La(III) ION SELECTIVE ELECTRODE WITH PTFE MEMBRANE CONTAINING TRIBUTYL PHOSPHATE IONOPHORE

by Beta Nur Pratiwi

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Writing Issues

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15	Comma misuse within clauses	
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words per sentence

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ABSTRACT

Methods for quantitative[4] determination of lanthanum that have been developed are generally spectroscopic method[5] such as inductively coupled plasma mass spectrometry (ICP-MS), inductively coupled plasma atomic emission spectrometry (ICP-AES), and X-ray fluorescence spectrometry, which have[6] relatively high operational costs. The feasibility of potentiometric[7] method using ion selective[8] electrode (ISE) as an alternative method for lanthanum (III) determination needs to be studied because it is simple, easy to use, and has high sensitivity and selectivity. In this study, we developed ion[9] selective[10] electrode using PTFE[11] membrane impregnated with tributyl phosphate (TBP) as ionophore. TBP is commonly used as complexing[12] agent for rare earth[13] ions in

supported liquid membrane (SLM) separation process. We found that the compound can be used as ionophore[14] for ISE.

This study aims to make lanthanum[15] ion selective[16] electrode (III) (La-ISE) which has Nernstian[17] response. The parameters studied in the construction of this electrode were the effects of PTFE membrane immersion ionophore solution, ionic strength adjuster (ISA) and[18] the inner solution composition. The performance parameters studied for the La-ISE were linear range, response time, detection limit, selectivity and[19] life[20] time[21] of the electrode.

Construction of the electrode begins with the preparation of PTFE[22] membrane as the main component. PTFE membrane was impregnated for 12 hours in TBP[23] solution having concentration[24] of 0.25 M or 0.50 M in kerosene. After it was dried, the membrane was attached to the end of electrode[25] tube with adhesive. Then, the electrode was filled with internal[26] solution containing mixture[27] of KCl 10-3 M with La (III) 10-3 M. The internal reference electrode was Ag/AgCl electrode. Before it was used, the electrode was soaked in a solution of La (III) 10-3 M for 12 hours.

The effect of TBP concentration on the electrode performance was studied using two concentrations of TBP: 0.25 M and 0.50 M. The calibration curves obtained using both electrodes has[28] good linearity. Nernst factor obtained from both electrodes are[29] similar, although the Nernst factor obtained with electrode[30] having 0.50 M TBP closer to the theoretical value.

ISA used in the measurement was KNO3. The effect of ISA on the performance of the electrode was studied using electrodes containing TBP with concentration [31] of 0.25 M or 0.50 M. The concentration of KNO3 used in this study was 0.01 M and 0.10 M. The Nernst factors obtained with electrodes containing 0.25 M TBP in general [32] higher than those obtained with electrodes containing 0.50 M TBP in the same ISA. Electrode containing 0.50 M TBP resulted in Nernst [33] factor close to theoretical value when measurement [34] was conducted in 0.10 M KNO3.

Keywords: Lanthanum, electrode selective ion, ionophore, tributyl phosphate (TBP)

Introduction

Lanthanum is one of rare earth elements is known as an important element of their nature, especially having a strong magnetic properties [35]. Lanthanum has received much attention electrochemically due to its applications in the hydrogen storage materials of batteries, ion selective [36] electrode, chemical sensor, electrocatalytic hydrogenation, and ion gate effect [1]. It's elements found in nature in the form of minerals such as monazite and xenotime. Monazite and xenotime are [37] minerals that contains [38] lots of rare earth metal element (REE') of the lanthanide group. These mineral [39] also found in Indonesia, but not yet processed and utilized optimally because of the mastery of monazite ore processing technology still needs to be improved and strengthened. REE' these elements, [40] are now widely used for the manufacture of goods innovative high-tech, such as permanent magnets, catalysts, fiber optics, optoelectronics, ceramics pizoelectric [41], rechargeable batteries, microwave equipment, etc., [42] so that now the element REE has regarded as one of the 21st century [2,3]. Lanthanides are very important metals in high [43] technology industry because of their unique electronic, optical, and magnetic properties, and therefore their demand has been increasing in recent year [44]. But the element of REE'[45] mostly have physical and have very fundamental chemical properties are similar, which makes it difficult hard splitting into each element. It is also the cause of rare earth metals such as lanthanides become expensive [4].

Currently, many researchers who give great attention to rare earth metals are widely applied in industry. Therefore, the required development of method[46] for the determination and recovery of rare earth metals. Determination method has been developed which includes conventional means such as chemical precipitation, reverse osmosis, adsorption, ion exchange and[47] solvent extraction, but many difficulties are found in a variety of methods [5].

For the purposes of monitoring[48] the treatment process, quality control, and REE' presence in a given material, required analytical methods that have high accuracy and selectivity, low detection limits, and high reproducibility. The method that considered to meet these criteria, among others, spectroscopic techniques such as inductively coupled plasma mass spectrometry (ICPMS), inductively coupled plasma atomic emission spectrometry (ICPAES)[49], and X-ray fluorescence spectrometry. Hence, the available methods for low-level determination of rare-earth ions in solution[50] include spectrophotometry, isotope dilutions mass spectrophotometry, neutron activation analysis, X-ray fluorescence spectrometry, etc [5]. However, many of these spectroscopic methods requires[51] a lot of time involving multiple samples and also expensive for most analytical laboratories [6]. Meanwhile, if using chromatographic methods require a long[52] sample preparation. Therefore, alternative methods are needed that meet the analytical criteria, simple in execution and[53] relatively inexpensive.

One method that has the potential of the electrode is the potentiometric method with membrane[54]. Potentiometric[55] method provides several advantages such as speed and ease of preparation and procedures, simple instrumentation, relatively fast response, very low detection limits, wide measurement range, an acceptable selectivity and[56] low cost. This will make the availability of micro-electrodes and electrodes for the determination of the required REE [7]. The quick determination of minute quantities of ionic species by simple methods has a great[57] importance in analytical chemistry. Potentiometric detection based on ion selective[58] electrodes (ISEs) is the simplest of all and offers unique advantages [8].Membranous[59,60] electrode has many types, and in this paper was chosen with reference to[61] the type of tube and the solution in as well as sensor ionophore required. Therefore, it is feasible[62] the development of methods to make sensors for lanthanide ions with high selectivity using the appropriate ionophore. Electrodes for the potentiometric determination can yield several benefits such as ease and speed of preparation and procedures, simple instrumentation, relatively fast response, wide measurement range and[63] low cost. Potentiometric detectors based-on ion selective[64] electrode are[65] specially[66] suited for fast, accurate, reproducible and[67] selective determination of various metal ions. Such potentiometric detectors offer advantages such as selectivity, sensitivity, good precision, simplicity and[68] so on. These methods allow direct on-line monitoring of concentration[69] of selected species without an pretreatment[70] [9]. Carrier-based ion selective[71] electrodes (ISEs) are used extensively for the direct selective detection of ionic species. For this type of electrode, the formation constant of the ion-ionophore complex within the membrane phase is very[72] important parameter that dictates the practical selectivity of the sensor. In the area of membrane based[73] ISEs, emphasis[74] has been focused on the development of new ionophore and on[75] the composition of the membrane phase, aiming at enhancing the potentiometric responses of the ISEs. Fabrication of a new, ion specific[76] ISE with high selectivity and sensitivity, wide linear concentration range, long lifetime, good reproducibility and[77] low cost, is always in need [5,6]. In this paper the compound organophosphates especially TBP will be studied or used as ionophore in membranes in selective electrodes ion. The principle of formation of the measured potential in both surface and transport based on this principle the same as that occurs in the extraction, while the TBP solvent extraction lanthanides have been performed and shown to occur transport from the aqueous phase to organic phase by using TBP. In addition[78], TBP has not been used as ionophore[79] in potentiometric systems. Hence, to study the character of the membrane on the electrode as a potentiometric sensor, needed characterization, membrane potential, response time, sensitivity, selectivity towards the primary ion and ion bullies are less than 10-3, age (lifetime) is relatively long and has a design size can be miniaturized.

The main objective of this work is to introduce a selective and sensitive electrode for lanthanum, for the potentiometric monitoring of trace amount of La3+, by using TBP as ionophore. In spite of[80] ion selective[81] electrode based on ionophore[82] ligand are well established for many widespread activities in the field of ion selective[83] electrodes during the last two decades, however[84] there is no report previously in the literature TBP as ionophore and its applications for measurement ion La3+.

Experimental

Equipment

All potentiometric measurement[85] were made at 25±1oC with Ohmeter[86] instrument pH/mV meter. The glass cell, where the La3+ ion selective[87] electrode was placed, and a double junction saturated calomel electrode (SCE) was used as internal[88] reference electrode.

Chemicals and solutions

Tri butyl [89] phosphate were [90] obtained from Sigma Aldrich. Kerosene from sigma Aldrich, PTFE (Advantec, Japan) with pore size 0,45 μm and 0,2 μm. All other reagents used were of analytical grade and the solutions were prepared in doubly distilled water.

1.3 Membrane and Electrode Preparation

The method reported by [8,9,10] was adopted for the fabrication of membranes. Membrane prepared in Impregnated [91] Liquid membrane (ILM). Impregnated Liquid membranes used for prepared ESI-La, with Teflon, length 10 cm, and 1,5 diameter. PTFE (Advantec, Japan) with pore size 0,45 μm pore and 0,2 μm pore (impregnated in TBP), immersed for 12 and 24 hours respectively. The saturated calomel electrode and the inner solution (a mixture of 10-3 M KCl and 10-3 M La3+) was set in the tube and connected to coaxial cable. The electrode was conditioned before potentiometric measurement by immersing it into 10-3 [92] M La(III) solution for 12 and 24 hours. A number of [93] membranes of different compositions were prepared and only those which gave reproducible and stable potentials were selected for further studies.

In this study, the electrode was made and prepared in each different conditions [9 (Membrane thickness, concentration [95] of ionophore TBP, concentration [96] of ionic strength adjuster (ISA), Impregnation time, Influence of pH, Life time [97], limit detection). The potential response of all the three electrode [98] [99,100] using PTFE membrane 0,45 μm pore size with TBP in kerosene was investigated by varying the concentration of the test solution from 1.0×10-1 - 1.0×10-6 [10].

1.4 Potential Measurement

The potential measurements of the solutions, prepared in[101] the concentration range 1.0×10-1 - 1.0×10-6 M La3+ ions, were carried out at 25±1 oC with a Metrohm instrument pH/Ion meter. Saturated calomel electrode were[102] employed as reference electrodes and potential were measured by setting up the following assembly:

Internal[103] Reference electrode (SCE) internal solutions Membrane Test Solutions External reference electrode

Result And Discussion

2.1 Working Concentration Range and Slope

Figure 1. The Calibration curve of the La[104](III) membrane electrode based on TBP

2.2 The Effect of pH on the Potential Response

The effect of pH on the potential response of the electrode was studied at different concentration[105], Standard of 10-1, 10-2, 10-3 ,[106] 10-4, 10-5M over the pH range 1-10. A series of solutions of La3+ with pH ranging from 1 to 10 were prepared by adding H2SO4 and NaOH solutions. Solution potentials were measured by the cell system. pH dependence of the membrane electrode was investigated at series[107] of standard 10-1, 10-2, 10-3 ,[108] 10-4, 10-5M La3+

concentration in the pH range 1-10 by adjusting the pH solution with H2SO4 and NaOH. It was observed that the potential remains constant in the pH range relatively 4-5 and the same was taken as the working pH range of the electrodes. These results indicating the applicability of this electrode in the specific pH range were relatively the same as those reported by other researchers, stating that pH was kept constant at 3-8 [6,7]. On the contrary, relatively noteworthy fluctuations in the potential regarding pH behaviour [109] took place below and above the formerly stated pH limit. The fluctuation above the pH value of 6 might be justified by the formation of soluble and insoluble La3+ ion hydroxyl complexes in the solution. Hence, the fluctuations below the pH value of 3were attributed to the partial protonation of the employed ionophore [4]. Considering that deprotonation of the complexes of chelating reagent is one of key [110] processes for the complex formation. The pH of a sample solutions [111] seem to strongly affect the potentiometric responses. Therefore, influent of protonation and deprotonation complex formation were [112] measured by investigated the pH dependence of the potentiometric responses to the lanthanoid ion.

Figure 2. Effect of pH on Potential response of ISE-La(III)

The figure [113] 2 above explained correlation [114] between potentiometric response and pH suggest that the potentiometric responses observed with the membrane to the metal ion are induced by the formation of complexes. A typical potential versus pH curve, increasing solution of pH, potential relatively stable and close to Nernstian slope is 19 mV per decade., was observed from pH ≈ 7 to 2 both

10-2 or 10-4 concentration. This pH response suggested that TBP impregnated membrane PTFE at the membrane interface successively protonate with increasing the H+ concentration of the solution.

2.3 The study of sensor properties

The properties of an ion-selective electrode are characterized by parameters like these: measuring range, detection limit, response time.

2.3.1 Detection limit and Measuring range

Range measurements, the linear range of the electrode is defined as part of the calibration curve by linear regression which indicates that the data points do not deviate from linearity by more than 2 mV. Range measurements on an ion selective[115] electrode (ISE) including the linear part of the calibration curve. Detection limits and measurement ranges are determined from the graph of the relationship between potential and La3+ ion concentration. Potentiometric[116] sensor is indicated by the magnitude / value[117] of the membrane potential measured in the analyte. The smaller the concentration of the analyte that can be detected by following Nernst's law, the lower the electrode detection limit [9]. Therefore, the magnitude of detection can be determined through sloping straight line intersections that are still Nernstian and horizontally which are no longer Nernstian [3,5,9,13] as shown in Figure 21 below:

Figure 3. Graph for ESI-La detection limit

Limits of detection is[118] determined from the graph the[119] relationship between the potential and the concentration of ions La. Based on the graph, it can be determined the limit of detection by the oblique intersection of straight lines and flat. The limit of detection, as determined from the intersection of the two extrapolated segments of the calibration graph, was 3.98 × 10-7 M.

2.3.2 Response time

Dynamic response time is an important factor for an ion selective[120] electrode [1,6]. In this study, the practical response time was recorded by changing solution with different La(III) concentration from 9.9 × 10-6 - 2.06 × 10-4 M. The response time of an electrode is evaluated by measuring the average time required to achieve a potential within ± 0.1 mV of the final steady-state potential. The response time of the microelectrode was found to be about 27,7 seconds in the whole concentrations.

The ability of electrodes to respond to analytes is determined by the presence of ionophores or active ingredients present in the PTFE membrane. The more sensitive the active ingredient or ionophore to the analyte, the electrode will respond faster. The faster the electrode gives a constant potential response, the better the electrode. To study the ability of ESI-La to respond to La3 + ions, the response time of 4 ESI-La electrodes is measured at various concentrations. Furthermore, response time data can be seen in the following table:

Table 1 Response time data (seconds) of 4 electrodes.

La(III) [M]

Response time of electrode (seconds)

Average (second)

1

2

3

4

10-5

24

29

28

20

25,3

10-4

29

29

28

28

28,5

10-3

28

28

29

28

28,3

10-2

27

27

28

30

28,0

10-1

29

30

27

27

28,3

Average (seconds)

26,8

28,6

28

26,6

27,7

The table above is based on the measurement of the potential of each electrode used to measure the potential of a La3+ solution at various concentrations. Potential [121] was observed since the electrode was dipped in a solution for up to 300 seconds. The average electrode response time at various concentrations was 27.7 seconds.

2.3.3 Selectivity of electrodes

Selectivity is an important factor for ESI-La electrodes. According to [5,6,13], the selectivity of ion selective [122] electrodes is related to the complex stability between ions and ionophores. Therefore, ESI-La is expected to only respond to La3+ ions in solution and not respond to other ions. To see the effect of other ions on ESI-La, the electrode potential is measured in the presence of other ions. The presence of other ions studied were alkaline earth ions (Ca2+), ion group transition elements (Fe3+, Pb2+), lanthanide group ions (Ce3+ and Nd3+).

Table 2 The electrode selectivity constant for several other ions

Mn+	KA,Bpot	Log K
Ca2+	1,17 × 10-2	-2,6
Pb2+	4,57 × 10-3	-1,93
Fe3+	1,65 × 10-2	-2,34
Nd3+	1,2 × 10-1	-1,78
Ce3+	4,3 × 10-1	-0,92
La3+	1	0

Based on the selectivity constant in the table above it appears that the presence of Pb2+ ions is relatively unobtrusive because the KA,Bpotvalue[123] is very small (reaching hundreds of times less than the response to La3+ ions). Hence, the presence of Ca2+ and Fe3+ ions gives relatively little interference so it is not significantly disturbing. Meanwhile, the ions in one group compared in this study were only Ce3+ ions and Nd3+ ions did not significantly interfere with the measurement of La3+ ions, although the selectivity of Ce3+ and Nd3+ ions was only around the unit times smaller than La3+ ions.

2.3.4 Life time[124] of electrodes

The life time[125] of the electrodes is tested by measuring the potential of a number of[126] standard solutions, to obtain the slope of a curve that follows Nernst's law. The slope of the curve that no longer follows Nernst's law shows that the electrode has changed its ability to respond to the analyte. Therefore, to see the ability of the electrodes, the use of electrodes at various ages is 1, 3, 5, 7, 14 to 105 days (15 weeks). In each measurement, the slope of the curve is calculated as stated in the relationship graph between the magnitude of the slope of the electrode curve as a function of time.

Figure 4. Changes to the slope of the age range
1 to 105 days

The figure above shows a relatively constant curve slope (about 19 mV/decade) until the measurement time for 60 days, after which the slope of the curve begins to decline and at the age of 3 months electrodes, the slope of the curve is relatively small (14 mV / decade)[127]. With the slope of this smaller curve, the electrodes have decreased capability, which means their sensitivity decreases

Conclusions

In summary, potentiometric selectivity of polymer-membrane electrodes based on lanthanum is one of method[128] used as quantitative analysis of rare earth elements which are considered as the standard method that has a high[129] accuracy, fast response time, and low detection limits. Hence, electrode[130] was prepared by PTFE impregnated membrane in TBP. The Selectivity of ISE-La showed that electrode[131] didn't respond to alkaline elements and transition element[132] but still respond to lanthanide elements such as Ce3+ and Nd3+.

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Reference to a book:

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1.	, a	Improper Formatting	Correctness
2.	, Faculty	Improper Formatting	Correctness
3.	, UIN	Improper Formatting	Correctness
4.	the quantitative	Determiner Use (a/an/the/this, etc.)	Correctness
5.	~~method~~ → methods	Incorrect Noun Number	Correctness
6.	~~have~~ → has	Faulty Subject-Verb Agreement	Correctness
7.	the potentiometric	Determiner Use (a/an/the/this, etc.)	Correctness
8.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
9.	an ion	Determiner Use (a/an/the/this, etc.)	Correctness
10.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
11.	the PTFE	Determiner Use (a/an/the/this, etc.)	Correctness
12.	a complexing	Determiner Use (a/an/the/this, etc.)	Correctness
13.	~~rare earth~~ → rare-earth	Misspelled Words	Correctness
14.	an ionophore	Determiner Use (a/an/the/this, etc.)	Correctness
15.	a lanthanum	Determiner Use (a/an/the/this, etc.)	Correctness
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17.	a Nernstian	Determiner Use (a/an/the/this, etc.)	Correctness

18.	, and	Comma Misuse within Clauses	Correctness
19.	, and	Comma Misuse within Clauses	Correctness
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23.	the TBP	Determiner Use (a/an/the/this, etc.)	Correctness
24.	a concentration	Determiner Use (a/an/the/this, etc.)	Correctness
25.	the electrode	Determiner Use (a/an/the/this, etc.)	Correctness
26.	an internal	Determiner Use (a/an/the/this, etc.)	Correctness
27.	a mixture	Determiner Use (a/an/the/this, etc.)	Correctness
28.	~~has~~ → have	Faulty Subject-Verb Agreement	Correctness
29.	~~are~~ → is	Faulty Subject-Verb Agreement	Correctness
30.	an electrode	Determiner Use (a/an/the/this, etc.)	Correctness
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32.	, in general,	Comma Misuse within Clauses	Correctness
33.	the Nernst	Determiner Use (a/an/the/this, etc.)	Correctness
34.	the measurement, or a measurement	Determiner Use (a/an/the/this,	Correctness

		etc.)	
35.	strong magnetic properties, a strong magnetic property	Determiner Use (a/an/the/this, etc.)	Correctness
36.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
37.	~~xenotime are~~ → xenotime are	Improper Formatting	Correctness
38.	~~contains~~ → contain	Faulty Subject-Verb Agreement	Correctness
39.	~~These mineral~~ → This mineral, These minerals	Determiner Use (a/an/the/this, etc.)	Correctness
40.	elements,	Comma Misuse within Clauses	Correctness
41.	~~pizoelectric~~ → piezoelectric	Misspelled Words	Correctness
42.	etc.,	Punctuation in Compound/Complex Sentences	Correctness
43.	the high	Determiner Use (a/an/the/this, etc.)	Correctness
44.	~~year~~ → years	Incorrect Noun Number	Correctness
45.	~~REE'~~ → REE's	Incorrect Noun Number	Correctness
46.	a method, or the method	Determiner Use (a/an/the/this, etc.)	Correctness
47.	, and	Comma Misuse within Clauses	Correctness
48.	To monitor	Wordy Sentences	Clarity
49.	~~ICPAES~~ → ICP-AES	Misspelled Words	Correctness
50.	the solution	Determiner Use (a/an/the/this, etc.)	Correctness
51.	~~requires~~ → require	Faulty Subject-Verb Agreement	Correctness

52.	~~a~~ long	Determiner Use (a/an/the/this, etc.)	Correctness
53.	, and	Comma Misuse within Clauses	Correctness
54.	the membrane	Determiner Use (a/an/the/this, etc.)	Correctness
55.	The potentiometric	Determiner Use (a/an/the/this, etc.)	Correctness
56.	, and	Comma Misuse within Clauses	Correctness
57.	~~a~~ great	Determiner Use (a/an/the/this, etc.)	Correctness
58.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
59.	. Membranous	Improper Formatting	Correctness
60.	The membranous	Determiner Use (a/an/the/this, etc.)	Correctness
61.	~~with reference to~~ → concerning, regarding, about	Wordy Sentences	Clarity
62.	feasible for	Wrong or Missing Prepositions	Correctness
63.	, and	Comma Misuse within Clauses	Correctness
64.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
65.	~~are~~ → is	Faulty Subject-Verb Agreement	Correctness
66.	~~specially~~ → especially	Commonly Confused Words	Correctness
67.	, and	Comma Misuse within Clauses	Correctness
68.	, and	Comma Misuse within Clauses	Correctness
69.	the concentration	Determiner Use (a/an/the/this, etc.)	Correctness

70.	~~an~~ pretreatment	Determiner Use (a/an/the/this, etc.)	Correctness
71.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
72.	a very	Determiner Use (a/an/the/this, etc.)	Correctness
73.	~~membrane based~~ → membrane-based	Misspelled Words	Correctness
74.	the emphasis	Determiner Use (a/an/the/this, etc.)	Correctness
75.	~~on~~	Wordy Sentences	Clarity
76.	~~ion specific~~ → ion-specific	Misspelled Words	Correctness
77.	, and	Comma Misuse within Clauses	Correctness
78.	~~In addition~~ → Also, Besides	Wordy Sentences	Clarity
79.	an ionophore	Determiner Use (a/an/the/this, etc.)	Correctness
80.	~~In spite of~~ → Despite	Wordy Sentences	Clarity
81.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
82.	ionophore,	Comma Misuse within Clauses	Correctness
83.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
84.	however,	Comma Misuse within Clauses	Correctness
85.	~~measurement~~ → measurements	Incorrect Noun Number	Correctness
86.	~~Ohmeter~~ → Ohmmeter	Misspelled Words	Correctness
87.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
88.			

	an internal	Determiner Use (a/an/the/this, etc.)	Correctness
89.	~~Tri butyl~~ → Tributyl	Confused Words	Correctness
90.	~~were~~ → was	Faulty Subject-Verb Agreement	Correctness
91.	the Impregnated, or an Impregnated	Determiner Use (a/an/the/this, etc.)	Correctness
92.	a 10-3	Determiner Use (a/an/the/this, etc.)	Correctness
93.	~~A number of~~ → Several, Some, Many	Wordy Sentences	Clarity
94.	~~conditions~~ → condition	Incorrect Noun Number	Correctness
95.	the concentration	Determiner Use (a/an/the/this, etc.)	Correctness
96.	the concentration	Determiner Use (a/an/the/this, etc.)	Correctness
97.	~~Life time~~ → Lifetime	Confused Words	Correctness
98.	~~the~~ three	Determiner Use (a/an/the/this, etc.)	Correctness
99.	~~three electrode~~ → three-electrode	Misspelled Words	Correctness
100.	~~electrode~~ → electrodes	Incorrect Noun Number	Correctness
101.	~~prepared in~~ → prepared in	Improper Formatting	Correctness
102.	~~were~~ → was	Faulty Subject-Verb Agreement	Correctness
103.	The internal	Determiner Use (a/an/the/this, etc.)	Correctness
104.	~~the~~ La	Determiner Use (a/an/the/this, etc.)	Correctness
105.	~~concentration~~ → concentrations	Incorrect Noun Number	Correctness

106.	10-3 ,	Improper Formatting	Correctness
107.	a series	Determiner Use (a/an/the/this, etc.)	Correctness
108.	10-3 ,	Improper Formatting	Correctness
109.	~~behaviour~~ → behavior	Mixed Dialects of English	Correctness
110.	the key	Determiner Use (a/an/the/this, etc.)	Correctness
111.	sample solutions, a sample solution	Determiner Use (a/an/the/this, etc.)	Correctness
112.	~~were~~ → was	Faulty Subject-Verb Agreement	Correctness
113.	~~The~~ figure	Determiner Use (a/an/the/this, etc.)	Correctness
114.	the correlation	Determiner Use (a/an/the/this, etc.)	Correctness
115.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
116.	The potentiometric	Determiner Use (a/an/the/this, etc.)	Correctness
117.	magnitude/value	Improper Formatting	Correctness
118.	~~is~~ → are	Faulty Subject-Verb Agreement	Correctness
119.	of the	Wrong or Missing Prepositions	Correctness
120.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
121.	The potential	Determiner Use (a/an/the/this, etc.)	Correctness
122.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness

123.	, Bpotvalue	Improper Formatting	Correctness
124.	~~Life time~~ → Lifetime	Confused Words	Correctness
125.	~~life time~~ → lifetime	Confused Words	Correctness
126.	~~a number of~~ → several, some, many	Wordy Sentences	Clarity
127.	~~mV / decade~~ → mV/decade	Improper Formatting	Correctness
128.	the method	Determiner Use (a/an/the/this, etc.)	Correctness
129.	~~a~~ high	Determiner Use (a/an/the/this, etc.)	Correctness
130.	the electrode	Determiner Use (a/an/the/this, etc.)	Correctness
131.	the electrode	Determiner Use (a/an/the/this, etc.)	Correctness
132.	~~element~~ → elements	Incorrect Noun Number	Correctness
133.	~~I'MHERE~~ → I'M HERE	Misspelled Words	Correctness
134.	, and	Comma Misuse within Clauses	Correctness
135.	~~yuan~~ → Yuan	Misspelled Words	Correctness
136.	~~chemistry~~ → Chemistry	Misspelled Words	Correctness
137.	~~chlozapine~~ → clozapine, chlorine	Misspelled Words	Correctness
138.	solvent extraction	Improper Formatting	Correctness
139.	~~diglycol~~ → glycol	Misspelled Words	Correctness
140.	a neutral	Determiner Use (a/an/the/this, etc.)	Correctness
141.	, and	Improper Formatting	Correctness

142.	, H.K	Improper Formatting	Correctness
143.	~~dicyclohexano~~ → cyclohexanol, cyclohexane	Misspelled Words	Correctness
144.	~~sensor for~~ → sensor for	Improper Formatting	Correctness
145.	~~Preapartions~~ → Preparations	Misspelled Words	Correctness
146.	, and	Comma Misuse within Clauses	Correctness
147.	*tert*	Unknown Words	Correctness
148.	~~Sciff's~~ → Schiff's	Misspelled Words	Correctness
149.	~~chimica~~ → Chimica	Misspelled Words	Correctness
150.	~~acta~~ → Acta	Misspelled Words	Correctness
151.	sensors are, or sensors were	Incorrect Verb Forms	Correctness
152.	~~vanadyl ions~~ → vanadyl ions	Improper Formatting	Correctness
153.	~~Lanthanoid ion~~ → Lanthanoid ion	Improper Formatting	Correctness
154.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
155.	~~ion selective~~ → ion-selective	Misspelled Words	Correctness
156.	~~a~~ membrane	Determiner Use (a/an/the/this, etc.)	Correctness
157.	~~Elsivier~~ → Elsevier	Misspelled Words	Correctness