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ภาคผนวก

ภาคผนวก ก

เครื่องมือที่ใช้ในการทดลอง



เครื่องจักรอีดีเอ็ม

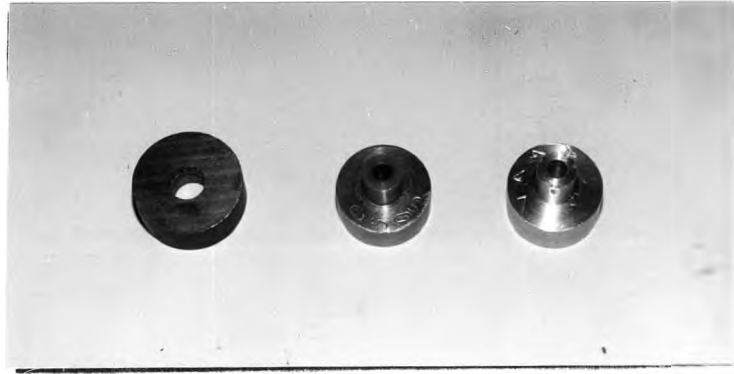


เครื่อง Profile Projector

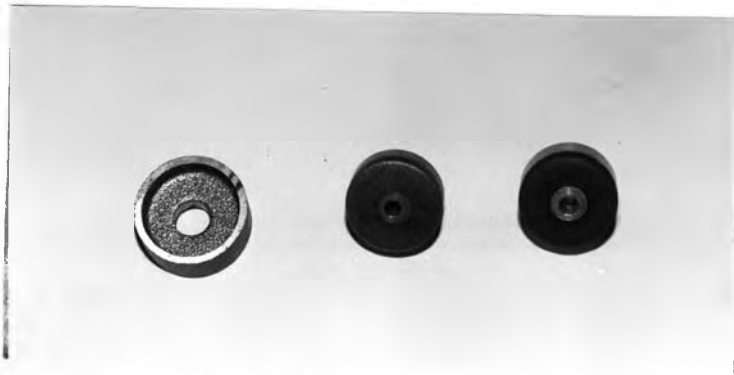




เครื่องวัดความหยาบของผิว



ชิ้นงานและอีเล็กโตรดก่อนการทดลอง



ชิ้นงานและอีเล็กโตรดหลังการทดลอง

## ภาคผนวก ข

## รายละเอียดผลการทดลอง

สัญลักษณ์

- NO. = การทดลองครั้งที่
- EL. = ชนิดของวัสดุอิเล็กทรอนิกส์  
Cu = ทองแดง  
Al = อลูมิเนียม
- I = กระแสคิซซาร์จ (A)
- $t_i$  = ระยะเวลาพัลส์ ( $\mu s$ )
- WW<sub>1</sub> = น้ำหนักของชิ้นงานก่อนการทดลอง (g)
- EW<sub>1</sub> = น้ำหนักของอิเล็กโทรดก่อนการทดลอง (g)
- D<sub>1</sub> = เส้นผ่าศูนย์กลางของอิเล็กโทรดก่อนการทดลอง (mm)
- WW<sub>2</sub> = น้ำหนักของชิ้นงานหลังการทดลอง (g)
- EW<sub>2</sub> = น้ำหนักของอิเล็กโทรดหลังการทดลอง (g)
- D<sub>2</sub> = เส้นผ่าศูนย์กลางของรูกัดบนชิ้นงานหลังการทดลอง (mm)
- T = เวลาที่ใช้ในการทดลอง (min.)
- SR = ความหยาบของผิวงาน ( $\mu m$ )

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
1	Cu	9.85	50	32.400	41.568	24.165	19.166	33.471	24.250	94.5	3.85
2	Cu	9.85	50	32.409	39.385	23.750	19.694	32.242	23.840	90.0	4.00
3	Cu	9.85	50	35.144	35.971	24.130	22.950	29.932	24.235	88.0	3.90
4	Cu	9.85	100	32.250	41.367	23.875	16.050	37.535	24.015	72.5	4.20
5	Cu	9.85	100	35.067	40.402	22.595	19.241	37.481	22.730	64.5	4.40
6	Cu	9.85	100	34.062	37.799	23.740	18.137	35.139	23.890	66.0	4.25
7	Cu	9.85	200	34.635	38.849	23.910	19.812	36.104	24.105	72.0	4.30
8	Cu	9.85	200	32.360	39.723	24.145	18.501	37.741	24.365	53.5	4.50
9	Cu	9.85	200	33.041	39.490	23.875	18.832	37.469	24.085	64.0	4.35
10	Cu	9.85	500	31.149	37.120	23.865	15.348	35.422	24.165	110.0	4.40
11	Cu	9.85	500	35.182	36.533	24.110	19.469	35.007	24.425	106.5	4.50
12	Cu	9.85	500	32.114	34.193	24.075	18.465	33.071	24.365	100.5	4.45
13	Cu	9.85	1000	35.131	40.875	23.800	20.835	39.394	24.150	250.0	4.60
14	Cu	9.85	1000	33.766	37.560	23.550	17.102	35.901	23.915	290.0	4.70
15	Cu	9.85	1000	34.241	38.706	23.805	20.080	37.104	24.175	272.0	4.75

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
16	Cu	14.8	50	35.106	37.422	23.830	22.496	33.623	23.945	30.5	4.35
17	Cu	14.8	50	33.853	36.818	23.950	18.561	31.683	24.050	39.5	4.40
18	Cu	14.8	50	34.108	36.879	24.085	20.055	31.985	24.190	37.0	4.35
19	Cu	14.8	100	35.210	35.776	24.005	22.957	32.743	24.185	26.0	4.70
20	Cu	14.8	100	35.107	36.180	23.465	21.280	32.916	23.635	28.5	4.75
21	Cu	14.8	100	34.194	38.203	23.760	20.073	34.722	23.930	29.5	4.70
22	Cu	14.8	200	34.667	36.816	23.805	21.292	29.836	24.035	25.5	4.90
23	Cu	14.8	200	35.931	43.145	23.925	21.402	40.758	24.160	28.0	4.75
24	Cu	14.8	200	33.927	36.488	23.735	19.853	34.344	23.980	26.5	4.95
25	Cu	14.8	500	33.578	39.062	23.890	18.760	38.303	24.260	40.0	4.90
26	Cu	14.8	500	35.912	37.495	24.000	19.462	36.689	24.400	42.5	5.00
27	Cu	14.8	500	34.114	39.741	23.745	20.332	39.015	24.120	38.0	4.85
28	Cu	14.8	1000	35.718	38.441	23.860	20.962	37.911	24.280	59.5	5.55
29	Cu	14.8	1000	35.938	39.174	23.840	20.346	38.610	24.250	61.0	5.50
30	Cu	14.8	1000	36.104	36.297	23.850	20.431	35.727	24.255	62.5	5.50

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
31	Cu	20.2	50	35.355	38.614	23.680	24.669	34.031	23.800	17.0	4.80
32	Cu	20.2	50	35.964	38.889	23.735	22.386	32.426	23.850	23.0	4.75
33	Cu	20.2	50	34.182	37.581	23.695	19.735	30.301	23.830	27.0	4.65
34	Cu	20.2	100	35.330	37.317	23.780	23.599	33.799	24.000	17.0	5.25
35	Cu	20.2	100	33.855	38.850	24.025	19.215	33.969	24.215	23.5	5.35
36	Cu	20.2	100	34.253	40.314	23.790	19.957	35.466	23.990	22.0	5.40
37	Cu	20.2	200	35.328	37.158	23.785	21.873	35.405	24.090	15.0	5.45
38	Cu	20.2	200	33.142	40.122	23.895	20.401	38.690	24.105	13.5	5.40
39	Cu	20.2	200	33.469	40.228	23.910	18.820	38.588	24.240	15.5	5.50
40	Cu	20.2	500	35.938	39.973	23.915	19.512	33.170	24.345	23.0	5.60
41	Cu	20.2	500	35.224	37.832	23.765	20.880	37.091	24.210	20.0	5.55
42	Cu	20.2	500	34.114	40.835	24.000	20.717	40.264	24.420	17.5	5.60
43	Cu	20.2	1000	35.335	35.278	23.755	19.889	34.929	24.300	30.0	5.75
44	Cu	20.2	1000	33.488	41.688	23.685	18.754	41.344	24.210	29.0	5.65
45	Cu	20.2	1000	33.192	39.641	23.845	18.106	39.281	24.375	30.5	5.60

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
46	Cu	24.7	50	35.138	40.006	23.705	24.560	34.877	23.875	13.5	5.05
47	Cu	24.7	50	34.338	41.568	23.835	24.546	34.934	24.025	17.0	5.10
48	Cu	24.7	50	35.392	41.392	23.795	23.476	35.525	23.980	15.0	4.90
49	Cu	24.7	100	35.211	35.270	23.900	23.880	31.507	24.135	13.5	5.55
50	Cu	24.7	100	36.111	35.496	23.930	24.020	31.435	24.170	14.0	5.50
51	Cu	24.7	100	34.916	36.462	23.895	23.112	32.889	24.140	13.0	5.50
52	Cu	24.7	200	35.185	35.745	23.655	22.015	33.748	24.040	13.0	5.60
53	Cu	24.7	200	36.249	38.465	23.380	21.581	36.074	23.745	14.5	5.75
54	Cu	24.7	200	35.573	37.911	23.850	21.285	35.445	24.220	14.5	5.80
55	Cu	24.7	500	35.236	35.147	24.000	20.171	34.135	24.490	17.	5.65
56	Cu	24.7	500	34.313	34.300	23.995	18.232	33.193	24.485	18.0	5.85
57	Cu	24.7	500	36.924	37.461	23.610	23.259	36.626	24.080	15.5	5.65
58	Cu	24.7	1000	34.514	34.607	24.030	19.019	34.129	24.635	20.5	6.00
59	Cu	24.7	1000	35.843	36.168	23.815	19.829	35.669	24.440	22.0	5.95
60	Cu	24.7	1000	36.227	36.279	24.130	22.085	35.814	24.760	18.0	6.00

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
61	Cu	30.5	50	35.248	35.346	24.095	24.662	29.453	24.345	11.0	5.70
62	Cu	30.5	50	34.181	36.223	23.890	22.163	30.318	24.155	12.0	5.75
63	Cu	30.5	50	36.193	36.308	23.910	23.222	30.409	24.185	12.0	5.65
64	Cu	30.5	100	32.976	37.742	23.880	21.254	33.363	24.270	9.5	6.00
65	Cu	30.5	100	35.463	34.280	23.930	22.990	29.387	24.345	10.0	6.15
66	Cu	30.5	100	32.823	36.245	24.815	18.743	30.615	25.215	12.0	6.10
67	Cu	30.5	200	35.230	37.876	24.100	22.302	35.216	24.585	10.0	6.15
68	Cu	30.5	200	36.422	33.480	24.095	24.294	30.799	24.605	10.0	6.20
69	Cu	30.5	200	34.219	35.151	23.885	20.682	32.316	24.385	11.0	6.20
70	Cu	30.5	500	32.792	38.213	24.015	19.094	36.932	24.685	11.0	6.40
71	Cu	30.5	500	34.419	35.478	23.875	20.176	34.126	24.525	11.5	6.35
72	Cu	30.5	500	35.048	37.680	24.010	20.892	36.303	24.675	11.5	6.45
73	Cu	30.5	1000	35.198	34.574	23.825	20.376	33.796	24.520	13.5	6.50
74	Cu	30.5	1000	36.295	34.666	23.820	21.859	33.832	24.500	13.5	6.60
75	Cu	30.5	1000	36.312	36.393	24.010	20.366	35.608	24.685	12.5	6.45



No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
76	A1	9.85	50	42.891	11.953	23.965	40.618	8.927	24.095	242.0	4.15
77	A1	9.85	50	42.431	12.217	23.905	40.451	9.605	24.020	198.0	4.30
78	A1	9.85	50	41.988	10.916	24.035	39.830	8.019	24.160	215.0	4.30
79	A1	9.85	100	42.900	13.535	23.980	40.399	12.528	24.190	175.0	4.50
80	A1	9.85	100	43.011	11.384	24.010	40.393	10.250	24.200	190.0	4.40
81	A1	9.85	100	42.882	13.056	24.005	40.010	11.865	24.200	195.0	4.45
82	A1	9.85	200	36.050	10.970	24.040	25.833	9.700	24.300	165.0	4.70
83	A1	9.85	200	42.922	13.973	24.055	34.398	12.724	24.305	150.0	4.55
84	A1	9.85	200	42.844	12.087	23.990	34.592	11.000	24.240	120.5	4.60
85	A1	9.85	500	34.115	12.111	24.005	20.723	11.517	24.320	95.0	4.95
86	A1	9.85	500	42.941	13.948	24.015	29.669	13.288	24.305	105.0	4.80
87	A1	9.85	500	42.243	12.703	24.030	29.559	12.175	24.325	85.5	4.75
88	A1	9.85	1000	35.208	10.435	24.025	20.503	10.016	24.355	172.0	4.95
89	A1	9.85	1000	42.989	12.768	23.995	28.884	12.399	24.340	155.0	5.00
90	A1	9.85	1000	42.875	11.493	24.010	28.217	11.100	24.360	163.0	5.05

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
91	A1	14.8	50	36.019	12.072	23.850	27.820	7.634	23.995	198.0	4.40
92	A1	14.8	50	35.690	11.522	24.045	26.508	6.807	24.185	207.0	4.45
93	A1	14.8	50	42.984	13.616	23.950	33.655	8.850	24.080	215.0	4.35
94	A1	14.8	100	34.214	12.016	24.025	25.628	10.044	24.280	94.0	4.70
95	A1	14.8	100	35.923	11.481	23.985	26.491	9.418	24.215	98.5	4.70
96	A1	14.8	100	42.878	12.992	24.000	33.515	10.679	24.245	111.5	7.75
97	A1	14.8	200	36.028	11.167	23.985	26.183	9.916	24.280	65.0	4.95
98	A1	14.8	200	36.027	12.226	23.960	25.043	10.824	24.250	74.5	5.00
99	A1	14.8	200	42.721	14.075	23.990	32.512	12.694	24.265	72.0	5.00
100	A1	14.8	500	36.012	11.828	23.975	23.106	11.103	24.355	43.0	5.15
101	A1	14.8	500	34.956	14.646	23.945	21.954	13.722	24.335	53.5	5.15
102	A1	14.8	500	42.992	11.462	23.925	29.893	10.531	24.305	55.0	5.30
103	A1	14.8	1000	34.175	12.361	23.800	19.868	11.886	24.230	57.5	5.25
104	A1	14.8	1000	42.185	13.981	23.750	28.064	13.579	24.195	50.0	5.30
105	A1	14.8	1000	34.898	12.115	23.905	20.620	11.624	24.355	60.0	5.35

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
106	A1	20.2	50	35.086	12.350	23.120	24.637	10.511	23.300	45.0	4.90
107	A1	20.2	50	34.930	12.782	23.875	24.624	11.018	24.055	43.0	4.75
108	A1	20.2	50	42.994	13.537	23.905	32.712	11.812	24.065	41.0	4.80
109	A1	20.2	100	36.017	12.338	24.210	25.386	10.592	24.500	39.5	5.30
110	A1	20.2	100	34.956	11.667	24.005	24.641	10.141	24.300	33.5	5.25
111	A1	20.2	100	43.140	14.052	23.950	32.326	12.093	24.260	45.5	5.40
112	A1	20.2	200	35.952	12.307	23.835	24.749	10.837	24.190	35.5	5.55
113	A1	20.2	200	34.897	11.067	23.860	24.685	9.947	24.220	27.5	5.65
114	A1	20.2	200	42.994	12.998	23.925	31.922	11.631	24.295	32.5	5.60
115	A1	20.2	500	36.027	11.397	23.830	24.885	10.511	24.250	30.0	5.80
116	A1	20.2	500	34.378	11.659	23.905	22.327	10.628	24.315	35.0	5.80
117	A1	20.2	500	42.978	11.437	23.705	32.094	10.828	24.130	23.0	5.75
118	A1	20.2	1000	36.002	11.437	23.930	22.910	10.733	24.460	34.0	6.05
119	A1	20.2	1000	33.906	13.524	23.895	20.366	12.776	24.440	36.0	6.10
120	A1	20.2	1000	43.052	12.160	23.925	30.291	11.588	24.475	29.0	5.90

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
121	A1	24.7	50	35.967	11.555	23.895	25.886	9.940	24.130	32.0	5.15
122	A1	24.7	50	34.836	12.938	23.970	24.772	11.430	24.215	30.0	5.10
123	A1	24.7	50	42.936	12.568	24.000	32.589	10.776	24.240	35.0	5.10
124	A1	24.7	100	34.988	11.230	23.945	25.041	9.764	24.310	26.0	5.25
125	A1	24.7	100	34.778	11.929	23.975	24.797	10.586	24.335	23.5	5.40
126	A1	24.7	100	42.963	12.305	24.005	32.108	10.850	24.365	25.5	5.50
127	A1	24.7	200	36.032	12.120	23.915	24.450	10.696	24.380	25.5	5.70
128	A1	24.7	200	35.441	12.707	23.965	24.032	11.290	24.415	25.5	5.70
129	A1	24.7	200	41.906	12.862	23.920	30.853	11.574	24.375	23.5	5.85
130	A1	24.7	500	35.460	11.727	24.035	24.911	10.813	24.600	21.5	6.05
131	A1	24.7	500	34.763	13.389	23.895	23.082	12.404	24.445	23.5	6.00
132	A1	24.7	500	42.942	13.340	23.920	29.539	12.167	24.480	27.5	6.00
133	A1	24.7	1000	35.666	11.866	23.890	21.710	11.074	24.520	26.5	6.10
134	A1	24.7	1000	42.841	13.363	23.920	29.530	12.555	24.555	26.5	6.15
135	A1	24.7	1000	43.046	12.543	23.885	30.344	11.838	24.515	24.5	6.20

No.	EL.	I	t <sub>i</sub>	WW <sub>1</sub>	EW <sub>1</sub>	D <sub>1</sub>	WW <sub>2</sub>	EW <sub>2</sub>	D <sub>2</sub>	T	SR
136	A1	30.5	50	36.058	11.967	23.875	25.797	10.543	24.175	21.0	5.65
137	A1	30.5	50	42.985	13.906	23.915	32.047	12.354	24.210	23.0	5.65
138	A1	30.5	50	42.979	12.615	23.960	32.522	11.130	24.275	22.0	5.55
139	A1	30.5	100	36.072	11.673	23.750	25.240	11.130	24.165	18.5	6.10
140	A1	30.5	100	41.962	12.851	23.860	30.698	11.492	24.265	19.5	6.00
141	A1	30.5	100	42.941	14.403	23.915	31.919	13.067	24.325	19.0	6.20
142	A1	30.5	200	35.475	11.710	23.955	24.532	10.394	24.495	18.0	6.20
143	A1	30.5	200	42.998	12.981	23.930	31.911	11.746	24.450	17.0	6.25
144	A1	30.5	200	42.968	12.694	23.885	31.589	11.412	24.420	17.5	6.40
145	A1	30.5	500	35.964	11.705	23.890	23.124	10.756	24.500	15.5	6.45
146	A1	30.5	500	43.011	13.390	23.670	30.258	12.467	24.295	15.0	6.45
147	A1	30.5	500	42.914	11.883	23.890	31.342	11.017	24.505	14.0	6.50
148	A1	30.5	1000	34.236	10.883	23.775	22.923	10.090	24.475	15.5	6.70
149	A1	30.5	1000	42.984	13.539	23.820	30.209	12.565	24.520	19.0	6.65
150	A1	30.5	1000	42.448	10.964	23.935	30.407	10.102	24.615	17.0	6.55

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METAL REMOVAL RATE (COPPER ELECTRODE): SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 650.908

MULTIPLE CORRELATION: .980

SQUARED MULTIPLE CORRELATION: .961

ADJUSTED R =  $1 - (1 - R^2) * (N - 1) / DF$ , WHERE N = 25, AND DF = 19: .951

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	-300.283	147.187	0.	.	-2.04	.055
PLSE	0.378	0.243	0.369	0.03646	1.56	.136
CRNT	47.108	14.894	0.946	0.02279	3.16	.005
PLSE*						
PLSE	-0.001	0.000	-0.643	0.05051	-3.20	.005
CRNT*						
CRNT	-0.041	0.361	-0.034	0.02338	-.11	.910
PLSE*						
CRNT	0.006	0.006	0.137	0.10271	.97	.342

ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	3127889.945	5	625577.989	94.293	.000
RESIDUAL	126054.358	19	6634.440		

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## METAL REMOVAL RATE (ALUMINIUM ELECTRODE): SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 327.164

MULTIPLE CORRELATION: .989

SQUARED MULTIPLE CORRELATION: .978

$$\text{ADJUSTED } R^2 = 1 - (1 - R^2) * (N - 1) / \text{DF}, \text{ WHERE } N = 25, \text{ AND } \text{DF} = 19: .972$$

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	-210.922	68.012	0.	.	-3.10	.006
PLSE	0.659	0.112	1.044	0.03646	5.88	.000
CRNT	11.746	6.882	0.383	0.02279	1.71	.104
PLSE*						
PLSE	-0.001	0.000	-0.925	0.05051	-6.13	.000
CRNT*						
CRNT	0.379	0.167	0.504	0.02338	2.27	.035
PLSE*						
CRNT	0.004	0.003	0.135	0.10271	1.27	.218

## ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	1206759.839	5	241351.968	170.377	.000
RESIDUAL	26914.895	19	1416.573		

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## ELECTRODE WEAR RATE (COPPER ELECTRODE): SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 140.511

MULTIPLE CORRELATION: .971

SQUARED MULTIPLE CORRELATION: .944

$$\text{ADJUSTED } R^2 = 1 - (1 - R^2) * (N - 1) / DF, \text{ WHERE } N = 25, \text{ AND } DF = 19: .929$$

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	29.755	70.406	0.	.	.42	.677
PLSE	-0.399	0.116	-0.978	0.03646	-3.43	.003
CRNT	6.091	7.125	0.308	0.02279	.85	.403
PLSE*						
PLSE	0.001	0.000	1.364	0.05051	5.64	.000
CRNT*						
CRNT	0.322	0.173	0.664	0.02338	1.87	.077
PLSE*						
CRNT	-0.019	0.003	-1.073	0.10271	-6.32	.000

## ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	484456.708	5	96891.342	63.826	.000
RESIDUAL	28843.052	19	1518.055		

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## ELECTRODE WEAR RATE (ALUMINIUM ELECTRODE): SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 34.160

MULTIPLE CORRELATION: .991

SQUARED MULTIPLE CORRELATION: .983

$$\text{ADJUSTED } R^2 = 1 - (1 - R^2) * (N - 1) / DF, \text{ WHERE } N = 25, \text{ AND } DF = 19: .978$$

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	-14.181	5.901	0.	.	-2.40	.027
PLSE	-0.000	0.010	-0.005	0.03646	-.03	.976
CRNT	2.279	0.597	0.759	0.02279	3.82	.001
PLSE*						
PLSE	-0.000	0.000	-0.059	0.05051	-.44	.663
CRNT*						
CRNT	0.020	0.014	0.275	0.02338	1.40	.178
PLSE*						
CRNT	-0.001	0.000	-0.269	0.10271	-2.87	.010

## ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	11628.179	5	2325.636	218.102	.000
RESIDUAL	202.598	19	10.663		

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## SURFACE ROUGHNESS (COPPER ELECTRODE):SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 5.242

MULTIPLE CORRELATION: .975

SQUARED MULTIPLE CORRELATION: .951

$$\text{ADJUSTED } R^2 = 1 - (1 - R^2) * (N - 1) / DF, \text{ WHERE } N = 25, \text{ AND } DF = 19: .938$$

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	3.096	0.320	0.	.	9.66	.000
PLSE	0.002	0.001	0.904	0.03646	3.39	.003
CRNT	0.091	0.032	0.947	0.02279	2.81	.011
PLSE*						
PLSE	-0.000	0.000	-0.661	0.05051	-2.91	.009
CRNT*						
CRNT	-0.000	0.001	-0.062	0.02338	-.18	.855
PLSE*						
CRNT	0.000	0.000	0.068	0.10271	.43	.676

## ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	11.516	5	2.303	73.253	.000
RESIDUAL	0.597	19	0.031		

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## SURFACE ROUGHNESS (ALUMINIUM ELECTRODE): SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 5.390

MULTIPLE CORRELATION: .978

SQUARED MULTIPLE CORRELATION: .957

$$\text{ADJUSTED } R^2 = 1 - (1 - R^2) * (N - 1) / \text{DF}, \text{ WHERE } N = 25, \text{ AND } \text{DF} = 19: .945$$

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF. TOLERANCE		T	P(2 TAIL)
CONSTANT	3.415	0.287	0.		11.90	.000
PLSE	0.002	0.000	1.305	0.03646	5.23	.000
CRNT	0.069	0.029	0.750	0.02279	2.37	.028
PLSE*						
PLSE	-0.000	0.000	-0.964	0.05051	-4.54	.000
CRNT*						
CRNT	0.000	0.001	0.057	0.02338	.18	.857
PLSE*						
CRNT	0.000	0.000	0.097	0.10271	.65	.522

## ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	10.615	5	2.123	84.120	.000
RESIDUAL	0.480	19	0.025		

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## DISCHARGE GAP (COPPER ELECTRODE): SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 168.200

MULTIPLE CORRELATION: .985

SQUARED MULTIPLE CORRELATION: .970

$$\text{ADJUSTED } R^2 = 1 - (1 - R^2) * (N - 1) / DF, \text{ WHERE } N = 25, \text{ AND } DF = 19: .963$$

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
CONSTANT	28.649	30.215	0.	.	.95	.355
PLSE	0.407	0.050	1.690	0.03646	8.17	.000
CRNT	-2.589	3.058	-0.222	0.02279	-7.85	.408
PLSE*						
PLSE	-0.000	0.000	-1.287	0.05051	-7.32	.000
CRNT*						
CRNT	0.196	0.074	0.683	0.02338	2.64	.016
PLSE*						
CRNT	0.004	0.001	0.338	0.10271	2.74	.013

## ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	173631.857	5	34726.371	124.206	.000
RESIDUAL	5312.143	19	279.586		

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## DISCHARGE GAP (ALUMINIUM ELECTRODE): SECOND ORDER MODEL

NUMBER OF CASES PROCESSED: 25

DEPENDENT VARIABLE MEAN: 185.600

MODEL CONTAINS NO CONSTANT.

MULTIPLE CORRELATION: .996

SQUARED MULTIPLE CORRELATION: .992

$$\text{ADJUSTED } R^2 = 1 - (1 - R^2) * (N - 1) / \text{DF}, \text{ WHERE } N = 25, \text{ AND } \text{DF} = 20: .990$$

VARIABLE	COEFFICIENT	STD. ERROR	STD. COEF.	TOLERANCE	T	P(2 TAIL)
PLSE	0.327	0.057	0.831	0.01943	5.77	.000
CRNT	4.441	1.241	0.470	0.02332	3.58	.002
PLSE*						
PLSE	-0.000	0.000	-0.552	0.03540	-5.18	.000
CRNT*						
CRNT	0.022	0.045	0.060	0.02778	.50	.624
PLSE*						
CRNT	0.004	0.001	0.206	0.06134	2.54	.019

## ANALYSIS OF VARIANCE

SOURCE	SUM-OF-SQUARES	DF	MEAN-SQUARE	F-RATIO	P
REGRESSION	1002221.844	5	200444.369	493.210	.000
RESIDUAL	8128.156	20	406.408		

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ประวัติผู้เขียน

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อุตสาหกรรม จากมหาวิทยาลัยขอนแก่น เมื่อปี พ.ศ. 2525 ปัจจุบันรับราชการ  
ในตำแหน่งอาจารย์ ประจำแผนกวิชาช่างกลโรงงาน สถาบันเทคโนโลยีราชมงคล  
วิทยาเขตตาก