

APPENDIX A

Table A.1 MRR1: Material Removal Rate for positive polarity copper tool

Correlation coefficient = 99.37%

Source	DOF	SS	MS	P
Model	7	9.11728	1.30247	0.000
Linear	3	9.10414	3.03471	0.000
I_p	1	2.52001	2.52001	0.000
V_g	1	3.47161	3.47161	0.000
T_{on}	1	3.11251	3.11251	0.000
Square	1	0.00320	0.00320	0.620
I_p^2	1	0.00320	0.00320	0.620
2-way interaction	3	0.00994	0.00331	0.832
$I_p \cdot V_g$	1	0.00061	0.00061	0.827
$I_p \cdot T_{on}$	1	0.00151	0.00151	0.732
$V_g \cdot T_{on}$	1	0.00781	0.00781	0.447
Error	5	0.00452	0.00090	
Lack of Fit	1	0.05611	0.05611	0.000
Pure error	4	0.00132	0.00033	
Total	12	9.17471		

Table A.2 MRR2: Material Removal Rate for negative polarity copper tool

Correlation coefficient = 94.20%

Source	DOF	SS	MS	P
Model	7	37.0288	5.2898	0.008
Linear	3	22.3107	7.4369	0.005
I_p	1	19.6251	19.6251	0.001
V_g	1	2.0301	2.0301	0.089
T_{on}	1	0.6555	0.6555	0.000
Square	1	1.2950	1.2950	0.153
I_p^2	1	1.2950	1.2950	0.153
2-way interaction	3	13.4230	4.4743	0.015
$I_p \cdot V_g$	1	4.2486	4.2486	0.028
$I_p \cdot T_{on}$	1	3.4453	3.4453	0.040
$V_g \cdot T_{on}$	1	5.7291	5.7291	0.016
Error	5	2.2805	0.4561	
Lack of Fit	1	2.2791	2.2791	0.000
Pure error	4	0.0014	0.0004	
Total	12	39.3093		

Table A.3 MRR3: Material Removal Rate for positive polarity copper tungsten tool

Correlation coefficient =100.00%

Source	DOF	SS	MS	P
Model	7	19.5529	2.79328	0.000
Linear	3	18.8218	6.27395	0.000
I_p	1	3.2640	3.26401	0.000
V_g	1	8.5078	8.50781	0.000
T_{on}	1	7.0500	7.05001	0.000
Square	1	0.2858	0.28576	0.000
I_p^2	1	0.2858	0.28576	0.000
2-way interaction	3	0.4453	0.14845	0.000
$I_p \cdot V_g$	1	0.1275	0.12751	0.000
$I_p \cdot T_{on}$	1	0.1225	0.12251	0.000
$V_g \cdot T_{on}$	1	0.1953	0.19531	0.000
Error	5	0.0008	0.00017	
Lack of Fit	1	0.0001	0.00011	0.473
Pure error	4	0.0007	0.00018	
Total	12	19.5538		

Table A.4 MRR4: Material Removal Rate for negative polarity copper tungsten tool

Correlation coefficient= 99.99%

Source	DOF	SS	MS	P
Model	7	13.5226	1.93180	0.000
Linear	3	13.4515	4.48385	0.000
I_p	1	3.2131	3.21311	0.000
V_g	1	6.2481	6.24811	0.000
T_{on}	1	3.9903	3.99031	0.000
Square	1	0.0571	0.05712	0.000
I_p^2	1	0.07571	0.05712	0.000
2-way interaction	3	0.0139	0.00465	0.001
$I_p \cdot V_g$	1	0.0003	0.00031	0.199
$I_p \cdot T_{on}$	1	0.0136	0.01361	0.000
$V_g \cdot T_{on}$	1	0.0000	0.00001	0.779
Error	5	0.0007	0.00017	
Lack of Fit	1	0.0003	0.00031	0.152
Pure error	4	0.0004	0.00018	
Total	12	13.5233		

Table A.5 MRR5: Material Removal Rate for positive polarity graphite tool

Correlation coefficient= 99.97%

Source	DOF	SS	MS	P
Model	7	16.9259	2.41799	0.000
Linear	3	16.7178	5.57258	0.000
I_p	1	3.7812	3.78125	0.000
V_g	1	5.6784	5.67845	0.000
T_{on}	1	7.2580	7.25805	0.000
Square	1	0.0492	0.04924	0.001
I_p^2	1	0.0492	0.04924	0.001
2-way interaction	3	0.1589	0.05298	0.000
$I_p \cdot V_g$	1	0.0144	0.01445	0.011
$I_p \cdot T_{on}$	1	0.0136	0.01361	0.000
$V_g \cdot T_{on}$	1	0.0684	0.06845	0.000
Error	5	0.0046	0.00091	
Lack of Fit	1	0.0041	0.00405	0.005
Pure error	4	0.0005	0.00013	
Total	12	16.9305		

Table A.6 MRR6: Material Removal Rate for negative polarity graphite tool

Correlation coefficient= 98.63%

Source	DOF	SS	MS	P
Model	7	14.0986	2.01409	0.000
Linear	3	13.8180	4.60601	0.000
I_p	1	3.0381	3.03811	0.000
V_g	1	6.3546	6.35461	0.000
T_{on}	1	4.4253	4.42531	0.000
Square	1	0.0196	0.01957	0.511
I_p^2	1	0.0196	0.01957	0.511
2-way interaction	3	0.2610	0.08701	0.203
$I_p \cdot V_g$	1	0.1128	0.11281	0.150
$I_p \cdot T_{on}$	1	0.0741	0.07411	0.227
$V_g \cdot T_{on}$	1	0.0741	0.07411	0.227
Error	5	0.1956	0.03913	
Lack of Fit	1	0.1953	0.19531	0.000
Pure error	4	0.0003	0.00008	
Total	12	14.2943		

Table A.7 TW1: Tool Wear for positive polarity copper tool

Correlation coefficient= 98.96%

Source	DOF	SS	MS	P
Model	7	1.63299	0.233284	0.000
Linear	3	1.60360	0.534533	0.000
I_p	1	0.21780	0.217800	0.001
V_g	1	0.84500	0.845000	0.000
T_{on}	1	0.54080	0.540800	0.000
Square	1	0.00084	0.000838	0.642
I_p^2	1	0.00084	0.000838	0.642
2-way interaction	3	0.02855	0.009517	0.150
$I_p \cdot V_g$	1	0.02205	0.022250	0.052
$I_p \cdot T_{on}$	1	0.00605	0.006050	0.241
$V_g \cdot T_{on}$	1	0.00045	0.000450	0.732
Error	5	0.01712	0.003424	
Lack of Fit	1	0.01620	0.016200	0.001
Pure error	4	0.00092	0.000230	
Total	12	1.65011		

Table A. 8 TW2: Tool Wear for negative polarity copper tool

Correlation coefficient= 99.97%

Source	DOF	SS	MS	P
Model	7	8.07108	1.15301	0.000
Linear	3	7.86820	2.62273	0.000
I_p	1	1.09520	1.09520	0.000
V_g	1	4.44020	4.44020	0.000
T_{on}	1	2.33280	2.33280	0.000
Square	1	0.03233	0.03233	0.000
I_p^2	1	0.03233	0.03233	0.000
2-way interaction	3	0.17055	0.05685	0.000
$I_p \cdot V_g$	1	0.04205	0.04205	0.000
$I_p \cdot T_{on}$	1	0.01805	0.01805	0.002
$V_g \cdot T_{on}$	1	0.11045	0.11045	0.000
Error	5	0.00240	0.00048	
Lack of Fit	1	0.00000	0.00000	1.000
Pure error	4	0.00240	0.00060	
Total	12	8.07348		

Table A. 9 TW3: Tool Wear for positive polarity copper tungsten tool

Correlation coefficient = 99.80%

Source	DOF	SS	MS	P
Model	7	6.18744	0.88392	0.000
Linear	3	5.96965	1.98988	0.000
I_p	1	0.88445	0.88445	0.000
V_g	1	3.12500	3.12500	0.000
T_{on}	1	1.96020	1.96020	0.000
Square	1	0.13634	0.13634	0.001
I_p^2	1	0.13634	0.13634	0.001
2-way interaction	3	0.08145	0.02715	0.012
$I_p \cdot V_g$	1	0.02880	0.02880	0.019
$I_p \cdot T_{on}$	1	0.01620	0.01620	0.050
$V_g \cdot T_{on}$	1	0.03645	0.03645	0.012
Error	5	0.01233	0.00247	
Lack of Fit	1	0.01125	0.01125	0.003
Pure error	4	0.00108	0.00027	
Total	12	6.19977		

Table A.10 TW4: Tool Wear for negative polarity copper tungsten tool

Correlation coefficient= 99.39%

Source	DOF	SS	MS	P
Model	7	5.73583	0.81940	0.000
Linear	3	5.70330	1.90110	0.000
I_p	1	1.29605	1.29605	0.000
V_g	1	2.48645	2.48645	0.000
T_{on}	1	1.92080	1.92080	0.000
Square	1	0.02383	0.02383	0.126
I_p^2	1	0.02383	0.02383	0.126
2-way interaction	3	0.00870	0.00290	0.754
$I_p \cdot V_g$	1	0.00020	0.00020	0.873
$I_p \cdot T_{on}$	1	0.00845	0.00845	0.325
$V_g \cdot T_{on}$	1	0.00005	0.00005	0.936
Error	5	0.03548	0.00710	
Lack of Fit	1	0.03380	0.03380	0.001
Pure error	4	0.00168	0.00042	
Total	12	5.77131		

Table A.11 TW5: Tool Wear for positive polarity graphite tool

Correlation coefficient= 99.96%

Source	DOF	SS	MS	P
Model	7	5.95884	0.85126	0.000
Linear	3	5.78405	1.92802	0.000
I_p	1	1.92080	1.92080	0.000
V_g	1	2.59920	2.59920	0.000
T_{on}	1	1.26405	1.26405	0.000
Square	1	0.06514	0.06514	0.000
I_p^2	1	0.06514	0.06514	0.000
2-way interaction	3	0.10965	0.03655	0.000
$I_p \cdot V_g$	1	0.01805	0.01805	0.001
$I_p \cdot T_{on}$	1	0.05780	0.05780	0.000
$V_g \cdot T_{on}$	1	0.03380	0.03380	0.000
Error	5	0.03548	0.00710	
Lack of Fit	1	0.00125	0.00125	0.076
Pure error	4	0.00088	0.00022	
Total	12	5.96097		

Table A.12 TW6: Tool Wear for negative polarity graphite tool

Correlation coefficient= 99.90%

Source	DOF	SS	MS	P
Model	7	6.75024	0.96432	0.000
Linear	3	6.44485	2.14828	0.000
I_p	1	1.24820	1.24820	0.000
V_g	1	2.26845	2.26845	0.000
T_{on}	1	2.92820	2.92820	0.000
Square	1	0.18469	0.18469	0.000
I_p^2	1	0.18469	0.18469	0.000
2-way interaction	3	0.12070	0.04023	0.001
$I_p \cdot V_g$	1	0.05445	0.05445	0.001
$I_p \cdot T_{on}$	1	0.02420	0.02420	0.008
$V_g \cdot T_{on}$	1	0.04205	0.04205	0.003
Error	5	0.00685	0.00137	
Lack of Fit	1	0.00605	0.00605	0.005
Pure error	4	0.00080	0.00020	
Total	12	6.75709		

Table A.13 HV: Microhardness for positive polarity copper tool

Correlation coefficient= 82.91%

Source	DOF	SS	MS	P
Model	7	9865.3	1409.33	0.095
Linear	3	9123.4	3041.12	0.027
I_p	1	2628.1	2628.12	0.052
V_g	1	5460.1	5.46010	0.015
T_{on}	1	1035.1	1035.12	0.172
Square	1	318.6	318.56	0.417
I_p^2	1	318.6	318.56	0.417
2-way interaction	3	423.4	141.12	0.794
$I_p \cdot V_g$	1	300.1	300.12	0.430
$I_p \cdot T_{on}$	1	78.1	78.13	0.679
$V_g \cdot T_{on}$	1	45.1	45.12	0.753
Error	5	2033.9	406.78	
Lack of Fit	1	1275.1	1275.13	0.061
Pure error	4	758.8	189.70	
Total	12	11899.2		

Table A.14 HV2: Microhardness for negative polarity copper tool

Correlation coefficient= 85.34%

Source	DOF	SS	MS	P
Model	7	8271.81	1181.69	0.068
Linear	3	5252.50	1750.83	0.039
I_p	1	1682.00	1682.00	0.059
V_g	1	2112.50	2112.50	0.041
T_{on}	1	1458.00	1458.00	0.073
Square	1	2862.31	2862.31	0.025
I_p^2	1	2862.31	2862.31	0.025
2-way interaction	3	157.00	52.33	0.903
$I_p \cdot V_g$	1	24.50	24.50	0.781
$I_p \cdot T_{on}$	1	72.00	72.00	0.636
$V_g \cdot T_{on}$	1	60.50	60.50	0.664
Error	5	1420.50	284.10	
Lack of Fit	1	1104.50	1104.50	0.020
Pure error	4	316.00	79.00	
Total	12	9692.31		

Table A.15 HV3: Microhardness for positive polarity copper tungsten tool

Correlation coefficient= 90.83%

Source	DOF	SS	MS	P
Model	7	5957.72	851.10	0.023
Linear	3	5187.00	1729.00	0.007
I_p	1	1682.00	1682.00	0.013
V_g	1	2664.50	2664.50	0.005
T_{on}	1	840.50	840.50	0.046
Square	1	230.22	230.22	0.225
I_p^2	1	230.22	230.22	0.225
2-way interaction	3	540.50	180.17	0.323
$I_p \cdot V_g$	1	162.00	162.00	0.298
$I_p \cdot T_{on}$	1	338.00	338.00	0.154
$V_g \cdot T_{on}$	1	40.50	40.50	0.587
Error	5	601.20	120.24	
Lack of Fit	1	512.00	512.00	0.009
Pure error	4	89.20	22.30	
Total	12	6558.92		

Table A. 16 HV4: Microhardness for negative polarity copper tungsten tool

Correlation coefficient= 87.13%

Source	DOF	SS	MS	P
Model	7	5578.60	796.94	0.051
Linear	3	3593.37	1197.79	0.029
I_p	1	2278.12	2278.12	0.014
V_g	1	325.12	325.12	0.219
T_{on}	1	990.12	990.12	0.058
Square	1	562.85	562.85	0.124
I_p^2	1	562.85	562.85	0.124
2-way interaction	3	1422.37	474.12	0.143
$I_p \cdot V_g$	1	1176.12	1176.12	0.044
$I_p \cdot T_{on}$	1	231.12	231.12	0.290
$V_g \cdot T_{on}$	1	15.13	15.13	0.774
Error	5	824.33	164.87	
Lack of Fit	1	91.13	91.13	0.520
Pure error	4	733.20	183.30	
Total	12	6402.92		

Table A.17 HV5: Microhardness for positive polarity graphite tool

Correlation coefficient=97.09%

Source	DOF	SS	MS	P
Model	7	26177.8	3739.7	0.001
Linear	3	18982.5	6327.5	0.001
I_p	1	12012.5	12012.5	0.000
V_g	1	8.0	8.0	0.830
T_{on}	1	6962.0	6962.0	0.001
Square	1	94.8	94.8	0.472
I_p^2	1	94.8	94.8	0.472
2-way interaction	3	7100.5	2366.8	0.006
$I_p \cdot V_g$	1	2312.0	2312.0	0.012
$I_p \cdot T_{on}$	1	4608.0	4608.0	0.003
$V_g \cdot T_{on}$	1	180.5	180.5	0.332
Error	5	783.3	156.7	
Lack of Fit	1	420.5	420.5	0.098
Pure error	4	362.8	90.7	
Total	12	26961.1		

Table A.18 HV6: Microhardness for negative polarity graphite tool

Correlation coefficient=79.90%

Source	DOF	SS	MS	P
Model	7	74038.4	10576.9	0.134
Linear	3	54462.4	18154.1	0.060
I_p	1	19110.1	19110.1	0.073
V_g	1	22791.1	22791.1	0.056
T_{on}	1	12561.1	12561.1	0.126
Square	1	14532.7	14532.7	0.105
I_p^2	1	14532.7	14532.7	0.105
2-way interaction	3	5043.4	1681.1	0.728
$I_p \cdot V_g$	1	4278.1	4278.1	0.333
$I_p \cdot T_{on}$	1	300.1	300.1	0.788
$V_g \cdot T_{on}$	1	465.1	465.1	0.738
Error	5	18622.3	3724.5	
Lack of Fit	1	17955.1	17955.1	0.000
Pure error	4	667.2	166.8	
Total	12	92660.8		

Table A.19 SR1: Surface Roughness for positive polarity copper tool

Correlation coefficient=90.33%

Source	DOF	SS	MS	P
Model	7	4.07630	0.58233	0.026
Linear	3	3.79465	1.26488	0.007
I_p	1	1.17045	1.17045	0.015
V_g	1	1.80500	1.80500	0.006
T_{on}	1	0.81920	0.81920	0.028
Square	1	0.02895	0.02895	0.590
I_p^2	1	0.02895	0.02895	0.590
2-way interaction	3	0.25270	0.08423	0.478
$I_p \cdot V_g$	1	0.22445	0.22445	0.170
$I_p \cdot T_{on}$	1	0.00405	0.00405	0.838
$V_g \cdot T_{on}$	1	0.02420	0.02420	0.621
Error	5	0.43633	0.08727	
Lack of Fit	1	0.29645	0.29645	0.044
Pure error	4	0.13988	0.03497	
Total	12	4.51263		

Table A.20 SR2: Surface Roughness for negative polarity copper tool

Correlation coefficient= 82.69%

Source	DOF	SS	MS	P
Model	7	1.86939	0.267056	0.098
Linear	3	1.82294	0.607646	0.025
I_p	1	0.47531	0.475312	0.057
V_g	1	0.72601	0.726012	0.029
T_{on}	1	0.62161	0.621612	0.037
Square	1	0.01212	0.012116	0.710
I_p^2	1	0.01212	0.012116	0.710
2-way interaction	3	0.03434	0.011446	0.928
$I_p \cdot V_g$	1	0.02101	0.021013	0.626
$I_p \cdot T_{on}$	1	0.01051	0.010512	0.729
$V_g \cdot T_{on}$	1	0.00281	0.002813	0.857
Error	5	0.39133	0.078267	
Lack of Fit	1	0.22781	0.227813	0.078
Pure error	4	0.16352	0.040880	
Total	12	2.26072		

Table A.21 SR3: Surface Roughness for positive polarity copper tungsten tool

Correlation coefficient= 87.77%

Source	DOF	SS	MS	P
Model	7	1.75157	0.250224	0.045
Linear	3	1.67894	0.559646	0.011
I_p	1	0.40051	0.400513	0.035
V_g	1	0.81281	0.812813	0.010
T_{on}	1	0.46561	0.465612	0.027
Square	1	0.02369	0.023692	0.517
I_p^2	1	0.02369	0.023692	0.517
2-way interaction	3	0.04894	0.016312	0.802
$I_p \cdot V_g$	1	0.03781	0.037812	0.419
$I_p \cdot T_{on}$	1	0.00661	0.006613	0.728
$V_g \cdot T_{on}$	1	0.00451	0.004513	0.773
Error	5	0.24403	0.048806	
Lack of Fit	1	0.18911	0.189112	0.021
Pure error	4	0.05492	0.013730	
Total	12	1.99560		

Table A.22 SR4: Surface Roughness for negative polarity copper tungsten tool

Correlation coefficient= 86.23%

Source	DOF	SS	MS	P
Model	7	1.64404	0.234863	0.059
Linear	3	1.61354	0.537846	0.014
I_p	1	0.46561	0.465612	0.031
V_g	1	0.63281	0.632812	0.018
T_{on}	1	0.51511	0.515112	0.026
Square	1	0.00427	0.004269	0.787
I_p^2	1	0.00427	0.004269	0.787
2-way interaction	3	0.02624	0.008746	0.914
$I_p \cdot V_g$	1	0.01711	0.017112	0.593
$I_p \cdot T_{on}$	1	0.00551	0.005512	0.759
$V_g \cdot T_{on}$	1	0.00361	0.003612	0.804
Error	5	0.26243	0.052487	
Lack of Fit	1	0.17111	0.171113	0.052
Pure error	4	0.09132	0.022830	
Total	12	1.90648		

Table A.23 SR5: Surface Roughness for positive polarity graphite tool

Correlation coefficient= 86.15%

Source	DOF	SS	MS	P
Model	7	1.75771	0.251102	0.060
Linear	3	1.70134	0.567112	0.015
I_p	1	0.40951	0.409512	0.043
V_g	1	0.71401	0.714012	0.016
T_{on}	1	0.57781	0.577812	0.024
Square	1	0.00524	0.005236	0.773
I_p^2	1	0.00524	0.005236	0.773
2-way interaction	3	0.05114	0.017046	0.824
$I_p \cdot V_g$	1	0.03781	0.037812	0.451
$I_p \cdot T_{on}$	1	0.01051	0.010512	0.684
$V_g \cdot T_{on}$	1	0.00281	0.002812	0.832
Error	5	0.28261	0.056523	
Lack of Fit	1	0.17701	0.177012	0.061
Pure error	4	0.10560	0.026400	
Total	12	2.04032		

Table A.24 SR6: Surface Roughness for negative polarity graphite tool

Correlation coefficient= 75.62%

Source	DOF	SS	MS	P
Model	7	10.9991	1.57130	0.199
Linear	3	7.6276	2.54255	0.102
I_p	1	1.6928	1.69280	0.183
V_g	1	2.7848	2.78480	0.104
T_{on}	1	3.1500	3.15005	0.089
Square	1	2.8802	2.88017	0.100
I_p^2	1	2.8802	2.88017	0.100
2-way interaction	3	0.4912	0.16375	0.871
$I_p \cdot V_g$	1	0.0145	0.01445	0.892
$I_p \cdot T_{on}$	1	0.1568	0.15680	0.658
$V_g \cdot T_{on}$	1	0.3200	0.32000	0.532
Error	5	3.5455	0.70909	
Lack of Fit	1	0.3280	0.32805	0.558
Pure error	4	3.2174	0.80435	
Total	12	14.5445		

Table A.25 RS1: Residual Stress for positive polarity copper tool

Correlation coefficient= 81.27%

Source	DOF	SS	MS	P
Model	7	120017	17145.3	0.116
Linear	3	61409	20469.8	0.096
I_p	1	48360	48360.5	0.032
V_g	1	10804	10804.5	0.221
T_{on}	1	2244	2244.5	0.552
Square	1	39918	39917.6	0.043
I_p^2	1	39918	39917.6	0.043
2-way interaction	3	18690	6230.0	0.422
$I_p \cdot V_g$	1	4232	4232.0	0.422
$I_p \cdot T_{on}$	1	8	8.0	0.971
$V_g \cdot T_{on}$	1	14450	14450.0	0.167
Error	5	27660	5531.9	
Lack of Fit	1	23544	23544.5	0.009
Pure error	4	4115	1028.8	
Total	12	147677		

Table A.26 RS2: Residual Stress for negative polarity copper tool

Correlation coefficient= 63.62%

Source	DOF	SS	MS	P
Model	7	42684.0	6097.7	0.417
Linear	3	12634.4	4211.5	0.518
I_p	1	528.1	528.1	0.756
V_g	1	630.1	630.1	0.734
T_{on}	1	11476.1	11476.1	0.186
Square	1	1033.2	1033.2	0.665
I_p^2	1	1033.2	1033.2	0.665
2-way interaction	3	29016.4	9672.1	0.235
$I_p \cdot V_g$	1	8646.1	8646.1	0.241
$I_p \cdot T_{on}$	1	2415.1	2415.1	0.513
$V_g \cdot T_{on}$	1	17955.1	17955.1	0.113
Error	5	24410.9	4882.2	
Lack of Fit	1	780.1	780.1	0.735
Pure error	4	23630.8	5907.7	
Total	12	67094.9		

Table A.27 RS3: Residual Stress for positive polarity copper tungsten tool

Correlation coefficient= 24.95%

Source	DOF	SS	MS	P
Model	7	89600	12800.0	0.956
Linear	3	40587	13528.8	0.858
I_p	1	13778	13778.0	0.635
V_g	1	26680	26680.5	0.513
T_{on}	1	128	128.0	0.963
Square	1	7119	7118.8	0.731
I_p^2	1	7119	7118.8	0.731
2-way interaction	3	41895	13965.0	0.852
$I_p \cdot V_g$	1	3613	3612.5	0.806
$I_p \cdot T_{on}$	1	3698	3698.0	0.804
$V_g \cdot T_{on}$	1	3458	3458.5	0.459
Error	5	269502	53900.3	
Lack of Fit	1	9941	9940.5	0.715
Pure error	4	259561	64890.3	
Total	12	359102		

Table A.28 RS4: Residual Stress for negative polarity copper tungsten tool

Correlation coefficient= 58.02%

Source	DOF	SS	MS	P
Model	7	100966	14423.7	0.525
Linear	3	5817	1939.1	0.936
I_p	1	91	91.1	0.940
V_g	1	1540	1540.1	0.759
T_{on}	1	4186	4186.1	0.615
Square	1	93023	93023.1	0.053
I_p^2	1	93023	93023.1	0.053
2-way interaction	3	2125	708.5	0.984
$I_p \cdot V_g$	1	0	0.1	0.998
$I_p \cdot T_{on}$	1	45	45.1	0.958
$V_g \cdot T_{on}$	1	2080	2080.1	0.721
Error	5	73054	14610.8	
Lack of Fit	1	780	780.1	0.846
Pure error	4	72274	18068.5	
Total	12	174020		

Table A.29 RS5: Residual Stress for positive polarity graphite tool

Correlation coefficient= 45.31%

Source	DOF	SS	MS	P
Model	7	155559	22222.8	0.745
Linear	3	47871	15957.1	0.744
I_p	1	36315	36315.1	0.371
V_g	1	231	231.1	0.941
T_{on}	1	11325	11325.1	0.607
Square	1	56556	56555.6	0.274
I_p^2	1	56556	56555.6	0.274
2-way interaction	3	51132	17044.1	0.726
$I_p \cdot V_g$	1	18145	18145.1	0.518
$I_p \cdot T_{on}$	1	91	91.1	0.963
$V_g \cdot T_{on}$	1	32896	32896.1	0.392
Error	5	187777	37555.4	
Lack of Fit	1	3240	3240.1	0.804
Pure error	4	184537	46134.2	
Total	12	343336		

Table A.30 RS6: Residual Stress for negative polarity graphite tool

Correlation coefficient= 64.74%

Source	DOF	SS	MS	P
Model	7	69995	9999.2	0.396
Linear	3	8736	2912.1	0.771
I_p	1	1830	1830.1	0.645
V_g	1	6555	6555.1	0.396
T_{on}	1	351	351.1	0.839
Square	1	47521	47520.8	0.055
I_p^2	1	47521	47520.8	0.055
2-way interaction	3	13737	4579.1	0.642
$I_p \cdot V_g$	1	9180	9180.1	0.323
$I_p \cdot T_{on}$	1	2346	2346.1	0.603
$V_g \cdot T_{on}$	1	2211	2211.1	0.613
Error	5	38126	7625.3	
Lack of Fit	1	6441	6441.1	0.418
Pure error	4	31685	7921.3	
Total	12	108121		

Table A.31 BN1: Barkhausen Noise (rms) for positive polarity copper tool

Correlation coefficient= 76.42%

Source	DOF	SS	MS	P
Model	7	110.853	15.8361	0.186
Linear	3	79.439	26.4795	0.090
I_p	1	24.221	24.2208	0.119
V_g	1	12.251	12.2512	0.238
T_{on}	1	42.966	42.9665	0.054
Square	1	21.534	21.5344	0.136
I_p^2	1	21.534	21.5344	0.136
2-way interaction	3	9.880	3.2933	0.709
$I_p \cdot V_g$	1	4.621	4.6208	0.449
$I_p \cdot T_{on}$	1	4.993	4.9928	0.432
$V_g \cdot T_{on}$	1	0.266	0.2664	0.851
Error	5	34.208	6.8417	
Lack of Fit	1	0.259	0.2592	0.870
Pure error	4	33.949	8.4873	
Total	12	145.061		

Table A.32 BN2: Barkhausen Noise (rms) for negative polarity copper tool

Correlation coefficient= 91.51%

Source	DOF	SS	MS	P
Model	7	11.0320	1.57601	0.020
Linear	3	7.9092	2.63641	0.009
I_p	1	2.9403	2.94031	0.013
V_g	1	1.2561	1.25611	0.056
T_{on}	1	3.7128	3.71281	0.008
Square	1	2.0677	2.06766	0.025
I_p^2	1	2.0677	2.06766	0.025
2-way interaction	3	1.0551	0.35171	0.278
$I_p \cdot V_g$	1	0.1830	0.18301	0.388
$I_p \cdot T_{on}$	1	0.8256	0.82561	0.101
$V_g \cdot T_{on}$	1	0.0465	0.04651	0.654
Error	5	1.0235	0.20471	
Lack of Fit	1	0.2346	0.23461	0.337
Pure error	4	0.7889	0.19723	
Total	12	12.0556		

Table A.33 BN3: Barkhausen Noise (rms) for positive polarity copper tungsten tool

Correlation coefficient=75.81%

Source	DOF	SS	MS	P
Model	7	25.8096	3.68709	0.196
Linear	3	25.4940	8.49801	0.055
I_p	1	7.4691	7.46911	0.086
V_g	1	9.3096	9.30961	0.063
T_{on}	1	8.7153	8.71531	0.070
Square	1	0.0001	0.00012	0.994
I_p^2	1	0.0001	0.00012	0.994
2-way interaction	3	0.3154	0.10515	0.977
$I_p \cdot V_g$	1	0.2701	0.27011	0.702
$I_p \cdot T_{on}$	1	0.0300	0.03001	0.898
$V_g \cdot T_{on}$	1	0.0153	0.01531	0.927
Error	5	8.2355	1.64710	
Lack of Fit	1	3.8503	3.85031	0.134
Pure error	4	4.3852	1.09630	
Total	12	34.0451		

Table A.34 BN4: Barkhausen Noise (rms) for negative polarity copper tungsten tool

Correlation coefficient= 81.67%

Source	DOF	SS	MS	P
Model	7	22.7929	3.25613	0.110
Linear	3	22.2852	7.42841	0.029
I_p	1	6.5703	6.57031	0.052
V_g	1	8.9253	8.92531	0.032
T_{on}	1	6.7896	6.78961	0.050
Square	1	0.0575	0.05754	0.822
I_p^2	1	0.0575	0.05754	0.822
2-way interaction	3	0.4501	0.15005	0.927
$I_p \cdot V_g$	1	0.4095	0.40951	0.555
$I_p \cdot T_{on}$	1	0.0153	0.01531	0.907
$V_g \cdot T_{on}$	1	0.0253	0.02531	0.881
Error	5	5.1148	1.02296	
Lack of Fit	1	2.6335	2.63351	0.108
Pure error	4	2.4813	0.62032	
Total	12	27.9077		

Table A. 35 BN5: Barkhausen Noise (rms) for positive polarity graphite tool

Correlation coefficient= 90.77%

Source	DOF	SS	MS	P
Model	7	11.6300	1.66143	0.024
Linear	3	10.1993	3.39975	0.007
I_p	1	1.4450	1.44500	0.056
V_g	1	3.5378	3.53780	0.012
T_{on}	1	5.2165	5.21645	0.005
Square	1	1.1262	1.12623	0.081
I_p^2	1	1.1262	1.12623	0.081
2-way interaction	3	0.3045	0.10150	0.741
$I_p \cdot V_g$	1	0.0512	0.05120	0.661
$I_p \cdot T_{on}$	1	0.0420	0.04205	0.691
$V_g \cdot T_{on}$	1	0.2112	0.21125	0.388
Error	5	1.1833	0.23665	
Lack of Fit	1	0.0084	0.00845	0.874
Pure error	4	1.1748	0.29370	
Total	12	12.8132		

Table A.36 BN6: Barkhausen Noise (rms) for negative polarity graphite tool

Correlation coefficient= 96.62%

Source	DOF	SS	MS	P
Model	7	46.0605	6.5801	0.002
Linear	3	24.5977	8.1992	0.002
I_p	1	0.0351	0.0351	0.755
V_g	1	24.5350	24.5350	0.000
T_{on}	1	0.0276	0.0276	0.781
Square	1	5.8491	5.8491	0.008
I_p^2	1	5.8491	5.8491	0.008
2-way interaction	3	15.6136	5.2045	0.005
$I_p \cdot V_g$	1	5.3956	5.3956	0.009
$I_p \cdot T_{on}$	1	6.1425	6.1425	0.007
$V_g \cdot T_{on}$	1	4.0755	4.0755	0.016
Error	5	1.6105	0.3221	
Lack of Fit	1	0.1225	0.1225	0.597
Pure error	4	1.4880	0.3720	
Total	12	47.6710		

Table A.37 PEAK1: Peak value for positive polarity copper tool

Correlation coefficient= 86.02%

Source	DOF	SS	MS	P
Model	7	414.996	59.285	0.061
Linear	3	314.557	104.852	0.025
I_p	1	134.726	134.726	0.025
V_g	1	84.956	84.956	0.054
T_{on}	1	94.875	94.875	0.045
Square	1	90.681	90.681	0.049
I_p^2	1	90.681	90.681	0.049
2-way interaction	3	9.758	3.253	0.864
$I_p \cdot V_g$	1	0.485	0.485	0.857
$I_p \cdot T_{on}$	1	2.703	2.703	0.673
$V_g \cdot T_{on}$	1	6.570	6.570	0.516
Error	5	67.451	13.490	
Lack of Fit	1	9.879	9.879	0.454
Pure error	4	57.572	14.393	
Total	12	482.448		

Table A.38 PEAK2: Peak value for negative polarity copper tool

Correlation coefficient= 66.47%

Source	DOF	SS	MS	P
Model	7	105.792	15.1132	0.363
Linear	3	83.865	27.9549	0.163
I_p	1	19.406	19.406	0.235
V_g	1	48.610	48.6098	0.086
T_{on}	1	15.848	15.848	0.277
Square	1	15.336	15.3356	0.284
I_p^2	1	15.336	15.3356	0.284
2-way interaction	3	6.592	2.1974	0.888
$I_p \cdot V_g$	1	2.420	2.4200	0.654
$I_p \cdot T_{on}$	1	0.252	0.2520	0.884
$V_g \cdot T_{on}$	1	3.920	3.9200	0.571
Error	5	53.361	10.6722	
Lack of Fit	1	16.018	16.0178	0.260
Pure error	4	37.343	9.3358	
Total	12	159.153		

Table A.39 PEAK3: Peak value for positive polarity copper tungsten tool

Correlation coefficient= 42.29%

Source	DOF	SS	MS	P
Model	7	66.411	9.4873	0.789
Linear	3	56.504	18.8347	0.451
I_p	1	14.338	14.3380	0.414
V_g	1	37.976	37.9756	0.207
T_{on}	1	4.191	4.1905	0.651
Square	1	7.135	7.1347	
I_p^2	1	7.135	7.1347	0.558
2-way interaction	3	2.773	0.9242	0.983
$I_p \cdot V_g$	1	1.133	1.1325	0.813
$I_p \cdot T_{on}$	1	0.611	0.6105	0.862
$V_g \cdot T_{on}$	1	1.030	1.0296	0.821
Error	5	90.614	18.1229	
Lack of Fit	1	33.171	33.1705	0.203
Pure error	4	57.444	14.3610	
Total	12	157.026		

Table A.40 PEAK4: Peak value for negative polarity copper tungsten tool

Correlation coefficient= 83.65%

Source	DOF	SS	MS	P
Model	7	150.573	21.5104	0.086
Linear	3	146.271	48.7569	0.022
I_p	1	25.099	25.0986	0.094
V_g	1	94.051	94.0506	0.010
T_{on}	1	27.122	27.1216	0.085
Square	1	0.065	0.0654	0.920
I_p^2	1	0.065	0.0654	0.920
2-way interaction	3	4.237	1.4122	0.865
$I_p \cdot V_g$	1	3.014	3.0135	0.506
$I_p \cdot T_{on}$	1	0.485	0.4851	0.786
$V_g \cdot T_{on}$	1	0.738	0.7381	0.738
Error	5	29.422	5.8844	
Lack of Fit	1	9.879	9.8790	0.228
Pure error	4	19.543	4.8857	
Total	12	179.995		

Table A.41 PEAK5: Peak value for positive polarity graphite tool

Correlation coefficient= 94.13%

Source	DOF	SS	MS	P
Model	7	73.2698	10.4671	0.008
Linear	3	64.0799	21.3600	0.002
I_p	1	3.4453	3.4453	0.110
V_g	1	6.6066	6.6066	0.043
T_{on}	1	54.0280	54.0280	0.001
Square	1	5.9300	5.9300	
I_p^2	1	5.9300	5.9300	0.051
2-way interaction	3	3.2599	1.0866	0.402
$I_p \cdot V_g$	1	0.1128	0.1128	0.740
$I_p \cdot T_{on}$	1	3.0876	3.0876	0.125
$V_g \cdot T_{on}$	1	0.0595	0.0595	0.809
Error	5	4.5662	0.9132	
Lack of Fit	1	0.0001	0.0001	0.993
Pure error	4	4.5661	1.1415	
Total	12	77.8360		

Table A.42 PEAK6: Peak value for negative polarity graphite tool

Correlation coefficient= 88.88%

Source	DOF	SS	MS	P
Model	7	113.728	16.247	0.037
Linear	3	99.769	33.256	0.011
I_p	1	19.500	19.500	0.047
V_g	1	21.353	21.353	0.041
T_{on}	1	58.916	58.916	0.006
Square	1	1.058	1.058	0.569
I_p^2	1	1.058	1.058	0.569
2-way interaction	3	12.902	4.301	0.320
$I_p \cdot V_g$	1	2.892	2.892	0.360
$I_p \cdot T_{on}$	1	7.354	7.354	0.169
$V_g \cdot T_{on}$	1	2.657	2.657	0.378
Error	5	14.235	2.847	
Lack of Fit	1	6.607	6.607	0.136
Pure error	4	7.628	1.907	
Total	12	127.963		