

6 June 2025 | online webinar

EU Green Week Partner Event

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PEACOC Project

**Magnetic Density Separation [MDS] and Other
Recycling Operations**



Content

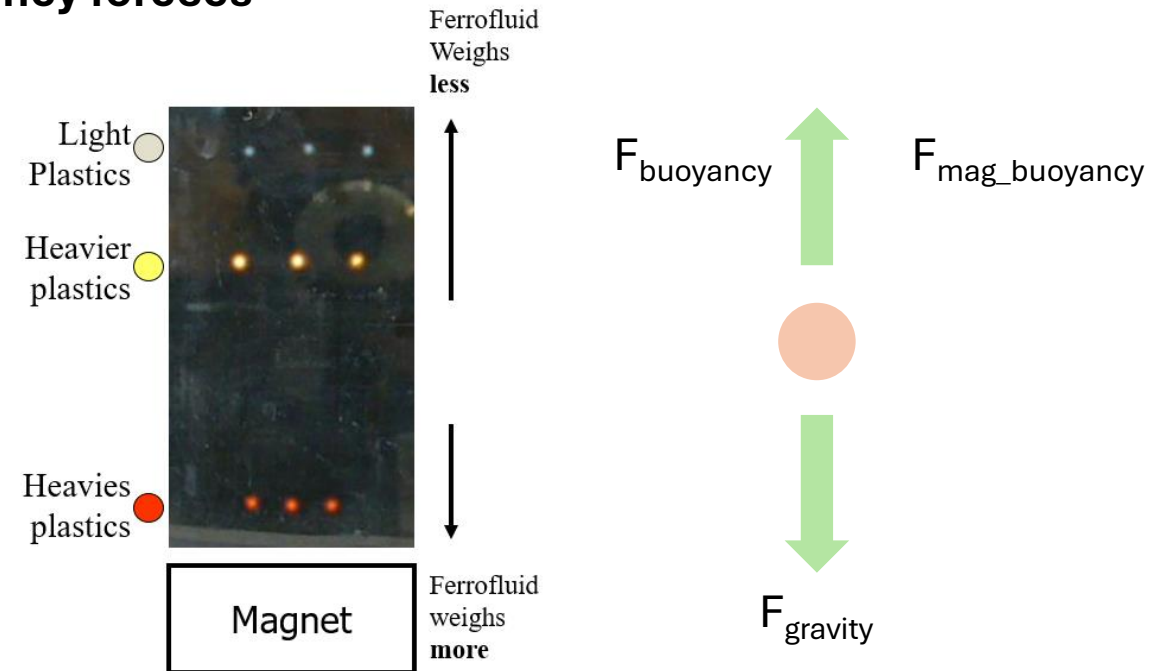
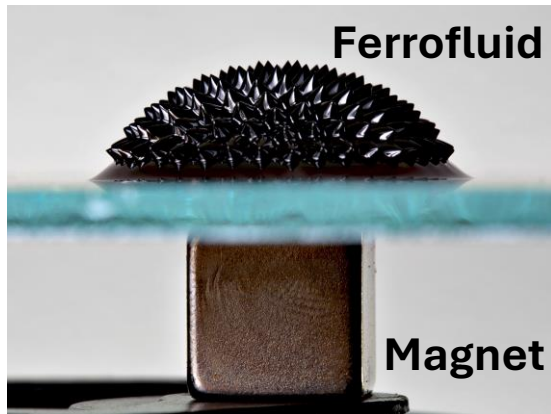
1. Magnetic density separation [MDS]
2. PMs concentration from PCBAs at large scale
3. PMs concentration from PV panels at large scale
4. TUD team

1. Magnetic density separation [MDS]

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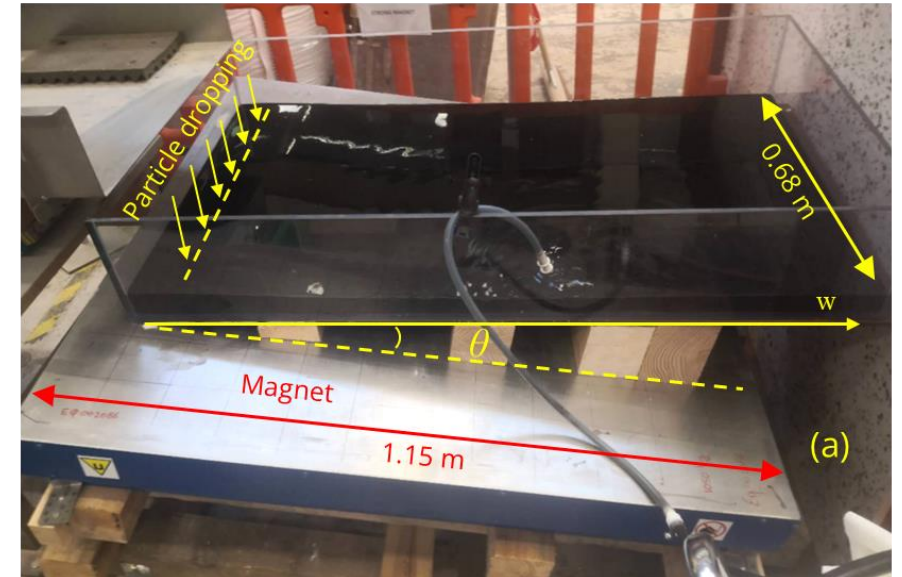
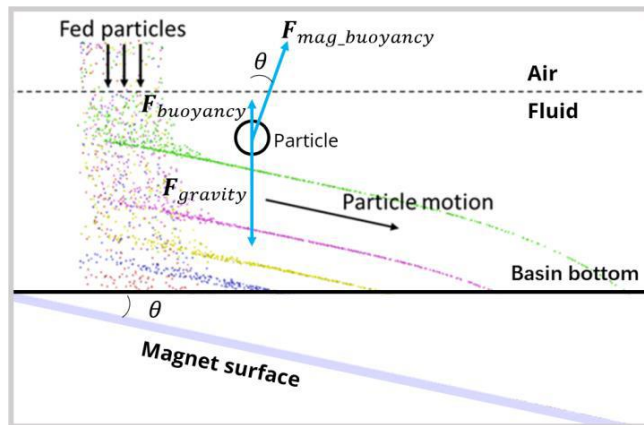
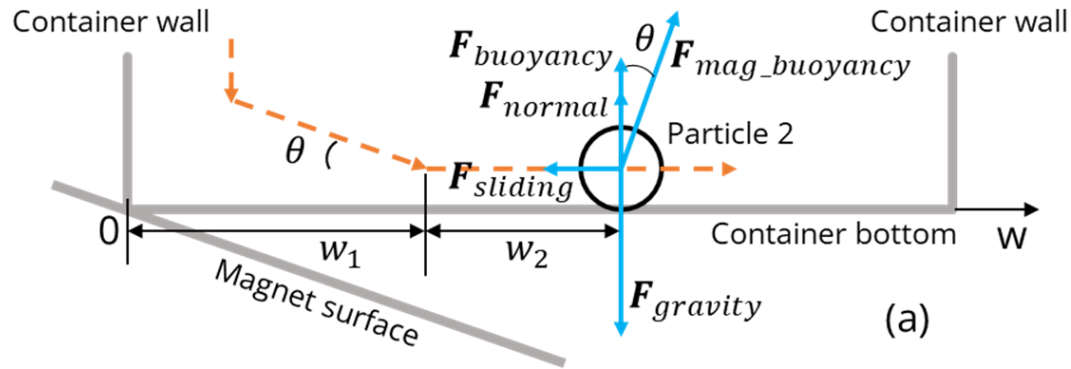
Magnetic density separation [MDS] technology is an effective method for the physical beneficiation in various fields.

Forces: gravity, buoyancy, and magnetically induced buoyancy force



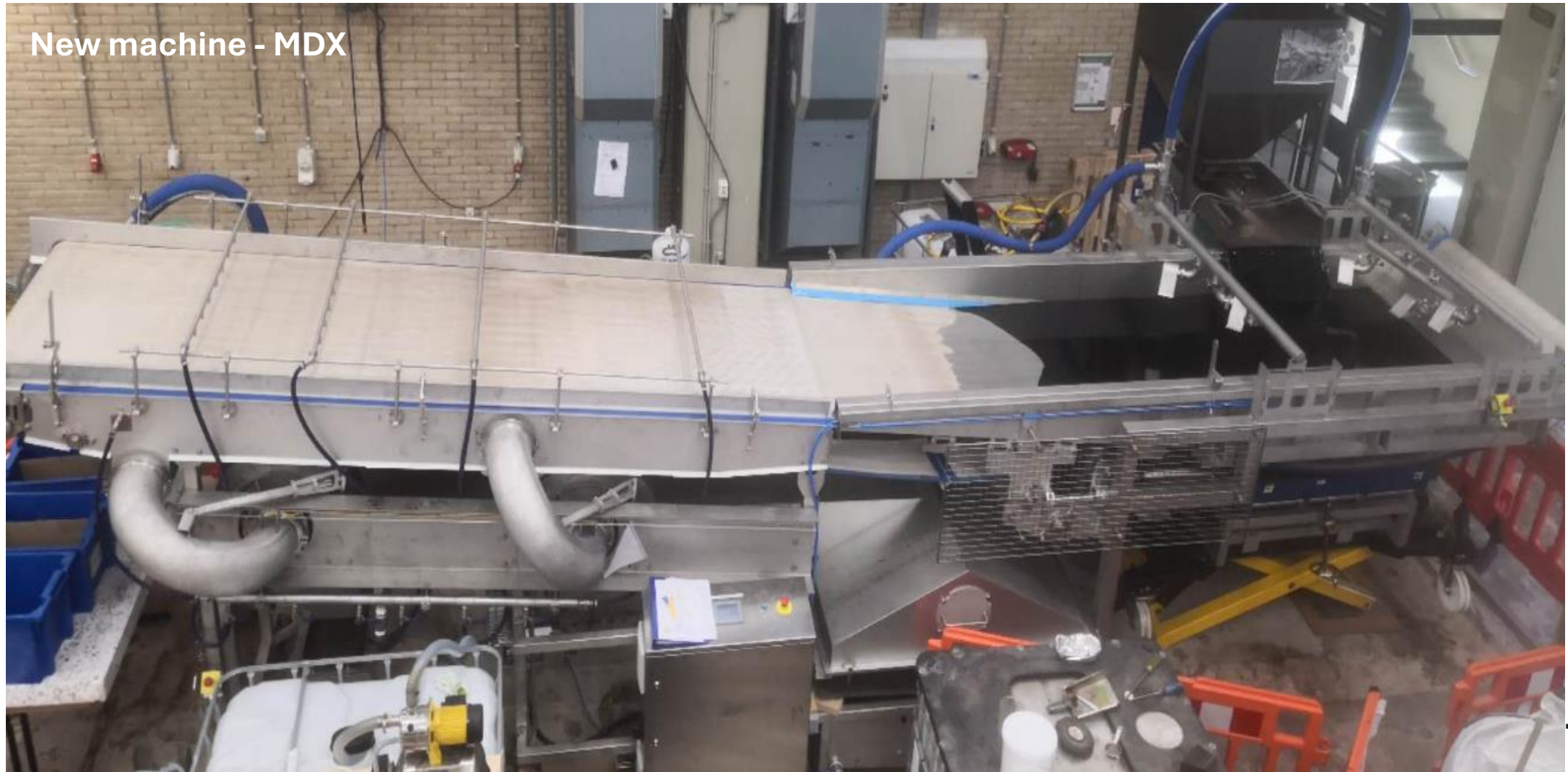
Traditional MDS process

1. Magnetic density separation [MDS]

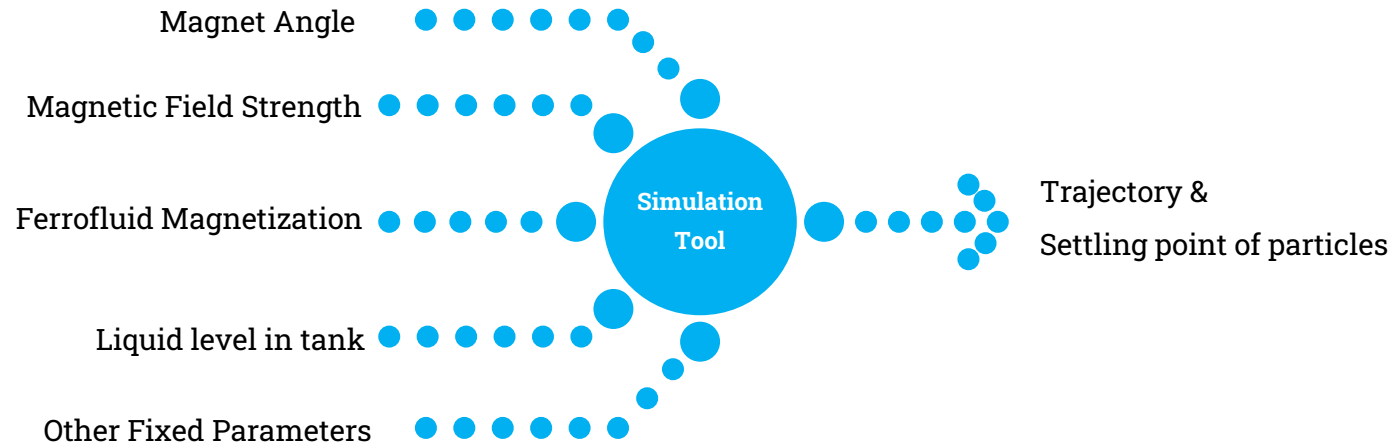


New MDS process

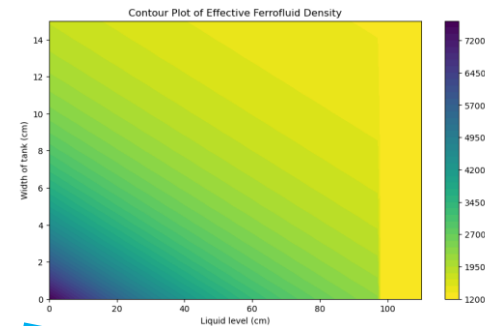
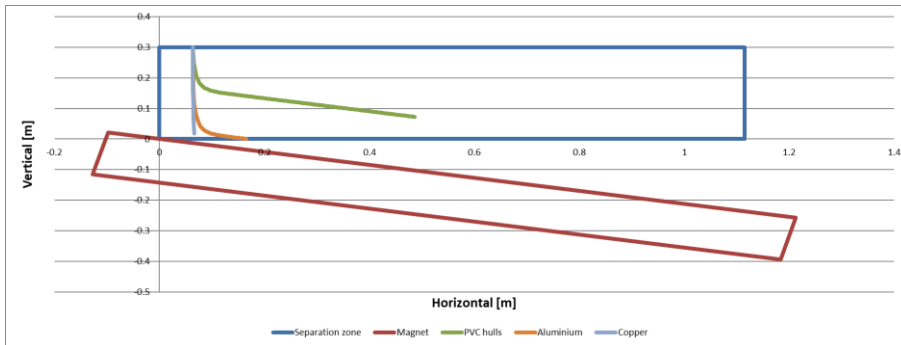
1. Magnetic density separation [MDS]



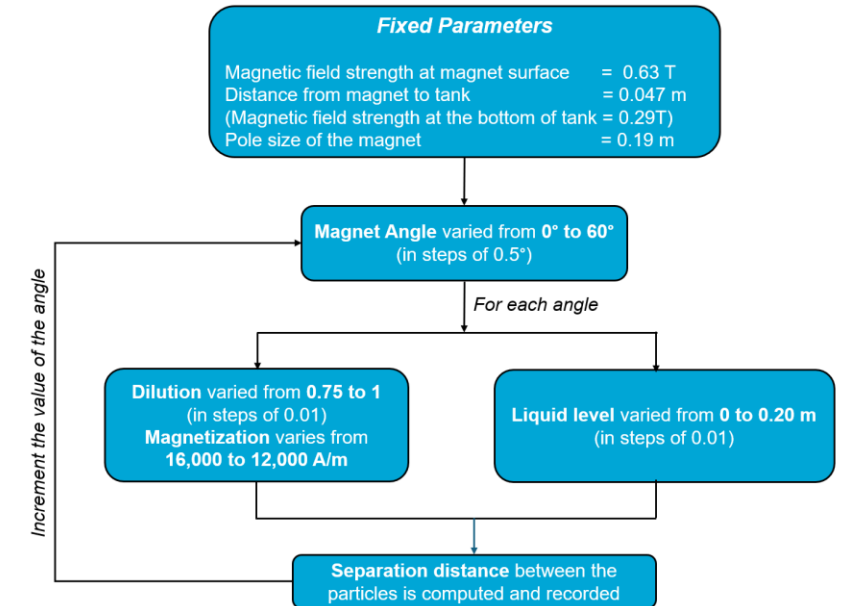
1. Magnetic density separation [MDS]



$$F = (\rho_p - \rho) gV \{ \sin \varphi e_x - \cos \varphi e_y \} + \frac{\pi MVB_0}{p} e^{-\pi y/p} e_y$$



Magnet



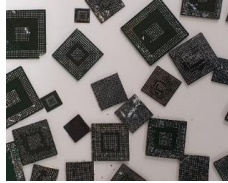
Wang, L., Rem, P., Di Maio, F., van Beek, M., & Tomás, G. (2024). An Innovative Magnetic Density Separation Process for Sorting Granular Solid Wastes. Recycling, 9(3), 48.

2. PMs concentration from PCBAs at large scale

2. PMs concentration from PCBAs at large scale



Electronic components



CPUs



IC chips



**Plastic electrical connectors
Copper socket frames**

Roller separation



25 kg/h



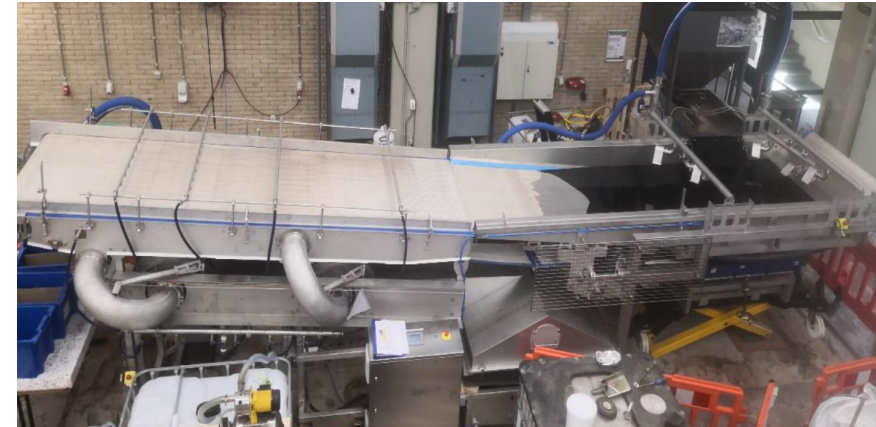
Magnetic separation



50 kg/h



MDS separation



1,000 kg/h

2. PMs concentration from PCBAs at large scale



2. PMs concentration from PCBAs at large scale

EC masss (g)							Gold				Value			
		CPU's	Chips	Card Slot	Other	Sum	Au (mg)	Recovery	Au (mg/kg)	Increase start	Increase previous	€	€/kg	
<4	Mag	7.7	472.95	0	344.5	825.15	208.8	3%	253.05	4.34	1	18.79	22.77	
	Non	P1	7.1	13.9	0	152	173	15.21	0%	87.92	1.51	1.00	1.37	7.91
		P2	632	1017.5	0	778.8	2428.3	1261.59	20%	519.54	8.90	1.08	113.54	46.76
		P3	92.75	12.35	0	200.6	305.7	127.62	2%	417.46	7.15	0.87	11.49	37.57
		P4	0	0	0	7.85	7.85	0.00	0%	0.00	0.00	0.00	0.00	0.00
4-8	Mag	2.95	139.3	0	5991.15	6133.4	62.40	1%	10.17	0.17	1.00	5.62	0.92	
	Non	P1	105.6	99.8	0	1871.75	2077.15	181.31	3%	87.29	1.50	0.34	16.32	7.86
		P2	1270.3	3045	30.95	4630	8976.25	2960.37	46%	329.80	5.65	1.27	266.43	29.68
		P3	21.45	391.2	0	1313.7	1726.35	192.62	3%	111.58	1.91	0.43	17.34	10.04
		P4	0	0	0	72.65	72.65	0.00	0%	0.00	0.00	0.00	0.00	0.00
8-14	Mag	0	7.1	0	18670	18677.1	2.98	0%	0.16	0.00	1.00	0.27	0.01	
	Non	P1	11.25	14.45	22.8	3146.75	3195.25	24.36	0%	7.62	0.13	0.14	2.19	0.69
		P2	553.55	327.8	548.95	10865	12295.3	951.28	15%	77.37	1.33	1.45	85.61	6.96
		P3	11	37.7	6.6	3249.7	3305	31.35	0%	9.49	0.16	0.18	2.82	0.85
		P4	0	0	0	127.55	127.55	0.00	0%	0.00	0.00	0.00	0.00	0.00
14-18	Mag	0	0	134.2	17535	17669.2	20.27	0%	1.15	0.02	1.00	1.82	0.10	
	Non	P1	0	0	52	1305.1	1357.1	7.85	0%	5.79	0.10	0.46	0.71	0.52
		P2	49.3	135.05	684.5	9320	10188.85	225.18	4%	22.10	0.38	1.76	20.27	1.99
		P3	0.35	5.4	32.4	7500	7538.15	7.62	0%	1.01	0.02	0.08	0.69	0.09
		P4	0	0	0	83.2	83.2	0.00	0%	0.00	0.00	0.00	0.00	0.00
>18	Mag	0	1.2	0	4269.25	4270.45	0.50	0%	0.12	0.00	1.00	0.05	0.01	
	Non	P1	0	0	70.5	604.9	675.4	10.65	0%	15.77	0.27	1.26	0.96	1.42
		P2	6.4	2.8	480.8	2529.8	3019.8	82.24	1%	27.23	0.47	2.17	7.40	2.45
		P3	0.8	6.5	8.1	3790.4	3805.8	5.01	0%	1.32	0.02	0.10	0.45	0.12
		P4	0	2.15	0	378.2	380.35	0.90	0%	2.37	0.04	0.19	0.08	0.21
		Highest Au concentration	Medium Au concentration		Low Au concentration									



Highest Au concentration



Medium Au concentration



Low Au concentration

2. PMs concentration from PCBAs at large scale

Highest Au concentration:

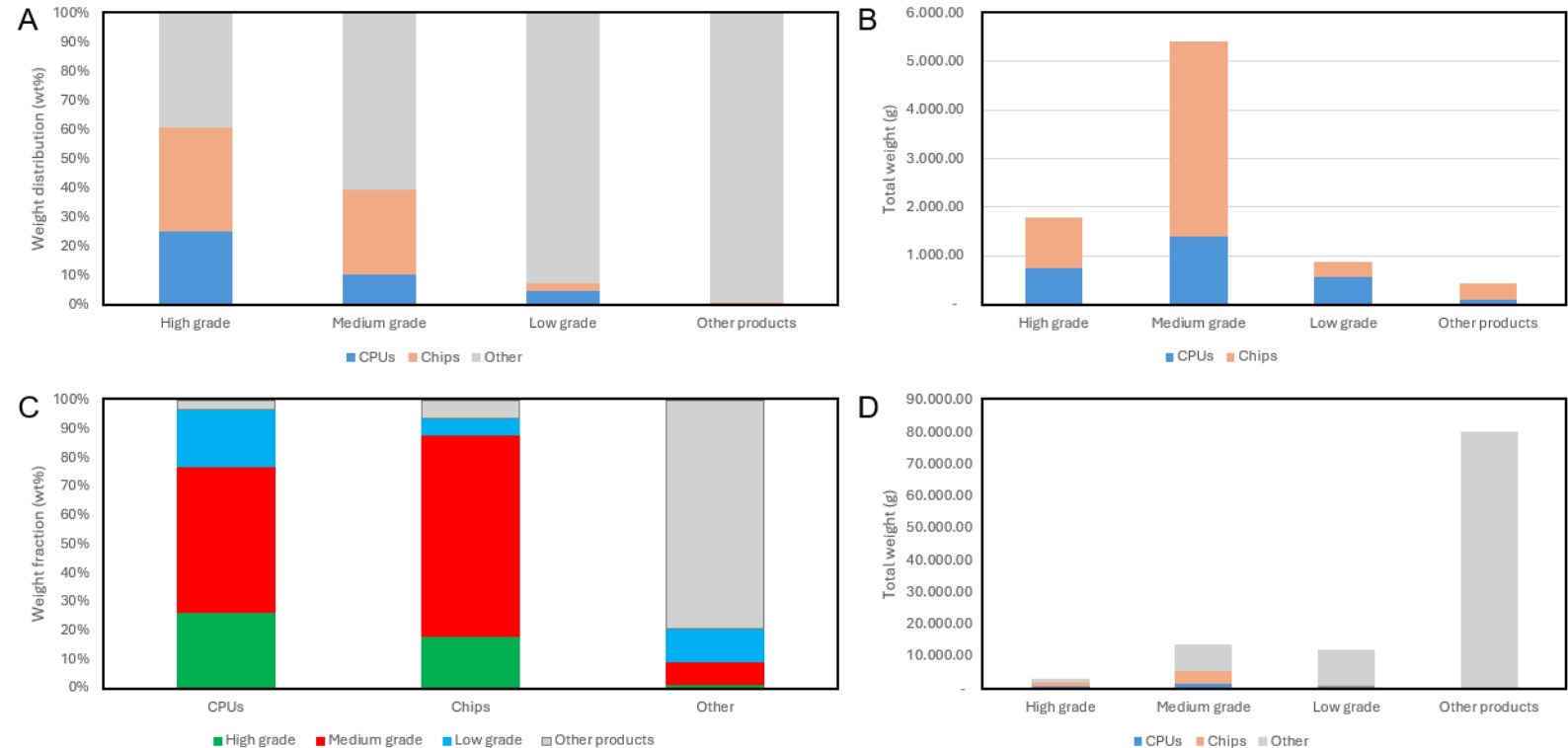
- <4 mm non-magnetic fraction.

Medium Au concentration:

- <4 mm magnetic fraction.
- 4-8 mm non-magnetic fraction.

Low Au concentration:

- 8-14 mm non-magnetic fraction, product 2.



3. PMs concentration from PV scrap at large scale

3. PMs concentration from PV scrap at large scale

Sieve

Density separation

Magnetic separation



PMs (Ag)
~ 1%



70 kg/h



10 kg/h



50 kg/h



1

2

3

4

5

6

7

8

9

PMs (Ag)
~ 4.8%

PMs (Ag)
~ 5.4%

3. PMs concentration from PV scrap at large scale

The processed data of all the PV pannels

			Batch 1	Batch 2	Batch 3	Batch 4	
Sieve size	Density	Magnetic	Mass (g)	Mass (g)	Mass (g)	Mass (g)	Total (g)
< 200	Heavy	Mag	1,356.71	7,607.00	11,861.25	5,817.85	26,642.81
		Non	1,056.51	4,069.05	12,428.25	3,840.20	21,394.01
	Light	Mag	835.75	2,565.60	3,540.70	2,399.20	9,341.25
		Non	9,703.85	23,352.00	31,901.75	14,905.00	79,862.60
200 - 1000	Heavy	Mag	3,926.80	26,499.00	34,251.00	28,545.00	93,221.80
		Non	6,542.50	56,740.00	62,245.00	49,885.00	175,412.50
	Light	Mag	4,039.30	8,779.00	11,987.65	8,070.00	32,875.95
		Non	41,763.70	91,738.00	98,569.20	68,290.00	300,360.90
			> 1000	24,920.00	52,203.25	55,815.00	37,310.00
		SUM (g)		94,150.00	273,550.00	322,599.80	219,062.25

4. Team members



Dr. Francesco Di Maio
15+ patents in separation technologies.
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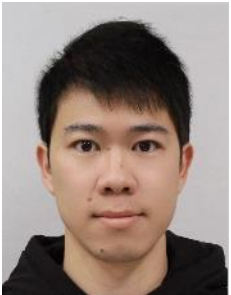
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THANK YOU

