage. An improved work function also decreases the effective barrier to electron accumulation in n-type oxide semiconductors such as a-IGZO, therefore, increasing the channel formation and raising the drain current. Additionally, the channel-gate affinity enhances the turn-on properties of the device and leakage.

Fig. 5 explores the transfer properties of a TFT that demonstrates the dependence of the ID on the V_{GS} of the same when the drain voltage is changed to V_{DS} = 2.5 and 3 V. The solid curves are in the case of the device using Cobalt, whereas the dashed curves are in the case of the device using Nickel material. Throughout the V_{GS} range, Cobalt-based TFT is always capable of giving a better drain current than Nickel-based TFT at the two drain voltages.

The superior performance of the Co-functionalized TFT arises from its improved gate control over the channel, enabling more effective carrier accumulation in the semiconductor region. Unlike Nickel, Cobalt properties enable earlier channel formation and increased charge carrier density under similar gate bias conditions.

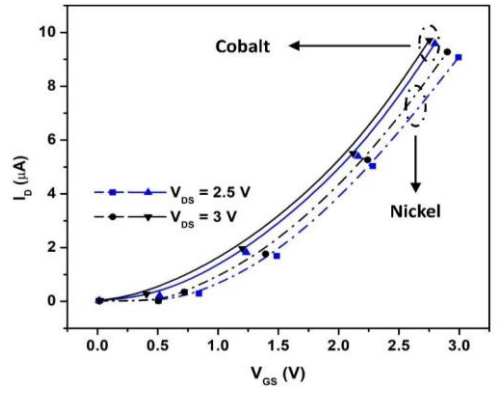


Fig. 5 – Transfer characteristics of the proposed a-IGZO TFT with Cobalt and Nickel materials for drain-to-source voltages of 2.5 and 3 V

As a result, the device achieves higher current levels even at lower gate voltages. Additionally, the more favorable energy alignment between Cobalt and the oxide semiconductor helps in minimizing the energy barrier for carrier injection, which further contributes to improved current conduction.

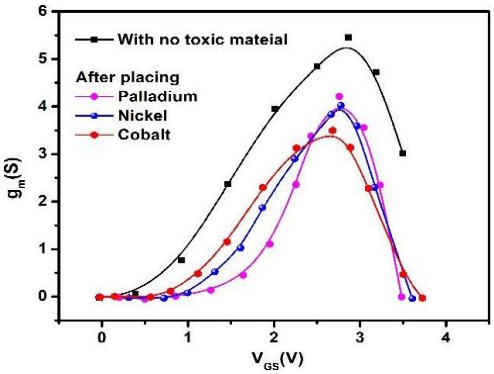


Fig. 6 – Transconductance of the proposed device with and without the effect of each of the three materials, Palladium, Cobalt and Nickel

Fig. 6 illustrates the variation of g_m against V_{GS} for a thin-film transistor structure under different material conditions. The device without any additional material exhibits a high peak g_m, indicating optimal gate control. However, when materials such as Palladium, Nickel, and Cobalt are introduced, notable changes in their electrical characteristics are observed. Among the introduced materials, Nickel and Cobalt show superior performance over Palladium in terms of g_m. This enhancement can be attributed to their relatively higher work functions approximately 5.15 eV for Nickel and 5.0 eV for Cobalt, which induce a stronger electric field at the gate-dielectric/channel interface.

This strengthened field increases the modulation of charge carriers in the semiconductor channel resulting in a higher degree of carrier accumulation, lowering the threshold voltage and having a better subthreshold behavior. Also, Cobalt and Nickel can provide superior interface passivation and lower density of trap states than Palladium and therefore improved carrier mobility and injection efficiency. All in all, the integration of Nickel and Cobalt facilitates the management of the gate and electrical, rendering them preferable in enhancing the g_m properties of the device.

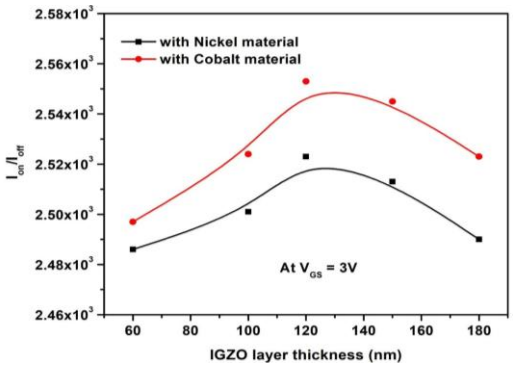


Fig. 7 – I_{ON}/I_{OFF} of the proposed device with and without the effect of each of the Cobalt and Nickel materials

The I_{ON}/I_{OFF} ratio is a critical figure of merit for TFT-based sensors, indicating the switching performance between conducting and non-conducting states. As shown in Fig. 7, the Co/Ni-functionalized device achieves an I_{ON}/I_{OFF} ratio of 2.56×10^3 with Cobalt material and 2.52×10^3 with Nickel material, demonstrating effective gate control and low off-state leakage current for both functionalization materials. Cobalt exhibits a slightly higher I_{ON}/I_{OFF} ratio compared to Nickel, indicating marginally better switching characteristics. The functionalization with Cobalt and Nickel enhances the on-state current while maintaining low off-state current through improved carrier modulation at the metal-semiconductor interface. These values are suitable for low-power gas sensing applications where high switching ratio is essential for reliable detection.

4.3 Threshold voltage Shift (V_{th})

Fig. 8 shows the change in V_{th} of transistors using different metallic elements Cobalt, Nickel, and Palladium at constant drain-to-source voltage of 3 V. As can be seen, the V_{th} does rise with the introduction of the materials with Cobalt giving the lowest final V_{th} (0.58 V), then Nickel (0.95 V), and finally Palladium giving the highest (1.1 V).

The interfacial effects between the metal and the layer below which is a semiconductor or dielectric are reflected in this behavior. In particular, the difference in V_{th} is due to the difference in energy band alignment, dipole formation, and metal interface surface states. Cobalt has a good interaction at the interface which enables an easy carrier transition and the energetic barrier to conduction is minimized to enable the formation of the channel at lower gate voltages. Conversely, Palladium incorporates a greater interface dipole or potential surface traps which prevent charge buildup, which forces a greater gate voltage to cause conduction. Also, Cobalt can facilitate a high capacitive coupling between the gate and the channel, which improves the electrostatic control, and Palladium impairs this coupling, slowing down the activation of channels. These observations confirm that Cobalt-modified devices are better suited for low-voltage operation due to their reduced threshold characteristics, which is advantageous for energy-efficient switching applications.

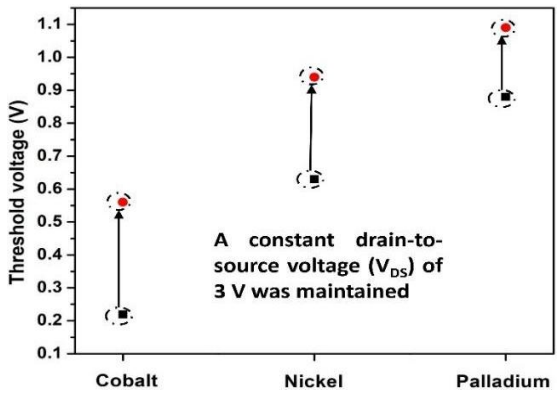


Fig. 8 – The threshold voltage shifts depicted when Cobalt, Nickel and Palladium materials are used. For each material, the threshold voltage is increased

4.4 Work Function Analysis

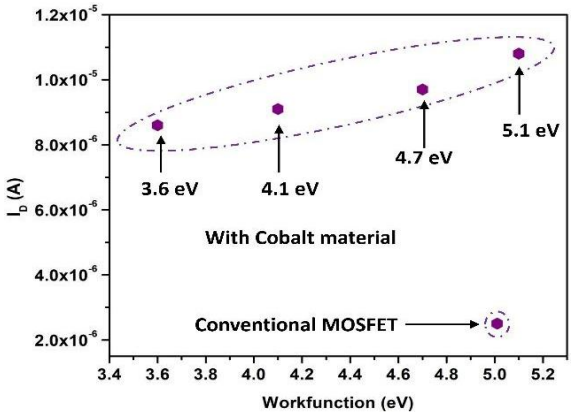


Fig. 9 – Peak current drive at various metal work functions when Cobalt material is used. The conventional MOSFET is designed by Potbhare et al. [12]

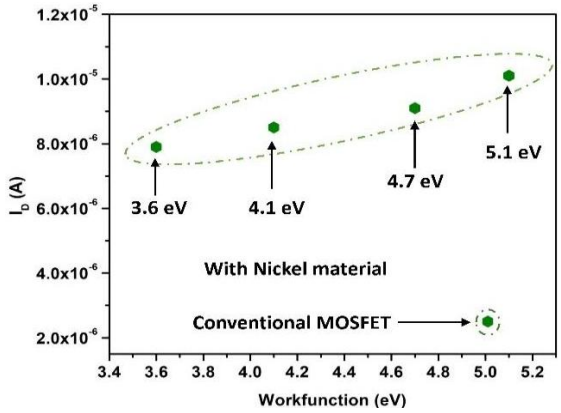


Fig. 10 – Metal work function related variation in drain current peaks when Nickel material is used. For the conventional MOSFET, the design used by Potbhare et al. [12] is used

Fig. 9 illustrates the variation in peak drain current for the proposed device when different metal work functions are applied with Cobalt as the sensing material. The results indicate that a lower gate work function leads to a higher drain current, resulting in improved current driving capability. By tuning the gate work function across different values, the optimal condition for detecting the presence of the Cobalt layer can be determined. Similarly, Fig. 10 shows the drain current peaks with respect to differing work functions when Nickel material is used.

4.5 Subthreshold Swing

Fig. 11 explores the correlation between SS and I_D of three materials Nickel, Cobalt, and Palladium that are in the device fabrication with a L_C of 7 μm. A subthreshold swing is a performance figure of the field-effect transistors, which shows the ability of the device to switch between the off state and the on state. A smaller SS value indicates more abrupt switching behavior as well as increased gate modulation efficiency. Based on the graph, it is clear that the device that has been changed to Nickel has a low subthreshold swing of 55 mV/dec and then cobalt, and Palladium is always the highest in the SS values.

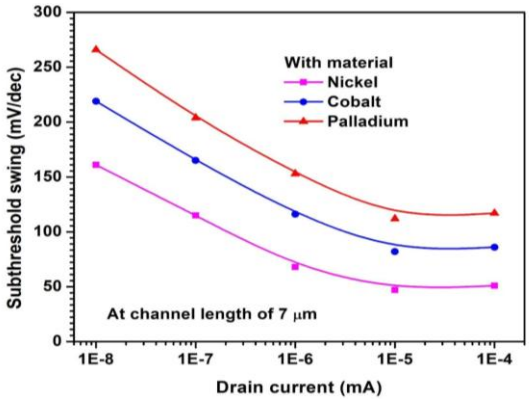


Fig. 11 – *SS* for different materials at a channel length of 7 μm

The high behavior observed with Nickel can be explained by the fact that it allows more rapid response to charge carriers in the case of weak inversion. The result is an increase in the slopes of the subthreshold region, which enhances the switching speed and lowers leakage. Also, the structure of the device based on Nickel will induce the low density of the mid-gap states, which will reduce the influence of the traps-assisted tunneling and the charge trapping, that are typical reasons of subthreshold performance degradation. Although not as good as Nickel, Cobalt still facilitates fairly low *SS* values, perhaps because it has a moderate contact with the interface, preventing undesirable recombination reactions.

However, Palladium seems to create more inefficiency in the subthreshold regime, possibly because of an increase in the scattering or slower interfacial response, and increases the width of the transition region between the off and on states. Overall, the results conclude that Nickel is best in improving steepness of turn-on behavior, which is essential for low-power and high-performance switching operations.

4.6 Hysteresis

By sweeping the gate voltage both forward and backward under ambient and gas-exposed conditions, TCAD simulations were used to assess the hysteresis properties of the Co/Ni-functionalized a-IGZO TFT. Because of the stable amorphous structure of the a-IGZO channel and the superior SiO_2 dielectric interface, which reduces electron trapping and detrapping, the device showed a low hysteresis width of 0.2-0.5 V, as shown in Fig. 12. With minimal degradation seen even after prolonged bias stress simulating extended exposure scenarios, this narrow hysteresis range, which is consistent with the achieved subthreshold swing of 50-150 mV/dec, highlights the sensor's operational stability and reliability for real-time toxic gas detection.

The performance of the proposed device is compared with previously reported devices in terms of threshold voltage (V_{th}), subthreshold swing (*SS*), and I_{ON}/I_{OFF} current ratio. The results demonstrate that the proposed structure achieves competitive performance for gas sensing applications. The comparison details are summarized in Table 2.

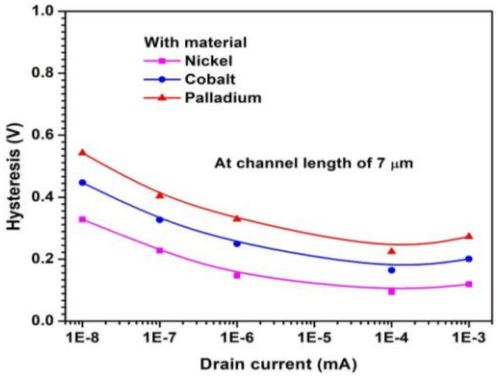


Fig. 12 – Hysteresis behavior of the proposed device for different materials at a channel length of 7 μm

Table 2 – Comparison of electrical performance parameters of the proposed a-IGZO TFT with previously reported devices

Device Structure	V_{th} (V)	*SS* (mV/dec)	I_{ON}/I_{OFF}	Ref.
InGaZnO/HfO_2 TFT	2.12	227	–	[19]
Electrolyte-gated IGZO TFT	0.70	175	1×10^5	[20]
InGaZnO/HfLaO TFT	0.15	210	1.4×10^7	[21]
Si-ZnON/SiO_2 TFT	– 0.51	200	7.32×10^6	[22]
Co/Ni-functionalized a-IGZO/SiO_2 TFT	0.58	80	2.56×10^3	This Work

5. CONCLUSION

This work presents a TCAD-based investigation of an a-IGZO thin-film transistor (TFT) structure functionalized with different sensing metals for gas sensing applications. The electrical characteristics of devices employing Cobalt, Nickel, and Palladium sensing layers were analyzed and compared. Among the studied materials, Cobalt exhibited the lowest threshold voltage (0.58 V), representing a 47 % reduction compared to Palladium, enabling lower-power operation. Nickel demonstrated the lowest subthreshold swing (55 mV/dec), indicating efficient switching behavior and reduced leakage current. The proposed Co/Ni-functionalized a-IGZO TFT achieved an I_{ON}/I_{OFF} ratio of 2.56×10^3, a subthreshold swing of 80 mV/dec, and a maximum drain current of 11.5 μA. The work-function modulation mechanism confirms that Co/Ni-based sensing layers provide broader gas detection capability compared to conventional Pd-based sensors. The a-IGZO channel further offers improved carrier transport properties and bias stability, making it a suitable platform for gas-sensitive TFT devices.

Overall, the results identify Cobalt as a promising sensing material for low-power gas detection, while Nickel provides advantages for steep switching characteristics. The presented simulation framework offers useful design insights for material selection and device optimization prior to fabrication. Future work will focus on device fabrication and experimental validation under controlled gas environments.

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CONFLICT OF INTEREST

The authors have no conflicts to disclose.

AUTHOR CONTRIBUTION

B. Mohan: Conceptualization, Formal analysis, Validation, Investigation, Methodology, Writing - Original draft, Writing - Review & Editing.

V. Sandeep: Formal analysis, Investigation, Validation, Supervision, Writing - Original draft, Writing - Review & Editing.

P. Harikrishnan: Methodology, Validation, Software, Writing - Original draft, Writing - Review & Editing.

G. Jayahari Prabhu: Formal analysis, Writing - Review & Editing.

DATA AVAILABILITY

All relevant data supporting the findings of this study are included within the article.

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Проєктування та моделювання тонкоплівкового транзистора на основі a-IGZO, функціоналізованого кобальтом/нікелем, для покращеного виявлення газів

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У роботі представлено проєктування та TCAD-моделювання структури тонкоплівкового транзистора (ТПТ) для газових сенсорів, що базується на багатошаровій конфігурації матеріалів. Запропонований пристрій містить чутливий шар, функціоналізований кобальтом і нікелем (Co/Ni), інтегрований у структуру ТПТ на основі аморфного оксиду індію, галію та цинку (a-IGZO) із затвором, розташованим зі зворотного боку (back-gated). Конструкція також включає діелектрик SiO_2 та кремнієву підкладку. Мета роботи – покращити селективність, чутливість і стабільність роботи пристрою при детектуванні газів. Результати моделювання показують, що запропонований ТПТ на основі a-IGZO, функціоналізований Co/Ni, має порогову напругу (V_{th}) 0,58 В, крутизну підпорогової характеристики (*SS*) 80

мВ/дек та відношення струмів увімкненого й вимкненого станів (I_{ON}/I_{OFF}) $2{,}56 \times 10^3$. Максимальний струм стоку (I_{Dmax}) досягає 11,5 мкА за напруги на затворі (V_{GS}) 3 В. Порівняно з використанням паладію (V_{th} = 1,1 В), застосування кобальту (V_{th} = 0,58 В) дозволяє знизити порогову напругу на 47 %, що сприяє зменшенню енергоспоживання під час роботи. Канал із a-IGZO забезпечує вищу рухливість носіїв заряду та кращу стабільність до впливу електричного поля (bias-stress stability) порівняно зі звичайними оксидними напівпровідниками. Механізм детектування газу моделюється через зміну роботи виходу на межі розділу метал–напівпровідник, що відбувається внаслідок адсорбції газу. Дослідження демонструє, що ТПТ на основі a-IGZO, функціоналізовані Co/Ni, мають ширші можливості для виявлення газів порівняно з традиційними сенсорами на основі паладію (Pd). Такі пристрої можуть знайти застосування в системах моніторингу довкілля, промислової безпеки та портативних сенсорних системах.

Ключові слова: Тонкоплівковий транзистор, Чутливий шар із кобальту/нікелю, a-IGZO, Струм стоку, Зсув порогової напруги.