ABSTRACT

Nitrate ion-selective sensors (ISE) was fabricated for the purpose of small, low cost, on-the-go and real-time nitrate ion monitoring for precision agriculture (PA) and the performance was evaluated. The sensor was constructed on two types of printed circuit board (PCB) which are PCB with and without silver (Ag) layer. Two different carbons *i.e.* Electrodag (ED) and Jujo (J) were printed on these PCB electrode surface. All these carbon boards were characterized using potentiostat. PCB without Ag layer which modified with ED followed by J carbon paste had shown current peak of 0.0055 mA. Conducting polymer polypyrrole (PPy) was deposited on each different types of electrodes and once again cyclic voltammetry shown that PCB without Ag layer which modified ED and J carbon give the highest anodic peak current *i.e.* 0.43 mA. The nitrate recognition sensor membrane was prepared by using tetraoctylammonium nitrate (TOAN) as ionophore with methyl methacrylate (MMA) and *n*-butyl acrylate (nBA) as plasticizer. The sensor performance was checked in different concentration of nitrate solution varied from 1 X 10^{-4} M to 1 X 10^{-1} M. PCB sensor tip without Ag layer with ED and J carbon pastes displayed slope value of -61.153 mV/decade, slightly exceed the Nernstian slope value for single ion detection which is -59.16 mV/decade. The linear range for the nitrate ISE is up to 1 X 10^{-5} M and limit of detection (LOD) is at 6.3 X 10^{-7} M of nitrate concentration. Temperature test was performed to study the nitrate ISE performance depreciation. It was found that at 10 ºC, the slope of the ISE sensor is around -50 mV/decade, which is below Nernstian response whereas sensor tip tested at 50 ºC shown super Nernstian behavior.

ABSTRAK

Pengesan terpilih untuk ion nitrat telah dibina untuk tujuan pengesanan yang bersaiz kecil, kos rendah dan boleh digunakan di mana-mana dan pada bila-bila masa untuk pemantauan ion nitrat bagi kegunaan pertanian tepat. Pengesan ini telah dibina di atas dua jenis papan litar bercetak; iaitu yang tiada lapisan perak dan juga mengandungi lapisan perak. Dua karbon yang berbeza iaitu Electrodag (ED) dan Jujo (J) telah dicetak pada permukaan elektrod papan litar bercetak ini. Pencirian dilakukan pada semua jenis karbon di atas papan litar bercetak ini dengan menggunakan potentiostat. Papan litar bercetak tanpa lapisan perak yang diubahsuai dengan ED diikuti oleh J bancuhan karbon telah menghasilkan puncak arus sebanyak 0.0055 mA. Polimer polypyrrole (PPy) telah didepositkan pada setiap jenis elektrod dan sekali lagi voltammetri berkitar menunjukkan bahawa papan litar bercetak tanpa lapisan perak yang diubahsuai dengan ED dan J karbon memberi puncak arus tertinggi iaitu 0.43 mA. Membran pengesan untuk pemilihan ion nitrat telah disediakan dengan menggunakan tetraoctylammonium nitrat (TOAN) sebagai ionophore dengan metyl methacrylate (MMA) dan *n*-butyl acrylate (nBA) sebagai bahan pemplastik. Prestasi sensor telah diperiksa dalam kepekatan nitrat yang berbeza dari 1 X 10^{-4} M sehingga ke 1 X 10^{-1} M. Pengesan tanpa lapisan perak dengan ED dan J karbon memaparkan nilai kecerunan sebanyak -61.153 mV/dekad yang sedikit melebihi nilai kecerunan Nernst untuk pengesanan ion tunggal iaitu -59.16 mV/dekad. Julat linear untuk pengesan terpilih untuk ion nitrat ialah sehingga 1 X 10^{-5} M dan had pengesanan adalah pada kepekatan nitrat sebanyak 6.3 X 10^{-7} M. Ujian suhu telah dijalankan untuk mengkaji prestasi pengesan. Keputusan menunjukkan bahawa pada 10 ºC, kecerunan pengesan adalah pada sekitar -50 mV/dekad, iaitu di bawah kecerunan optima Nernst manakala pada 50 ºC pengesan menunjukkan nilai kecerunan jauh lebih besar dari Nernst.

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LIST OF ABBREVIATIONS

DI	Distilled
ED	Electrodag
J	Jujo
ISE	Ion-selective electrode
LOD	Limit of detection
NHE	Normal hydrogen electrode
PA	Precision agriculture
PCB	Printed circuit board
PPy	Polypyrrole
RE	Reference electrode
SCE	Saturated calomel electrode
SHE	Standard hydrogen electrode
WE	Working electrode