Supplementary Information

Development of coated-wire silver ion selective electrodes on the paper using conductive films of silver nanoparticles

Wanwisa Janrungroatsakul,† Chutiparn Lertvachirapaiboon,‡ Wittaya Ngeontae,§ Wanlapa Aeungmaitrepirom,‡ Orawon Chailapakul,‡ Sanong Ekgasit‡ and Thawatchai Tuntulani*,‡

† Department of Chemistry, Faculty of Science, Naresuan University, Phitsanulok 65000, Thailand.
‡ Department of Chemistry, Faculty of Science, Chulalongkorn University, Bangkok 10330, Thailand.
§ Materials Chemistry Research Unit, Department of Chemistry and Center of Excellence for Innovation in Chemistry, Faculty of Science, Khon Kaen University, Khon Kaen 40002, Thailand.

Content

Fig. S1 SEM images of the nano silver ink after left in air.

Fig. S2 Cyclic voltammograms of AgNPs colloids and AgNO₃ solution using a GC electrode.

Fig. S3 Potential response of the coated-wire Ag-ISE at variation of solution pH.

Fig. S4 Reversibility of the coated-wire Ag-ISE.

Table 1 Comparison of the potentiometric parameters of the proposed the coated-wire Ag-ISEs with other Ag-ISEs reported previously.

(a) (b)

Fig. S1 SEM images of the nano silver ink after (a) left in air for overnight (b) left in air for one week.
Fig. S2 Cyclic voltammograms of bare GC electrode in 0.01 mol/L KNO₃ solution containing $1.0 \times 10^{-4}$ mol/L AgNO₃ (blue) and 0.01 mol/L KNO₃ solution containing 50 nm (red) and 100 nm (green) of silver nanoparticles colloid at a potential scan rate of 50 mV/s.
Fig. S3 Potential response of the coated-wire Ag-ISE fabricated from sintering nano silver at room temperature at variation of solution pH observed in three different Ag⁺ concentrations.
**Fig. S4** Reversibility of the coated-wire Ag-ISE fabricated from sintering nano silver at room temperature at the concentration between $10^{-4}$ and $10^{-3}$ M.
Table S1 Comparison of the potentiometric parameters of the proposed the coated-wire Ag-ISEs with other Ag-ISEs reported previously.

<table>
<thead>
<tr>
<th>Ref</th>
<th>Ionophore</th>
<th>Working concentration range (M)</th>
<th>Slope (mV decade)</th>
<th>pH range</th>
<th>Detection limit (M)</th>
<th>Response time (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[1]</td>
<td>25,27-Di(benzothiazolyl)-26,28-hydroxycalix[4]arene (CU1)</td>
<td>$1.0 \times 10^{-6}$ to $1.0 \times 10^{-2}$</td>
<td>59.7 ± 0.8</td>
<td>2.0 – 8.0</td>
<td>$5.0 \times 10^{-7}$</td>
<td>&lt;5 s</td>
</tr>
<tr>
<td>[2]</td>
<td>5,11,17,23-tetra-tet-butyl-25,27-dihydroxy-calix[4]arene-thiacrown-4</td>
<td>$1.0 \times 10^{-6}$ to $1.0 \times 10^{-2}$</td>
<td>53.8 ± 1.6</td>
<td>2.0 – 6.0</td>
<td>$8.0 \times 10^{-7}$</td>
<td>5-10 s</td>
</tr>
<tr>
<td>[3]</td>
<td>N,N′-Bis(3-methyl-1-phenyl-4-benzylidine-5-pyrazolone)propylenediamine</td>
<td>$1.0 \times 10^{-6}$ to $1.0 \times 10^{-4}$</td>
<td>59.3</td>
<td>3.0 – 7.0</td>
<td>$9.3 \times 10^{-7}$</td>
<td>5 s</td>
</tr>
<tr>
<td>[4]</td>
<td>4'-aminobenzo-15-crown-5 (B15C5)</td>
<td>$2.7 \times 10^{-7}$ to $1.0 \times 10^{-1}$</td>
<td>58.5</td>
<td>3.0 – 9.0</td>
<td>$1.0 \times 10^{-8}$</td>
<td>~15 s</td>
</tr>
<tr>
<td>[5]</td>
<td>2-acetylbenzimidazole benzylohydroazine</td>
<td>$1.1 \times 10^{-7}$ to $1.0 \times 10^{-3}$</td>
<td>61.2 ± 0.5</td>
<td>3.5 – 8.5</td>
<td>$7.0 \times 10^{-8}$</td>
<td>~3 s</td>
</tr>
<tr>
<td>[6]</td>
<td>2,c-8,c-14,c-20-tetrabuty1-4,6,10,12,16,18,22,24-octaacetylcrown-4arene</td>
<td>$1.0 \times 10^{-5}$ to $1.0 \times 10^{-1}$</td>
<td>58.0 ± 1</td>
<td>1.5 – 6.0</td>
<td>$1.0 \times 10^{-8}$</td>
<td>&lt;20 s</td>
</tr>
<tr>
<td>[7]</td>
<td>hexadentate mixed azahioether crowns containing a 1,10-phenanthroline sub-unit</td>
<td>$3.0 \times 10^{-8}$ to $5.0 \times 10^{-2}$</td>
<td>58.8 ± 0.5</td>
<td>3.0 – 7.0</td>
<td>$1.0 \times 10^{-8}$</td>
<td>&lt;15 s</td>
</tr>
<tr>
<td>[8]</td>
<td>N,N′-Bis(2-thiethylmethylene)-1,2-diaminobenzene</td>
<td>$1.0 \times 10^{-6}$ to $1.0 \times 10^{-4}$</td>
<td>59.7</td>
<td>5.0 – 9.0</td>
<td>$6.0 \times 10^{-7}$</td>
<td>≤ 17 s</td>
</tr>
<tr>
<td>[9]</td>
<td>2-[(2-[2-carboxyphenyl]sulfanylidene)ethyl]sulfonyl][benzoic acid</td>
<td>$2.0 \times 10^{-8}$ to $1.0 \times 10^{-2}$</td>
<td>59.0 ± 1</td>
<td>2.5 – 8.7</td>
<td>$1.2 \times 10^{-8}$</td>
<td>-</td>
</tr>
<tr>
<td>[10]</td>
<td>Schiff base of [bis 5-(4-nitrophenylazo)salisyaldimine]1,8-diamino, 3,6-dioxy octan (BNSAO)</td>
<td>$1.9 \times 10^{-6}$ to $2.7 \times 10^{-2}$</td>
<td>56.2 ± 0.7</td>
<td>2.5 – 7.0</td>
<td>$7.8 \times 10^{-7}$</td>
<td>~5 s</td>
</tr>
</tbody>
</table>

This work 25,27-Di(benzothiazolyl)-26,28-hydroxycalix[4]arene (CU1) $1.0 \times 10^{-6}$ to $1.0 \times 10^{-2}$ 59.7 ± 1 2.5 – 8.0 $4.5 \times 10^{-7}$ 5 s

<sup>a</sup>conventional PVC membrane electrode. <sup>b</sup>solid contact PVC membrane electrode. <sup>c</sup>coated-wire PVC membrane electrode.

References


