Optical sensing of pH based on methyl Blue on PVC Film

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Abstract: The development of an optical pH sensor for high pH values is described on the immobilization of methyl blue on PVC films. The membrane is useful for repetitive and reversible pH measurements in the pH rang of 9-12.The advantages of the membrane include rapid equilibration time, long term stability, reversibility, high sensitivity, easy to work, freedom from interference of other cautions, and ease of fabrication.

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Key words: Methyl Blue, Optical Sencing, PVC Film.

1-INTRODUTION:

Chemical sensor technology involves the key processes of chemical recognition of the analytes of interest and subsequent transduction of the analytical signal.[1]

Because of its advantages of easy fabrication, good sensitivity, selectivity and low cost, optical chemical sensors have drawn much attention in analytical chemistry. Over the post two decades, the development and applications of optical chemical sensors have grown rapidly. Among all sensors; optical pH sensors have received the most attention because of the importance of pH measurements in various scientific research and practical applications [2]. Optical pH sensors are based on pH-dependent changes of the absorbance or luminescence of certain indicator molecules immobilized on/in certain solids. In most cases, a thin layer of polymer containing an immobilized indicator dye is the core element of such sensors. The indicators are weak acids, whose dissociated and un dissociated forms display different

The requirements of a well-developed optode are well established. Reversibility in the response due to concentration changes of the analyte, improvement in the sensitivity, selectivity and stability of the membranes are still challenging areas for designing optical sensors.

In this paper the fabrication and evaluation of a pH sensor for high pH values where the glass electrodes usually encounter alkaline error are described. The sensor is constructed by immobilizing methyl blue on an optically transparent PVC membrane. The sensor was evaluated with respect to dynamic range, response time, and reproducibility pKa value of the immobilized indictor, reversibility, long-term stability and effects of ionic strength of the solution on the analytical signal. [3]

2. Experimental:

2.1. Reagents

All reagents were of the best available analytical-reagent grade. methyl Blue was obtained from Merck that it dissolved of distilled water. A universal buffer solution was obtained from Merck.[4]

2.2. Preparation of sensor membrane.

The immobilized pH indicator on PVC was prepared according to the following procedure.[3]

The films were treated with a clear solution of methyl blue in water for 12 hours. Then these membranes were washed with distilled water. They were kept under water. When not in use.

2.3. INSTRUMENTATION:

A PerkinElmer lambda 2 UV-VIS spectrophotometer was used for recording the visible spectra and absorbance measurements. A Jenwey model 744 pH meter with a combined double junction glass electrode, calibrate against three standard buffer solutions at pH 4.0, 7.0,10.0 was used for pH adjustment.

3. Result and discussion:

3.1. Optical characteristics of the sensor membrane methyl blue is a pH indicator, The structure of which is depicted in fig.1. The optical spectra of methyl blue in solution water and immobilized on PVC. Films are shown in fig.2. The spectral change is a result of an acid-base equilibrium of the indicator. These changes are completely reversible with variation of pH. The membrane responds to pH by changing color reversibly form blue to brown-red as are salt of increase in pH. The spectral characteristic of the immobilized methyl Blue showed a maximum at 586.n.m.in its acidic form this wave length was selected for further studies.[5-6]

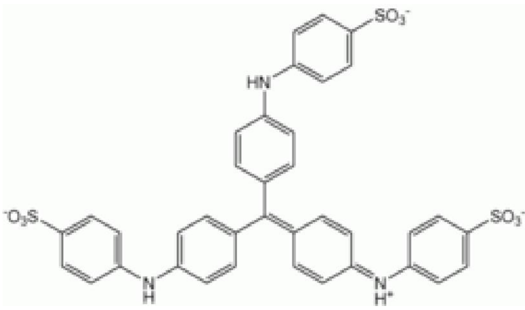

Fig. 1. Structur of methyl Blue

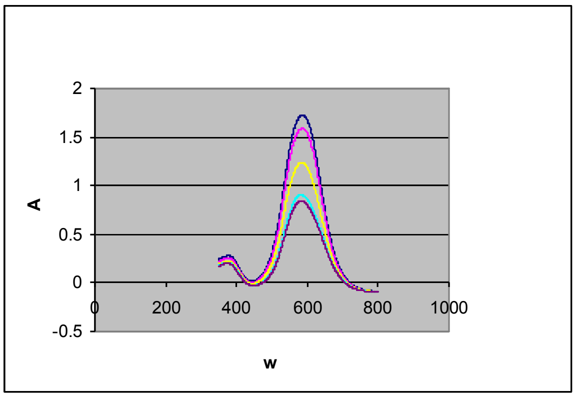

Fig. 2. Absorption spectra for methyl Blue in pH (12-9)

3.2. **Analytical figures of merit**:

The major requirements for an ideal optode membrane are fast response time, high sensitivity, selectivity, broad linear dynamic range, long life time and excellent reproducibility.

3.3. **Analytical performance of an optical pH sensor for acid-base titration**:

The use of these pH sensors offers the following advantages over conventional methods: possibility of in situ measurements; small sample volume reference electrode not required; and suitability for on-line pH control in industrial and biotechnological processes.

Titration of weak acids acetic acid, was titrated as representative weak acid.[7]

3 ml Volume of %1M acetic acid was titrated with 0.1M NaOH, and fig5.shows the end- point as measured 10 sec after each titrant addition. This value (0.55 +_ 0.02 ml) is the same as that obtained using a glass electrode.

3.4. **Stability of the PVC films**:

The stability of PVC-based optical sensors is highly dependent on the storage media. The films are stable for months when stored in water. [1] acid-base titration cycles as high as 500 can be achieved [8]. I test this exam on triacetylcellulose but its not stable. Then I change film to PVC, and I get the excellent result.

3.5. Effect of foreign ions

The response of the sensor was free from any metal interference. Some metal ions such as ،Co^{3+}، Bi^{3+}، Al^{3+}، V^{4+}، pb^{2+}، Cu^{2+}، Cd^{2+}، Hg^{+}، Fe^{2+} K^{+}، Na^{+}، $Ni^{2+,}$ Ba^{2+} ، are in their precipitated hydroxide form at the pH values where the sensor is responding. Ions such as Na^+ and K^+ did not have any effect on the response of the proposed pH optode. [8]

4. **Conclusion**

The above results show that the application of methyl blue immobilized on a PVC membrane can offer a suitable pH sensor for the rang of 9-12 pH measurement.

The membrane produced by this method possesses high stability, short response time and excellent spectral characteristics. Suggest the application of the proposed sensor to the measurements of high pH values in real samples of high metal ion content. Reversibility of the sensor is very good and it is stable over the applied pH range with no leaching of the dye. [9]

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