Effect of Drying Temperature on pH Sensitivity of TiO_2 Integrated All-Solid Electrodes (IASE)

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Abstract: Titanium dioxide (TiO2) sensing electrode and silver/silver chloride (Ag/AgCl) reference electrode were deposited on indium tin oxide (ITO) substrate and refer as an integrated all-solid electrode (IASE) for pH sensing application. TiO2 and Ag/AgCl thin film was fabricated using the sol-gel spin coating method and thermal evaporator. After the deposition process, the thin films were dried at room temperature, 50 °C, and 100 °C to study the influence of the drying process on the pH sensitivity and linearity of IASE. It was found that the sample dried at 100 °C shows high sensitivity and linearity with 67 mV/pH and 0.9827.

***Keywords*:** Drying Temperature, Ph Sensitivity, Integrated All-Solid Electrodes (IASE).

INTRODUCTION

pH is one of the most significant characteristics to be considered in a variety of applications such as agriculture [1], medical [2], and food processing [3]. The most popular pH determination method is using a glass electrode. Titanium dioxide (TiO_2) is one well-known metal oxide material due some advantages. TiO_2 has been widely used as a pH sensor to detect H^+ ions [4]. In this work, we present the study of the drying temperature effect on IASE for extended gate field effect transistor (EGFET) pH sensing application. The EGFET sensor was characterized for its transfer characteristic to analyze the sensitivity and linearity of IASE.

MATERIALS AND METHODS

The TiO_2 was prepared with the following mixture of absolute ethanol, glacial acetic acid (GAA), titanium (IV) isopropoxide (TTIP), Triton X-100, and deionized (DI) water based on previous group work [5]. The 300 nm of the Ag layer was done by using a thermal evaporator (TE) followed by a 5-second chlorination process using $FeCl_3$ to form Ag/AgCl RE.

RESULTS AND DISCUSSION

Fig. 1 shows the graph output voltage versus pH at (a) room temperature (b) 50 and (c) 100 °C. This graph was carried out from the transfer characteristic (drain current versus reference voltage) in different buffer solutions. The reference voltage was measured at 100 μA of drain current. The sensitivity and linearity value was extracted from the slope and regression value of the graph in Fig. 1. As a result, the sensitivity and linearity value of IASE was around 66.1, 67.3, and 67 mV/pH for room temperature, 50 and 100 °C respectively. Increasing the drying temperature from room temperature to 100 °C, has improved the linearity from 0.9561 to 0.9827. The detailed values are tabulated in Table 1.

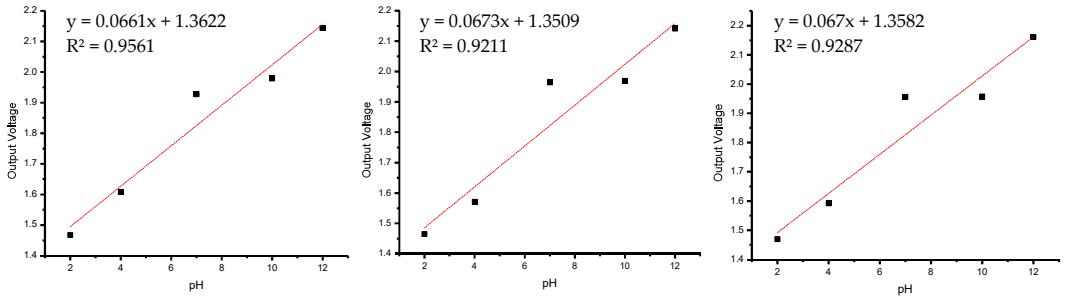

Fig. 1. The graph output voltage versus pH at (a) room temperature, (b) 50 °C, and (c) 100 °C

Table 1. Sensitivity and linearity value of IASE

Materials	RT	50 °C	100 °C
Sensitivity (mV/pH)	66.1	67.3	67
Linearity	0.9561	0.9211	0.9827

CONCLUSIONS

In conclusion, the IASE-based TiO_2 sensing electrode and Ag/AgCl reference electrode have been successfully fabricated on an ITO-coated glass substrate. The deposited IASE has been proven to be sensitive to pH. Increasing drying temperature has improved both sensitivity and linearity of the IASE. The highest sensitivity and linearity achieved in this work were 67.3 mV/pH and 0.9827.

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