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Article

A Multifocal Study Investigation of Pyrolyzed Printed Circuit Board Leaching

Gvozden Jovanović [1], Mladen Bugarčić [1], Nela Petronijević [1], Srecko R. Stopic [2], Bernd Friedrich [2], Branislav Marković [1,*], Srđan Stanković [3] and Miroslav Sokić [1]

[1] Institute for Technology of Nuclear and Other Mineral Raw Materials, 11000 Belgrade, Serbia

[2] IME Process Metallurgy and Metal Recycling, RWTH Aachen University, 52056 Aachen, Germany

[3] Federal Institute for Geosciences and Natural Resources, Stilleweg 2, 30655 Hannover, Germany

* Correspondence: b.markovic@itnms.ac.rs; Tel.: +381-11-3691-722

Origin of present elements in the element distribution Table 1 can be explained by various computer components. Therefore the fallowing elements can be found in:

- Silver (Ag) – Alloy electrum
- Gold (Au) – Alloy electrum, also present in elemental form
- Aluminum (Al) – Present in elemental form
- Barium (Ba) – Present as $BaSO_4$ but also as $Ba_xSr_{1-x}TiO_3$
- Carbon (C) – Formed during pyrolysis, originates from polymer materials
- Calcium (Ca) – Present as CaF_2
- Cerium (Ce) – Present as CeO_2
- Cobalt (Co) – Present as $LiCoO_2$
- Copper (Cu) – Present in elemental form
- Iron (Fe) – Present mainly in elemental form, as an oxide and as $Nd_2Fe_{14}B$
- Lithium (Li) – Present as $LiCoO_2$ and as organometallic Li present in polymer
- Neodymium (Nd) – Present as $Nd_2Fe_{14}B$
- Nickel(Ni) – Present in elemental form
- Manganese (Mn) – Present as an alloy but also as a dopant in $LiCoO_2$
- Lead (Pb) – Present as a soldering alloy PbSn60
- Palladium (Pd) – In elemental form
- Platinum (Pt) – Present in elemental form
- Silicon (Si) – Present as SiO_2
- Tin (Sn) – Present as a soldering alloy PbSn60
- Yttrium (Y) – Mainly present as Y_2O_3
- Zinc (Zn) – Present as ZnO as well as ZnS

Table S1. Leeching degree after 4 hours.

Leeching Medium	S/L	T (°C)	Leaching Degree (%)								
			Al	Cu	Zn	Sn	Ca	Pb	Ba	Co	Nd
1M H_2SO_4	0.025	60	42.74	34.00	41.20	7.75	14.89	0.97	0.05	83.10	74.50
1M H_2SO_4	0.042	60	40.32	35.06	44.2	1.82	8.93	0.64	0.03	77.14	67.71
1M H_2SO_4	0.058	60	34.00	24.71	38.48	1.42	6.41	0.45	0.02	61.63	40.89
2M H_2SO_4	0.025	60	55.47	33.67	41.11	50.92	14.89	0.71	0.05	57.14	54.86
2M H_2SO_4	0.042	60	47.20	26.20	40.53	6.61	8.93	0.43	0.03	66.86	55.82
2M H_2SO_4	0.058	60	42.80	22.71	40.19	3.28	6.38	0.35	0.02	58.78	48.52

3M H_2SO_4	0.025	60	54.55	27.33	40.98	44.77	20.69	0.39	0.05	77.14	48.44
0.5M H_2SO_4	0.025	60	35.59	37.33	41.42	1.37	35.33	0.95	0.05	81.90	66.06
0.5M H_2SO_4	0.025	80	37.03	40.25	44.57	1.72	15.14	0.47	0.02	76.73	69.67
1M H_2SO_4	0.042	40	24.40	21.70	35.20	1.30	21.20	0.62	0.03	71.43	68.26
2M H_2SO_4	0.100	60	41.58	18.08	41.00	16.12	8.49	0.22	0.06	78.57	/
2M H_2SO_4	0.150	60	35.20	16.94	39.26	4.26	5.76	0.19	0.04	52.86	/
2M H_2SO_4	0.200	60	33.89	13.42	40.00	9.73	4.44	0.16	0.03	55.00	/
2M H_2SO_4	0.300	60	34.16	10.92	40.37	5.32	3.17	0.14	0.02	53.25	/
2M H_2SO_4 + 2M H_2O_2	0.081	60	50.82	83.74	49.38	5.98	11.75	0.49	0.07	70.25	/
2M H_2SO_4 + 2M H_2O_2	0.121	60	48.60	80.16	49.38	3.36	8.23	0.30	0.05	65.65	/
2M H_2SO_4 + 2M H_2O_2	0.162	60	44.02	16.80	48.01	1.92	6.56	0.28	0.04	64.08	/
2M H_2SO_4 + 2M H_2O_2	0.243	60	42.61	13.01	46.64	1.00	4.27	0.21	0.02	59.28	/
2M H_2SO_4 + 1M H_2O_2	0.090	60	50.17	73.06	45.19	2.66	9.75	0.36	0.07	59.86	/
2M H_2SO_4 + 3M H_2O_2	0.074	60	55.65	95.57	51.07	5.93	12.89	0.39	0.08	70.49	/
2 M H_2SO_4 + 1M H_2O_2	0.179	60	46.46	16.26	44.69	1.24	5.33	0.21	0.03	66.64	/
2 M H_2SO_4 + 3M H_2O_2	0.148	60	49.33	16.43	48.82	1.93	6.72	0.28	0.04	67.11	/
AMD	0.100	60	0	10.83	28.38	0.00	3.54	0.16	0	57.86	/
AMD + 1 M H_2O_2	0.090	60	1.43	9.81	28.59	0.00	3.99	0.11	0	50.76	/
AMD + 2M H_2O_2	0.081	60	1.04	11.86	28.81	0.00	4.09	0.17	0	46.50	/
AMD + 3 M H_2O_2	0.074	60	0	14.71	38.25	0.01	7.59	0.09	0	89.08	/
AMD + 5 ml cc H_2SO_4	0.098	60	29.78	21.46	40.73	0.14	5.10	0.30	0	56.13	/
AMD + 1 M H_2O_2 + 5ml cc H_2SO_4	0.088	60	23.74	48.91	37.50	0.10	6.29	0.38	0	52.82	/
AMD + 2M H_2O_2 + 5 ml CC H_2SO_4	0.079	60	35.20	62.67	49.57	0.15	8.27	0.44	0	86.42	/
AMD + 3 M H_2O_2 + 5 ml cc H_2SO_4	0.073	60	35.58	63.44	50.75	0.13	10.41	0.49	0	75.20	/
H2O + 1 M H_2O_2	0.090	60	0.01	0.33	5.87	0.02	2.44	1.62	9.76	26.60	/
H2O + 3 M H_2O_2	0.074	60	0.01	0.39	6.94	0.03	2.38	2.22	9.94	32.19	/
NADES	0.100	60	15.86	2.51	28.85	1.52	0.28	27.09	0.49	27.59	n.d.
NADES + 3M H_2O_2	0.100	60	6.75	17.20	29.21	3.21	0.50	17.12	0.82	44.75	11.92
1 M H_2SO_4	0.100	60	38.45	77.62	54.21	1.71	10.85	0.57	0.12	93.78	61.45
2M HNO3 + 3M H_2O_2	0.100	60	41.86	94.71	74.46	0.84	37.11	78.76	22.94	95.13	93.74

Table S2. Leaching with two strong oxidizing agents.

$5Al_{(s)} + 18HNO_{3(aq)} + 3H_2O_{2(aq)} \rightarrow 5Al(NO_3)_{3(aq)} + 12H_2O_{(l)} + 3NO_{(g)}$	Eq. (S1)
$5Co_{(s)} + 12HNO_{3(aq)} + 2H_2O_{2(aq)} \rightarrow 5Co(NO_3)_{2(aq)} + 8H_2O_{(l)} + 2NO_{(g)}$	Eq. (S2)
$5Sn_{(s)} + 12HNO_{3(aq)} + 2H_2O_{2(aq)} \rightarrow 5Sn(NO_3)_{2(aq)} + 8H_2O_{(l)} + 2NO_{(g)}$	Eq. (S3)
$5Sn_{(s)} + 4HNO_{3(aq)} + 4H_2O_{2(aq)} \rightarrow 5SnO_{2(s)} + 6H_2O_{(l)} + 4NO_{(g)}$	Eq. (S4)
$5Cu_{(s)} + 12HNO_{3(aq)} + 2H_2O_{2(aq)} \rightarrow 5Cu(NO_3)_{2(aq)} + 8H_2O_{(l)} + 2NO_{(g)}$	Eq. (S5)