Chapter 4

Array type voltage type pH sensor

4.1 Array type pH sensor

In thick film ceramic array type voltage type pH sensor, aluminum oxide (Al_2O_3) ceramic material is adopted as the substrate of sensor, through industrial grade thick film automated printer coating technique, array type sensor device is accomplished, then through the vacuum deposition system [144] manufactured by Hermosa Optics Inc., titanium dioxide (TiO_2) is then deposited as the sensor thin film, meanwhile, the operation temperature of the evaporation system is below 273℃ for the deposition of TiO_2 sensor film, the thin film thickness is 5000A° under standard condition of 1sccm and under 760 torr, and Al_2O_3/Gold/ TiO_2 structure is used as array type voltage type pH sensor. Array type voltage type pH sensor with stable process is accomplished.

For thick film ceramic array type voltage type pH sensor device, through industrial grade automated printer coating screen process technology and through the use of high temperature sintering for the Ag conductor and Au electrode drawing design, a stable structure sensor containing several solid materials is prepared, meanwhile, the sensor has characteristics such as hard, deformation resistance, wear resistance, corrosion resistance, high temperature and high pressure resistance, temperature and acid resistance, no aging and high durability, etc. The sensor window is Au conductor electrode, and it owns four work electrodes of A, B, C & D, meanwhile, AgCl glass reference electrode S120C manufactured by standard commercial SENSOREX Corporation is adopted for the measurement, meanwhile, the process related application of the sensor itself is investigated and analyzed too. For the front-end readout, instrumentation amplifier is used for signal processing, and a basic measurement system of solid state pH sensor is then accomplished, finally, a complete array type linear pH sensor architecture is shown.

For array type pH sensor, screen printing is used to prepare Au conductor, then a deposition of TiO_2 sensor thin film by evaporation method is carried out. In the sensor device, the acid or base quantity in the solution to be tested will change the electric potential of the device, then such change will be measured. From the experimental result, it is clear that the circuit can sense the hydrogen ion. In the test standard, pH buffer solution in the range of pH3~pH13 is used, and it is found that the sensor can sense the hydrogen ion, and the obtained sensitivity is 50~55mV/pH in the range of pH3-pH13. From the experimental result, it is proved that pH sensor film can show a large pH sensing range, it can show high durability, meanwhile, it has low drift, and a highly sensitive and linear array type voltage type pH sensor is then successfully

prepared.

4.2

This paper is mainly to develop thick film ceramic array type voltage type pH sensor. Through industrial grade thick film printer process technology, the design, layout, structure, physical property and chemical property of the sensor can all reach certain standard. Meanwhile, the design and analysis of voltage type pH sensor device is also accomplished, and a wide field of application of biomedical sensor is accomplished too. Moreover, in association with electrochemical principle, pH sensor device wherein the Au electrode is evaporation-deposited with TiO_2 is successfully developed. In such sensor system, the chemical reaction between pH sensor device and pH buffer solution is used, meanwhile, signal generated from such physical and chemical reaction is then measured.

4.3

In this study, the front-end sensor structure used is of TiO2/Gold/Al_2O_3 architecture, and an architecture similar to EGFET is adopted, the original drain and source electrode is then abandoned, meanwhile, the gate electrode is changed into sensor film structure. In this study, vacuum deposition system is used to deposit TiO_2 sensor thin film, which is deposited on the Au electrode window of Al_2O_3 ceramic substrate. In other words, under fixed evaporation condition, the preparation of sensor thin film for the front-end sensor device is then accomplished. For TiO2/Gold/ Al_2O_3 finished with TiO_2 evaporation, only the sensor window TiO_2 thin film is exposed to the solution to be tested, and such architecture can facilitate the pH value measurement of aqueous solution.

4.4Electrochemical sensor interface

Electric reaction of the sensor in acidic and basic solution:

In the hydrogen ion sensing process, the sensor thin film is in contact with the solution, therefore, an interface electric potential will form at the interface between the aqueous solution and the sensor thin film, and the interface electric potential will change along with the ionic concentration of the solution. Since only a very thin

dielectric layer exists between the sensor thin film and the semiconductor surface, the interfacial electric potential between the sensor thin film and the solution to be tested will affect the semiconductor surface, therefore, the electric charge density in the surface inversion layer will change, consequently, the channel current flowing through the ionic sensor will be regulated.