

#Supplementary File

Array of Miniaturized Amperometric Gas Sensors Using Atomic Gold Decorated Pt/PANI Electrodes in Room Temperature Ionic Liquid Films

Anifatul Faricha ¹, Shohei Yoshida ², Parthojit Chakraborty ³, Keisuke Okamoto ², Tso-Fu Mark Chang ³, Masato Sone ³, Takamichi Nakamoto ^{1, 3*}

¹ Department of Information and Communications Engineering, Tokyo Institute of Technology, 226-8503, Kanagawa, Japan

² Department of Materials Science and Engineering, Tokyo Institute of Technology, 226-8503, Kanagawa, Japan

³ Institute of Innovative Research, Tokyo Institute of Technology, 226-8503, Kanagawa, Japan

*Correspondence: nakamoto.t.ab@m.titech.ac.jp

Lists of supplementary information files:

S1 : The reproducibility of Au₂ clusters decorated Pt/PANI using 3 different IDA electrodes

S2 : The data applying two different modified IDAs (using Pt/PANI/Au₂ as representative) with the same RTIL

S3 : The raw data for Table 4

S4: Schemes of our experimental set up and experiments performed in this research study

S1 : The reproducibility of Au₂ clusters decorated Pt/PANI using 3 different IDA electrodes

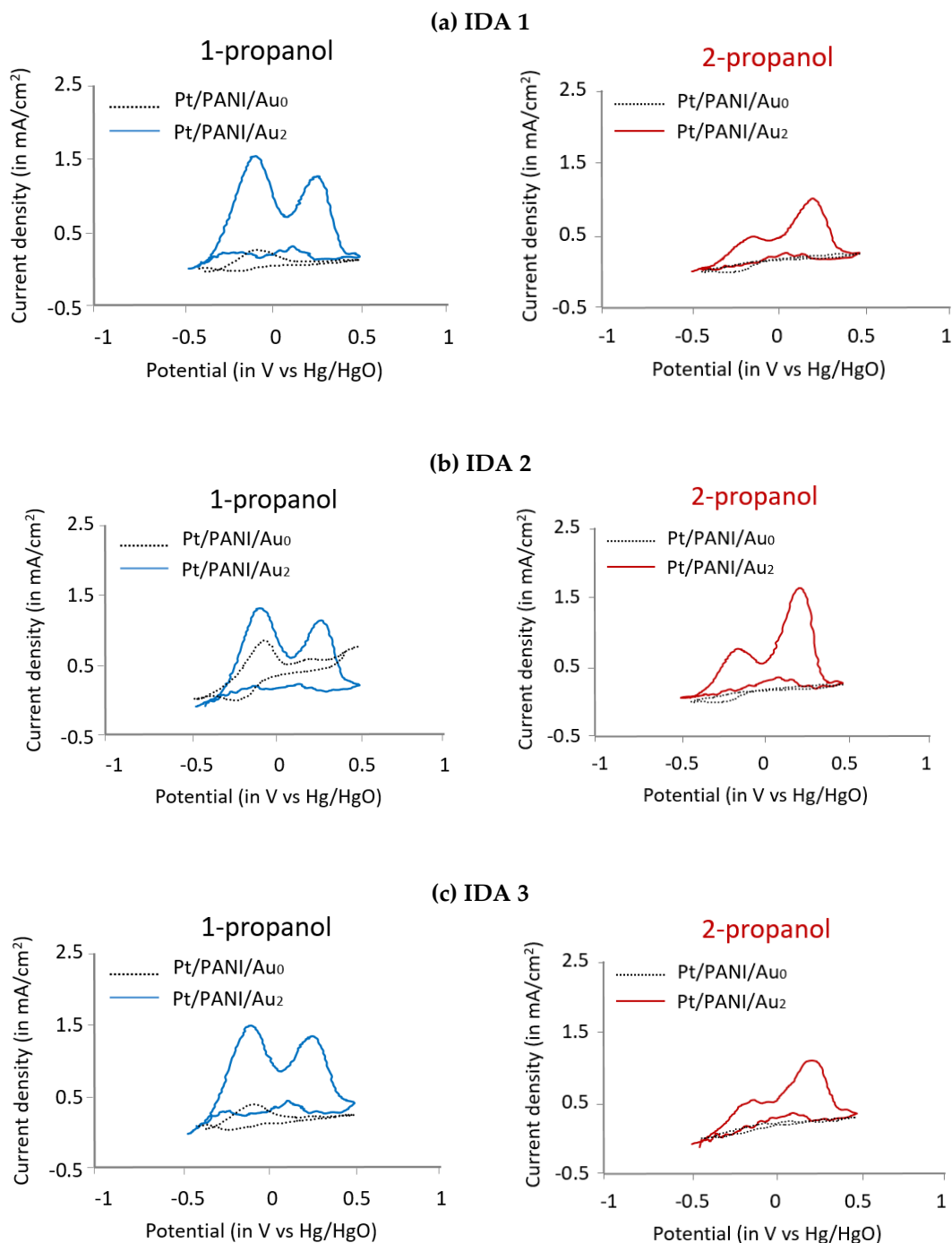


Figure S1. The comparison of electrooxidation from propanol isomers using Pt/PANI/Au₂ and Pt/PANI/Au₀ generated from 3 different IDA electrodes: (a) IDA 1; (b) IDA 2; (c) IDA 3.

S2 : The data applying two different modified IDAs (using Pt/PANI/Au₂ as representative) with the same RTIL

Modified WE : Pt/PANI/Au₂

RTIL : [EMIM][Ac]

RC : 100%

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²	
		<i>standard deviation</i> in mA/cm ²	
		IDA 1	IDA 2
+0.25	1-butanol	7.1	7.4
		0.1	0.141421
	Isobutanol	7.233	7.25
		0.0577	0.3535
	2-butanol	6.9	6.55
		0.1	0.777
+0.5	1-butanol	8.5	8.15
		0.5	0.212
	Isobutanol	10.33	10.55
		0.577	0.636
	2-butanol	6.76	7.05
		0.580	0.0707
+0.9	1-butanol	3.9	4.05
		0.3605	0.007
	Isobutanol	5.13	6.1
		0.814	0.14
	2-butanol	4.05	4
		0.3905	0.0001

* data from IDA 1 and IDA 2 were from 3 and 2 repeated measurements, respectively

Modified WE : Pt/PANI/Au₂

RTIL : [EMIM][Otf]

RC : 100%

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²	
		<i>standard deviation</i> in mA/cm ²	
		IDA 1	IDA 2
+0.25	1-butanol	4.667	4.5
		1.527	2.12
	Isobutanol	2.667	3
		0.577	0.707
	2-butanol	2.667	2
		0.288	0.0001
+0.5	1-butanol	3	2.25
		1.3228	0.3535
	Isobutanol	0.833	0.5
		0.288	0.001
	2-butanol	1.333	1.25
		0.577	0.3535
+1	1-butanol	2	1.5
		1	0.707
	Isobutanol	0.6	0.5
		0.173	0.001
	2-butanol	0.766	0.5
		0.288	0.00002

* data from IDA 1 and IDA 2 were from 3 and 2 repeated measurements, respectively

Modified WE : Pt/PANI/Au₂

RTIL : [EMIM][Cl]

RC : 100%

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²	
		<i>standard deviation</i> in mA/cm ²	
		IDA 1	IDA 2
+0.25	1-butanol	5	5
		<i>1.6667</i>	<i>2.357</i>
	Isobutanol	10	10
		<i>1.667</i>	<i>2.357</i>
	2-butanol	1.611	1.79
		<i>0.1575</i>	<i>0.1296</i>
+0.5	1-butanol	3.222	3.25
		<i>0.19245</i>	<i>0.117</i>
	Isobutanol	4.111	3.708
		<i>0.09622</i>	<i>0.5303</i>
	2-butanol	0.00001	0.0000003
		<i>0.0000001</i>	<i>0.0000001</i>
+1	1-butanol	3.22	3.25
		<i>0.19245</i>	<i>0.11785</i>
	Isobutanol	4.11	3.7083
		<i>0.09622</i>	<i>0.5303</i>
	2-butanol	0.0000001	0.0000001
		<i>0.0000001</i>	<i>0.0000001</i>

* data from IDA 1 and IDA 2 were from 3 and 2 repeated measurements, respectively

S3 : The raw data for Table 4

IDA : Pt/PANI/Au₂

RTIL : [EMIM][Ac]

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²				
		<i>standard deviation</i> in mA/cm ²				
		0% RC	25% RC	50% RC	75% RC	100% RC
+0.25	1-butanol	0	0.5	3.042	6.0404	7.22
		0	0.015811	0.113225	0.151858	0.192354
	Isobutanol	0	0.5	2.592	6.566	7.24
		0	0.015811	0.074632	0.084735	0.181659
	2-butanol	0	0.0986	0.0986	0.0986	6.76
		0	0.014993	0.014993	0.014993	0.439318
+0.5	1-butanol	0	0.956	2.28	7.006	8.36
		0	0.092898	0.192354	0.071274	0.415933
	Isobutanol	0	0.956	8.18	9.072	10.42
		0	0.092898	0.216795	0.08167	0.531037
	2-butanol	0	0.956	0.954	6.126	6.88
		0	0.092898	0.094763	0.212791	0.56952
+0.9	1-butanol	0	0.956	2.356	2.356	3.96
		0	0.092898	0.202312	0.202312	0.270185
	Isobutanol	0	2.776	3.49	3.49	5.52
		0	0.043932	0.074162	0.074162	0.785493
	2-butanol	0	0.956	3.47	3.47	4.03
		0	0.092898	0.044721	0.044721	0.277489

IDA : Pt/PANI/Au₀

RTIL : [EMIM][Ac]

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²				
		<i>standard deviation</i> in mA/cm ²				
		0% RC	25% RC	50% RC	75% RC	100% RC
+0.25	1-butanol	0	0.0986	0.0986	0.1018	1.6
		0	0.014993332	0.014993332	0.011054411	0.547722558
	Isobutanol	0	0.0986	0.0986	0.0986	1.7
		0	0.014993332	0.014993332	0.014993332	0.447213595
	2-butanol	0	0.0986	0.0986	0.0986	1.12
		0	0.014993332	0.014993332	0.014993332	0.216794834
+0.5	1-butanol	0	0.954	0.954	0.954	1.34
		0	0.094762862	0.094762862	0.094762862	0.207364414
	Isobutanol	0	0.956	0.956	0.956	2.24
		0	0.092897793	0.092897793	0.092897793	0.450555213
	2-butanol	0	0.956	0.956	0.956	0.974
		0	0.092897793	0.092897793	0.092897793	0.043358967
+0.9	1-butanol	0	0.956	0.956	0.956	1.6
		0	0.092897793	0.092897793	0.092897793	0.547722558
	Isobutanol	0	0.956	0.956	0.956	1.7
		0	0.092897793	0.092897793	0.092897793	0.447213595
	2-butanol	0	0.956	0.956	0.956	1.12
		0	0.092897793	0.092897793	0.092897793	0.216794834

IDA : Pt/PANI/Au₂

RTIL : [EMIM][Otf]

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²				
		<i>standard deviation</i> in mA/cm ²				
		0% RC	25% RC	50% RC	75% RC	100% RC
+0.25	1-butanol	0	1.918	2.76	3.46	4.6
		0	0.08438	0.43359	0.841427	1.516575
	Isobutanol	0	1.59	2.39	2.66	2.8
		0	0.654217	0.219089	0.4219	0.570088
	2-butanol	0	1.154	1.94	2.37	2.4
		0	0.086487	0.089443	0.21095	0.41833
+0.5	1-butanol	0	0.94	0.94	2	2.7
		0	0.089443	0.089443	0.070711	1.036822
	Isobutanol	0	0.94	0.94	0.94	1
		0	0.089443	0.089443	0.089443	0.273861
	2-butanol	0	0.94	0.94	0.94	1.3
		0	0.089443	0.089443	0.089443	0.447214
+1	1-butanol	0	0.47	0.47	0.47	1.8
		0	0.044721	0.044721	0.044721	0.83666
	Isobutanol	0	0.391	0.391	0.391	0.56
		0	0.008944	0.008944	0.008944	0.134164
	2-butanol	0	0.391	0.47	0.47	0.66
		0	0.008944	0.044721	0.044721	0.250998

IDA : Pt/PANI/Au₀

RTIL : [EMIM][Otf]

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²				
		<i>standard deviation</i> in mA/cm ²				
		0% RC	25% RC	50% RC	75% RC	100% RC
+0.25	1-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
	Isobutanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
	2-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
+0.5	1-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
	Isobutanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
	2-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
+1	1-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
	Isobutanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001
	2-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.0000001

* Three different IDAs were used to check on different days, all three different IDAs showed the same response, and there were no signals of analyte obtained

IDA : Pt/PANI/Au₂

RTIL : [EMIM][Cl]

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²				
		<i>standard deviation</i> in mA/cm ²				
		0% RC	25% RC	50% RC	75% RC	100% RC
+0.25	1-butanol	0	0	0.786667	3.196667	5
		<i>0</i>	<i>0</i>	<i>0.069121</i>	<i>0.140633</i>	<i>1.666667</i>
	Isobutanol	0	0	1.596667	4.733333	10
		<i>0</i>	<i>0</i>	<i>0.096032</i>	<i>0.383695</i>	<i>1.666667</i>
	2-butanol	0	0	0	0	1.596667
		<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0.096032</i>
+0.5	1-butanol	0	0	1.596667	2.15	3.233333
		<i>0</i>	<i>0</i>	<i>0.096032</i>	<i>0.442531</i>	<i>0.149071</i>
	Isobutanol	0	0	1.5	3.7	3.9
		<i>0</i>	<i>0</i>	<i>0.096032</i>	<i>0.401386</i>	<i>0.31</i>
	2-butanol	0	0	0	0	0.0000003
		<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0.0000001</i>
+1	1-butanol	0	0	1.596667	2.15	3.233333
		<i>0</i>	<i>0</i>	<i>0.096032</i>	<i>0.442531</i>	<i>0.149071</i>
	Isobutanol	0	0	1.596667	3.766667	3.95
		<i>0</i>	<i>0</i>	<i>0.096032</i>	<i>0.401386</i>	<i>0.381584</i>
	2-butanol	0	0	0	0	0.0000001
		<i>0</i>	<i>0</i>	<i>0</i>	<i>0</i>	<i>0.0000001</i>

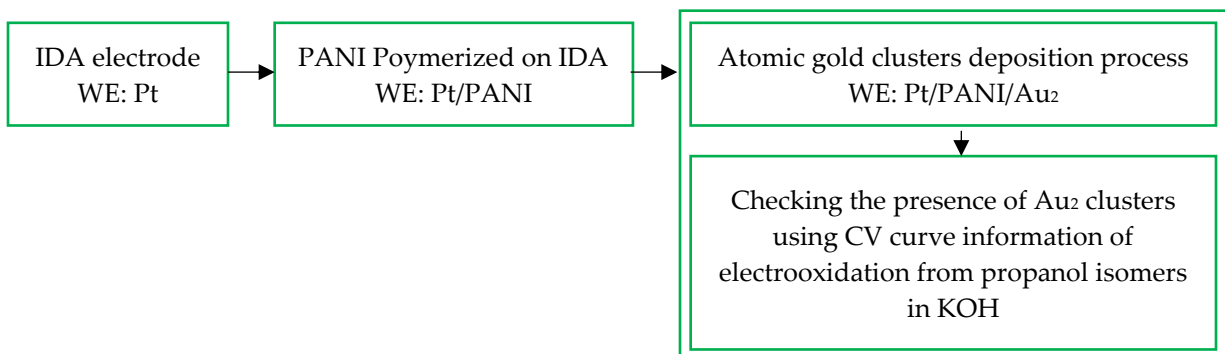
IDA : Pt/PANI/Au₀

RTIL : [EMIM][Cl]

<i>Es</i> against Ag/AgCl (V)	Analyte	Mean in mA/cm ²				
		<i>standard deviation</i> in mA/cm ²				
		0% RC	25% RC	50% RC	75% RC	100% RC
+0.25	1-butanol	0	0	0.7	4	3.233333
		0	0	0.069121	5.907387	0.149071
	Isobutanol	0	0	4.266667	4.733333	7.466667
		0	0	5.907387	0.383695	0.87718
	2-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.000001
+0.5	1-butanol	0	0	1.596667	2.15	3.33333
		0	0	0.096032	0.442531	0.15
	Isobutanol	0	0	1.596667	3.766667	3.95
		0	0	0.096032	0.401386	0.3
	2-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.000001
+1	1-butanol	0	0	1.596667	2.15	3.2
		0	0	0.096032	0.442531	0.149
	Isobutanol	0	0	1.5	3.7	3.9
		0	0	0.09	0.40	0.351584
	2-butanol	0	0	0	0	0.0000001
		0	0	0	0	0.000001

S4: Schemes of our experimental set up and experiments performed in this research study

I. Sensor fabrication



II. Butanol isomers gas measurements

