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Supplementary Materials

Evaluation of Uniform and Localized Corrosion Behaviour of Aluminum Alloy 1050 as Al/AgO Battery Anode in 6.0 M KOH in the Presence of an Organosulfur Inhibitor

Hamed Pourfarzad,[1,2,*] and Mohammad Peirow Asfia[3]

[1]*Center of Excellence in Electrochemistry, University of Tehran, Tehran, Iran*
[2]*Department of Analytical Chemistry, University of Kashan, Kashan, P.O. Box 15875-4413, Iran*
[3]*Department of Materials and Metallurgical Engineering, Amirkabir University of Technology (Tehran Polytechnic), Hafez Ave., P.O. Box 15875–4413, Tehran, Iran*

*Corresponding Author, Tel.: +989100998568
E-Mail: h.pourfarzad2030@gmail.com

Table S1. The results of the immersion test of aluminum 1050 samples in 6.0 M potassium hydroxide environment in the presence of different concentrations of thiourea as a corrosion inhibitor at temperatures of a) 5°C, b) 25°C, c) 65°C for two weeks of immersion time

	5°C		25°C		65°C	
Concentration of inhibitor	C.R (mpy)	η	C.R (mpy)	η	C.R (mpy)	η
0	472.5	---	5122.5	---	6366.9	---
2	393.5	16.72	8.3388	33.84	0.5308	16.63
4	354.4	25.00	.43045	40.55	5.5218	18.04
6	334.6	29.18	9.3015	41.12	.15168	18.83
8	297.7	37.00	.03030	40.85	3.5158	18.98
10	292.9	38.01	.63070	40.06	.95142	19.23

Table S2. The results of the immersion test of aluminum 1050 samples in 6.0 M potassium hydroxide environment in the presence of different concentrations of ZnO as a corrosion inhibitor at temperatures of a) 5°C, b) 25°C, c) 65°C for two weeks of immersion time

	5°C		25°C		65°C	
Concentration of inhibitor	C.R (mpy)	η	C.R (mpy)	η	C.R (mpy)	η
0	.5472	---	5.5122	---	9.6366	---
2	5.298	79.36	3.3456	53.32	4.5585	27.12
4	96.0	79.68	8.2775	81.45	1.4426	48.30
6	94.1	80.07	5.2508	03.51	6.4115	36.35
8	71.8	84.81	2.2494	31.51	3.3618	17.43
10	58.0	87.73	6.2480	58.51	4.3563	03.44

Table S3. Polarization parameter of aluminum alloy 1050 in aerated 6.0 M potassium hydroxide solution in the presence of the thiourea as an organic inhibitor and ZnO as inhibitor after 48 hours of immersion time, obtained from polarization plots

Thiourea							
Concentration of inhibitor	E (mV)	I_{corr} (A/cm^2)	β_a (V/dec)	$-\beta_c$ (V/dec)	R_p(Ω.cm^2)	C.R (mpy)	η
0	-1631	$^{2}\times10^{-}$1.08	177.0	133.0	3.10	.94638	---
2	-1686	$^{3}\times10^{-}$6.44	0.141	0.110	4.16	8.2763	40.42
4	-1693	$^{3}\times10^{-}$6.38	0.140	0.107	4.13	0.2738	40.98
6	-1686	$^{3}\times10^{-}$6.28	0.140	0.115	4.36	3.2695	41.90
8	-1689	$^{3}\times10^{-}$6.21	0.138	0.111	4.30	6.2661	42.62
10	-1686	$^{3}\times10^{-}$6.14	0.137	0.113	4.38	5.2631	43.27
ZnO							
Concentration of inhibitor	E (mV)	I_{corr} (A/cm^2)	β_a (V/dec)	$-\beta_c$ (V/dec)	R_p(Ω.cm^2)	C.R (mpy)	η
0	-1631	$^{2}\times10^{-}$1.08	177.0	133.0	3.10	9.4638	---
2	-1619	$^{3}\times10^{-}$9.68	187.0	133.0	3.50	8.4153	46.10
4	-1627	$^{3}\times10^{-}$8.15	174.0	142.0	4.20	5.3493	69.24
6	-1613	$^{3}\times10^{-}$6.06	138.0	109.0	4.40	4.2597	01.44
8	-1633	$^{3}\times10^{-}$5.74	127.0	0.120	4.70	6.2462	46.91
10	-1597	$^{3}\times10^{-}$5.42	117.0	0.119	4.80	5.2324	49.89

Table S4. EIS parameter during corrosion of aluminum alloy 1050 in aerated 6.0 M KOH solution in the presence of the inhibitors after 48 hours of immersion, estimated by fitted with the proposed equivalent circuits

Thiourea											
Concentration of inhibitor	R_s ($\Omega.cm^2$)	CPE		R_{ct1} ($\Omega.cm^2$)	L1	R1	CPE		R_{ct2} ($\Omega.cm^2$)	R_p ($\Omega.cm2$)	η
		Y_0					Y_0	n			
0	1.81	75 $\times^{5-}$10.6	1	1.02	004693.0	94.4	07818.0	1	0.300	14.1	---
2	1.82	93 $\times^{5-}$10.5	0.9799	1.73	01342.0	78.10	06134.0	1	59.0	082.	01.45
4	1.83	87 $\times^{5-}$105.	0.9784	1.79	01478.0	07.11	05832.0	1	61.0	152.	72.46
6	1.84	$\times^{5-}$10.435	0.9778	1.83	01675.0	45.11	05643.0	1	63.0	21.2	17.48
8	1.85	$\times^{5-}$10.245	0.9745	1.90	01765.0	87.11	05344.0	1	65.0	29.2	99.49
10	1.86	$\times^{5-}$10.105	0.9722	1.97	01944.0	74.12	05166.0	1	67.0	.382	83.51
ZnO											
Concentration of inhibitor	R_s ($\Omega.cm^2$)	CPE		R_{ct1} ($\Omega.cm^2$)	L1	R1	CPE		R_{ct2} ($\Omega.cm^2$)	R_p ($\Omega.cm2$)	η
		Y_0					Y_0	n			
0	1.81	75 $\times^{5-}$10.6	1	02.1	004693.0	.944	07818.0	1	0.300	15.1	---
2	801.	93 $\times^{4-}$107.	7838.0	04.1	243.2	24.13	392.0	681.0	18.2	15.3	57.63
4	781.	^{3}87 $\times10^{-}$1.	5465.0	08.1	287.4	37.23	932.0	498.0	96.2	00.4	33.71
6	1.73	$\times^{3-}$10.434	5378.0	10.1	9984.	88.29	974.0	.4320	98.3	05.5	29.77
8	1.72	$\times^{3-}$106.24	5354.0	12.1	064.5	.1131	006.1	0.402	.124	21.5	97.77
10	1.70	^{2} $\times10^{-}$1.05	5177.0	13.1	764.5	41.34	127.1	0.398	.414	51.5	17.79

					10g.lit $^{-1}$ conc of Thiourea + various concs of ZnO						
Concentration of inhibitor	R_s (Ω.cm^2)	CPE		R_{ct1} (Ω.cm^2)	L1	R1	CPE		R_{ct2} (Ω.cm^2)	R_p (Ω.cm2)	η
		Y_0					Y_0	n			
0	1.810	75×5-10.6	1	02.1	004693.0	94.4	07818.0	1	0.30	1.15	---
2	889.1	4×10-2.89	9799.0	69.1	0847.0	69.9	06207.0	6989.0	98.1	42.3	48.66
4	887.1	4×10-3.05	9784.0	92.1	09023.0	11.10	05898.0	6895.0	3.24	84.4	34.76
6	886.1	4×10-3.21	9778.0	19.2	0967.0	47.11	05431.0	6836.0	5.98	82.7	33.85
8	884.1	4×10-3.51	9698.0	34.2	1046.0	53.12	04412.0	6527.0	6.55	62.8	69.86
10	881.1	4×10-3.42	9711.0	26.2	1002.0	34.12	04643.0	6672.0	6.44	35.8	26.86

Table S5. The surface coverage percentage obtained from impedance and polarization tests and the free energy of absorption calculated from the Langmuir isotherm diagram in the presence of 10 g/l zinc oxide and different concentrations of thiourea as an inhibitor

EIS		**Polarization**		
$\mathbf{G^0_{ads}\Delta}$	**θ**	$\mathbf{G^0_{ads}\Delta}$	**θ**	**Concs**
	80.44		52.82	2
	88.56		62.10	4
-16.947	89.71	-16.177	62.02	6
	90.22		64.57	8
	90.47		64.76	10

Table S6. The surface coverage percentage obtained from impedance and polarization tests and the free energy of absorption calculated from the Langmuir isotherm diagram in the presence of zinc oxide as an inhibitor

EIS		**Polarization**		**Immersion**		
$\mathbf{G^0_{ads}\Delta}$	**θ**	$\mathbf{G^0_{ads}\Delta}$	**θ**	$\mathbf{G^0_{ads}\Delta}$	**θ**	**Concs**
	63.57		10.46		32.53	2
	71.33		24.69		45.81	4
-16.704	77.29	-15.950	44.01	-15.844	51.03	6
	77.97		46.91		51.31	8
	79.17		49.89		51.58	10

Table S7. The surface coverage percentage obtained from impedance and polarization tests and the free energy of absorption calculated from the Langmuir isotherm diagram in the presence of Thiourea as an inhibitor

EIS		Polarization		Immersion		
$G^0_{ads}\Delta$	θ	$G^0_{ads}\Delta$	θ	$G^0_{ads}\Delta$	θ	Concs
	45.01		40.42		33.84	2
	46.72		40.98		40.55	4
-17.090	48.17	-18.464	41.90	-18.220	41.12	6
	49.99		42.62		40.85	8
	51.83		43.27		40.06	10

Table S8. The surface coverage percentage obtained from impedance and polarization tests and the free energy of absorption calculated from the Langmuir isotherm diagram in the presence of 10 g/l Thiourea and different concentrations of zinc oxide as an inhibitor

EIS		Polarization		
$G^0_{ads}\Delta$	θ	$G^0_{ads}\Delta$	θ	Concs
	66.48		37.41	2
	76.34		43.81	4
-16.970	85.33	-16.503	51.05	6
	86.69		66.31	8
	86.26		60.10	10

Table S9. EDS results of aluminum alloy 1050 as anode for Al/AgO battery in the KOH solution in the absence and presence of the inhibitors

K	Zn	O	Al	C	Inhibitor
--	--	--	100	--	-----
--	--	18.99	71.76	9.24	Thiourea
2.18	39.94	42.96	8.07	6.84	ZnO
4.43	52.97	32.54	2.60	7.46	Thiourea/ZnO

Table S10. The results of the XRD test of the surface of aluminum alloy 1050 after 48 hours of immersion in 6.0 M KOH solution in the absence of inhibitor and in the presence of thiourea and zinc oxide simultaneously as inhibitors

$Al(HSO_4)_3$	$SC(NH_2)_2$	ZnO	Zn	Al	Inhibitor
--	--	--	--	100	-----
7	19	18	38	18	Thiourea/ZnO

Table S11. Anodic efficiency and specific capacity of the aluminum alloy 1050 in the presence of the Thiourea/ZnO inhibitor in KOH solution resulted from the galvanostatic discharge test at the current density of 50 $mA.cm^{-2}$

Inhibitor	Anode efficiency (%)	Specific Capacity ($mAh.g^{-1}$)
Absence	71.23	2116.6
Presence	90.19	2906.8

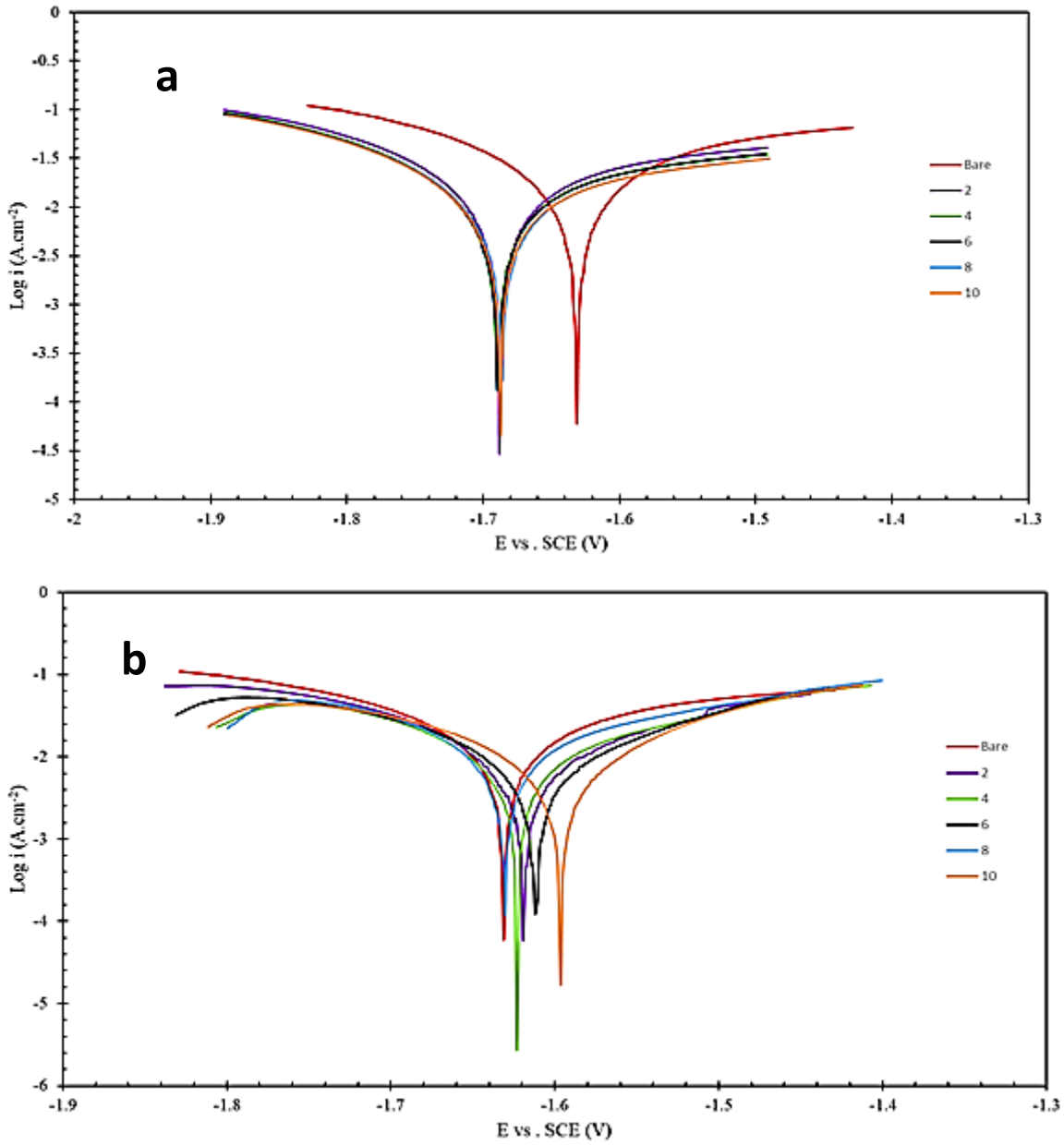

Figure S1. The Tafel plots were obtained from the polarization test of aluminum alloy 1050 in the environment of 6.0 M potassium hydroxide in the presence of a) thiourea and b) zinc oxide as a corrosion inhibitor.

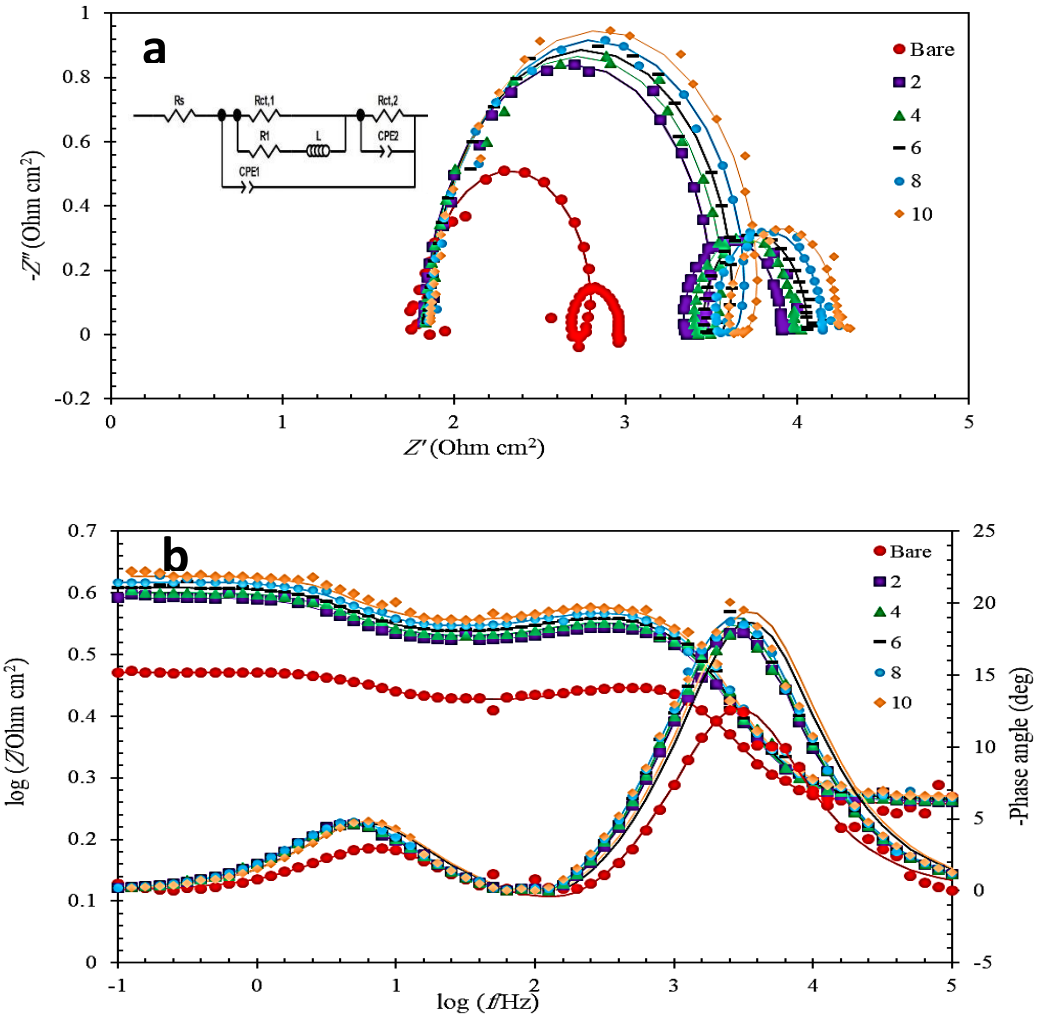

Figure S2. a) Nyquist and b) bode plots, resulting from the electrochemical impedance test of aluminum alloy 1050 in 6.0 M potassium hydroxide environment in the presence of different concentrations of thiourea as a corrosion inhibitor and its equivalent circuit

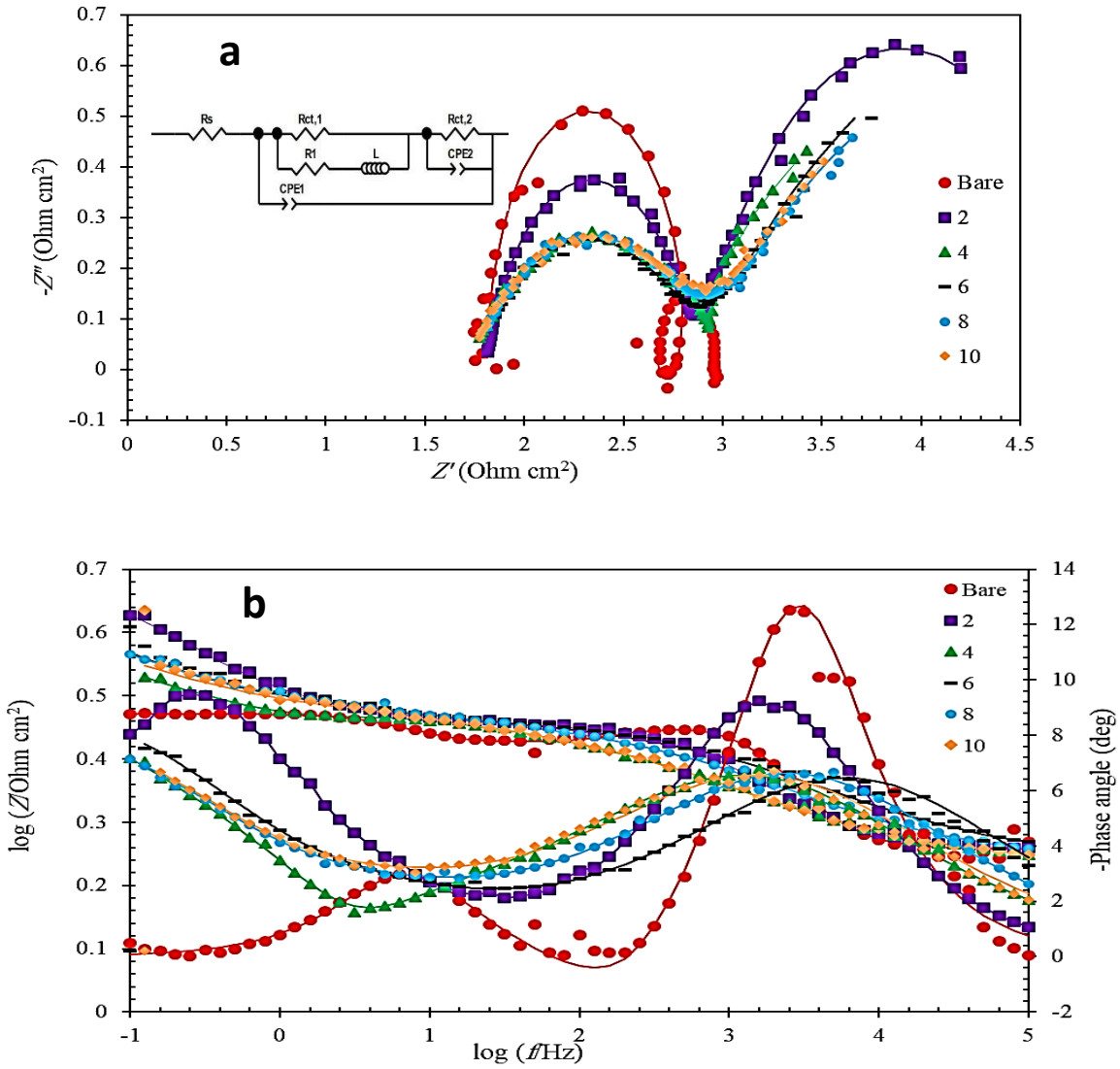

Figure S3. a) Nyquist and b) bode plots, resulting from the electrochemical impedance test of aluminum alloy 1050 in 6.0 M potassium hydroxide environment in the presence of different concentrations of ZnO as a corrosion inhibitor and its equivalent circuit

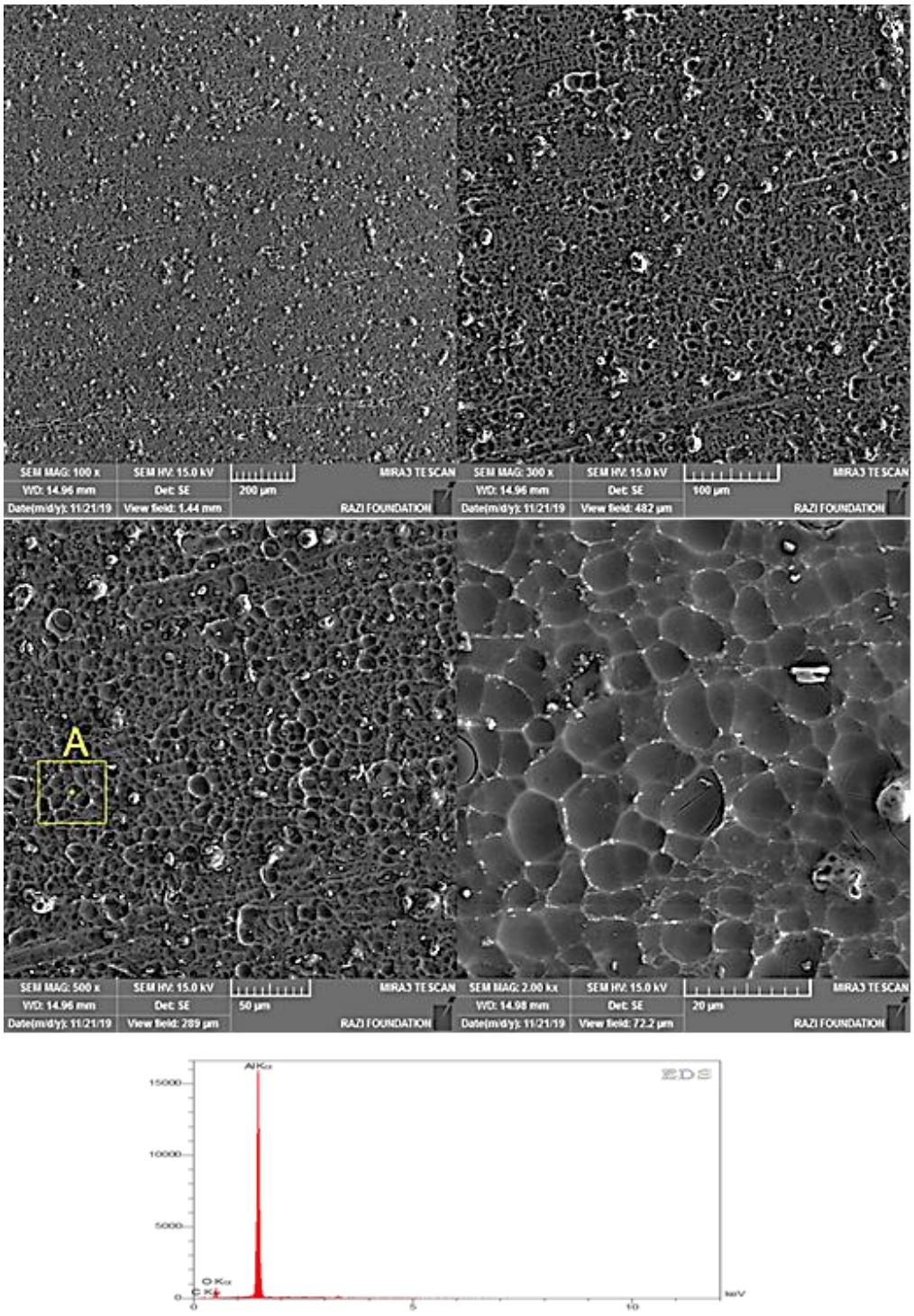

Figure S4. SEM images of the surface of the 1050 aluminum alloy sample after corrosion in 6.0 M potassium hydroxide environment for 48 hours in the presence of thiourea inhibitor in the following magnifications: a) 100, b) 300, c) 500, d) 2000, and the obtained graph from the EDS spectrum

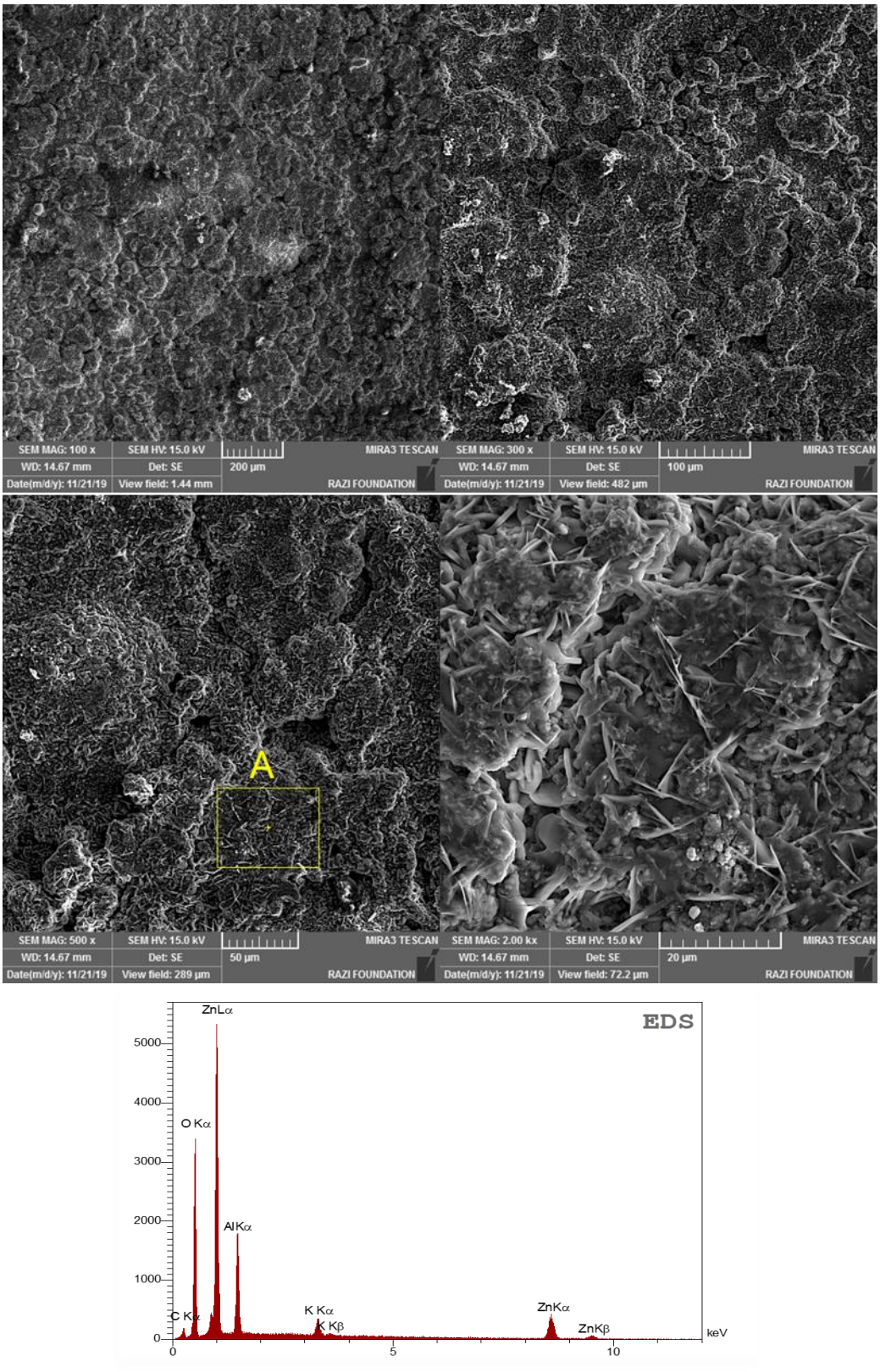

Figure S5. SEM images of the surface of the 1050 aluminum alloy sample after corrosion in 6.0 M potassium hydroxide environment for 48 hours in the presence of ZnO inhibitor in the following magnifications: a) 100, b) 300, c) 500, d) 2000, and the obtained graph from the EDS spectrum

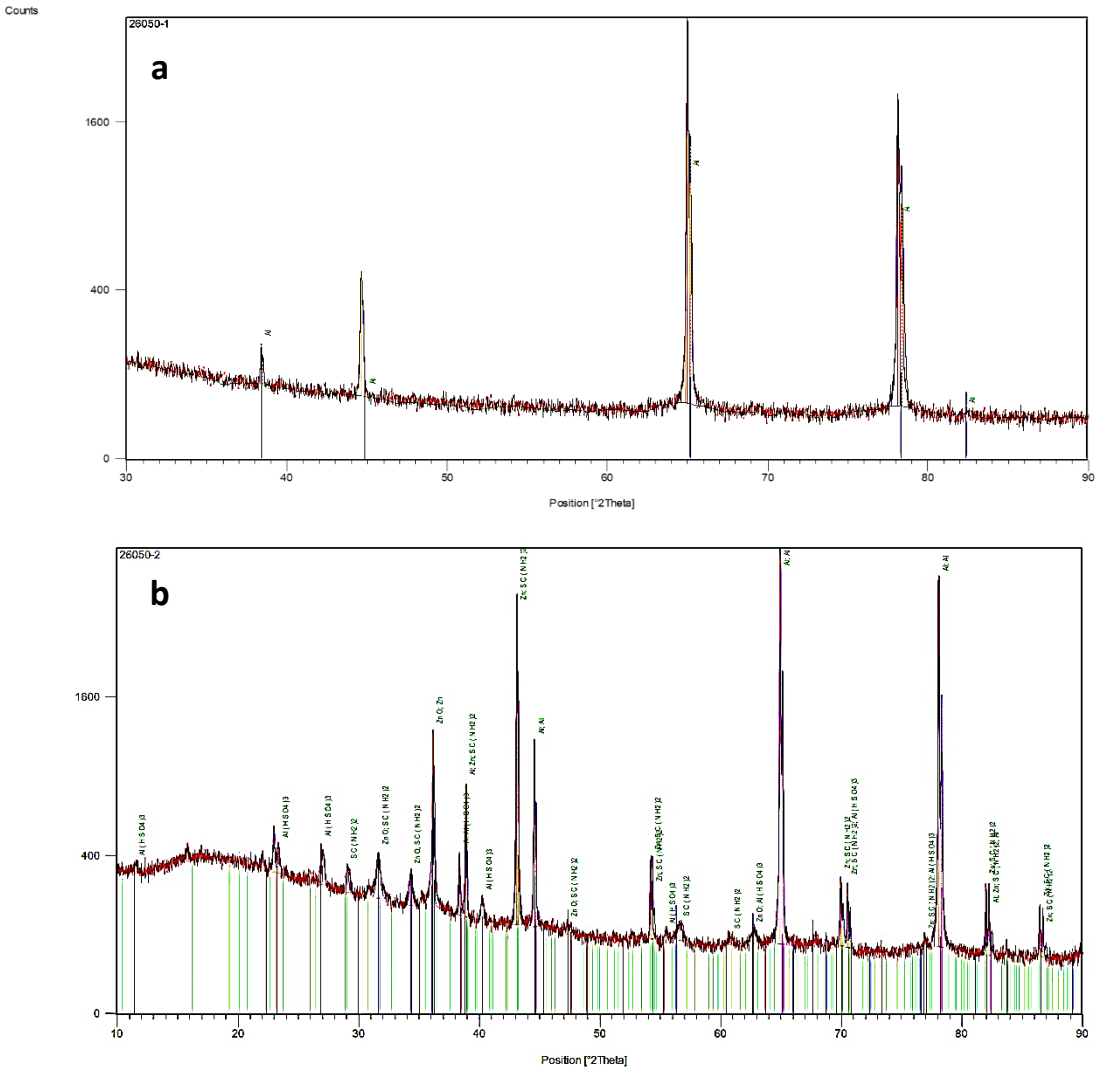

Figure S6. XRD patterns of the surface of aluminum alloy 1050 sample after corrosion in 6.0 M potassium hydroxide environment for 48 hours in a) absence of inhibitor and b) simultaneous presence of thiourea and zinc oxide as corrosion inhibitors