

Table-1
Size distribution (volumetric percentage) of PM emitted by the Pb recycling process.

	Refining PM	Furnace PM Vol %	Emissions PM
< 1 μm	2.4	7.4	21.0
1 – 2.5 μm	2.1	6.3	19.9
2.5 - 10 μm	16.7	14.0	<u>50.0</u>
10 - 30 μm	<u>56.4</u>	<u>38.4</u>	8.2
30 - 100 μm	22.4	30.2	0.9
> 100 μm	< LD	3.7	< LD

* The main size fraction is underlined and secondary is in bold characters. < LD: lower than detection threshold (LD = 0.01 vol. %). Results are averaged upon five replicates and standard deviations do not exceed 0.2%.

Table-2

Elemental total mass contents (mass of element/total mass expressed in %) of PM emitted by the Pb recycling process.

	Al	As	Cd	Cu	Fe	Na	Ni	Pb	Sb	Zn	S	Cl	C	O
Refining														
PM _{tot}	0.07	0.3	0.2	0.6	1.3	2.2	0.5	41	1.9	0.2	2.9	n.d.	2.2	20.5
PM _{10-2.5}	0.08	0.6	0.2	0.7	1.4	5.9	0.3	32	2.3	0.4	7.2	0.35	4.1	19.2
PM _{2.5-1}	0.09	0.5	0.2	0.7	1.4	8.9	0.2	32.3	2.1	0.4	7.4	n.d.	4.3	20
Furnace														
PM _{tot}	0.1	0.06	0.2	0.2	5.7	6.8	0.08	25.7	0.55	0.2	2.8	n.d.	4.6	20.1
PM _{10-2.5}	0.07	0.08	0.4	0.2	4.5	10.3	0.05	45.2	0.6	0.3	7.6	0.54	6.5	21
PM _{2.5-1}	0.05	0.08	0.7	0.1	2.1	8.3	0.02	38	0.49	0.4	8.2	n.d.	5.1	20.1
Emissions														
PM _{tot}	0.02	0.09	2.7	0.09	1.2	5	0.02	33.4	0.18	0.7	3.3	n.d.	1	15
PM _{10-2.5}	0.005	0.08	2.3	0.06	0.4	4	0.009	26.7	0.14	0.5	7.4	1.93	1.2	15.1
PM _{2.5-1}	0.001	0.09	2.5	0.05	0.1	3.2	0.004	27.3	0.13	0.5	7.8	n.d.	1.2	14.9

n.d. stands for not determined. Results are averaged upon three replicates, standard deviations not exceeding 0.1%.

Table-3
Minerals identified by powder XRD

Samples	Minerals
<i>Refining</i>	
PM_{tot}	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , Pb ₂ As ₂ O ₇ , CdSO ₄ , CdS, Na ₂ SO ₄
PM₁₀	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , Pb ₂ As ₂ O ₇ , CdSO ₄ , CdS, Na ₂ SO ₄ , ZnO
PM_{2.5}	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , Pb ₂ As ₂ O ₇ , CdSO ₄ , CdS, Na ₂ SO ₄ , ZnO
<i>Furnace</i>	
PM_{tot}	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , Pb ₂ As ₂ O ₇ , CdSO ₄ , CdS, Na ₂ SO ₄
PM₁₀	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , Pb ₂ As ₂ O ₇ , CdSO ₄ , CdS, Na ₂ SO ₄ , ZnO, ZnSO ₄
PM_{2.5}	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , Pb ₂ As ₂ O ₇ , CdSO ₄ , CdS, Na ₂ SO ₄ , 2PbO.PbSO ₄
<i>Emissions</i>	
PM_{tot}	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , CdSO ₄ , Cd(ClO ₄) ₂ , Na ₂ SO ₄
PM₁₀	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , CdSO ₄ , Cd(ClO ₄) ₂ , Na ₂ SO ₄
PM_{2.5}	Pb ⁰ , PbS, PbO.PbSO ₄ , Pb(ClO ₄) ₂ , CdSO ₄ , Cd(ClO ₄) ₂ , Na ₂ SO ₄ , FeS ₂

Table-4
Determination of main species observed by Raman microspectrometry

	Phases identified
Refining	
PM _{tot}	4PbO.PbSO₄, PbSO₄, α-PbO, Na₂SO₄ , PbCO ₃ , Pb ₃ (CO ₃) ₂ (OH) ₂ , (Fe,x) ₃ O ₄ .
PM ₁₀	4PbO.PbSO₄, PbSO₄, α-PbO, Na₂SO₄ , PbCO ₃ , Pb ₃ (CO ₃) ₂ (OH) ₂ , (Fe,x) ₃ O ₄
PM _{2.5}	PbO.PbSO₄, PbSO₄ , PbCO ₃ , α-PbO, Na₂SO₄ , α-Fe ₂ O ₃ .
Furnace	
PM _{tot}	PbO.PbSO₄, PbSO₄, α-PbO, Na₂SO₄ , PbCO ₃
PM ₁₀	PbO.PbSO₄, PbSO₄, α-PbO, Na₂SO₄ , PbCO ₃ , β-PbO, ZnSO ₄ , α-Fe ₂ O ₃
PM _{2.5}	PbO.PbSO₄, PbSO₄, α-PbO, Na₂SO₄ , PbCO ₃ α-Fe ₂ O ₃ , (Fe,Zn) ₃ O ₄ , Fe ₃ O ₄
Emissions	
PM _{tot}	PbO.PbSO₄, α-PbO , β-PbO, Na₂SO₄ , (Fe,Zn) ₃ O ₄ ,
PM ₁₀	PbO.PbSO₄, α-PbO, PbSO₄ , PbCO ₃ , Na₂SO₄ , ZnSO ₄ , CaSO ₄ .
PM _{2.5}	xPbO.PbSO₄ x=(1,2,3), α-PbO, PbSO₄, Na₂SO₄ , ZnSO ₄ .

Major compounds in bold characters.

Table-5**Calculated metal enrichment factors (EF) in PM_{10-2.5} and PM_{2.5-1} compared to PM_{tot}.**

	Al	As	Cd	Cu	Fe	Na	Ni	Pb	Sb	Zn	S	Cl	C	O
Refining														
EF PM _{10-2.5} /PM _{tot}	1.1	2.0	1.0	1.2	1.1	2.7	0.6	0.8	1.2	2.0	2.5	n.d.	1.9	0.9
EF PM _{2.5-1} /PM _{tot}	1.3	1.7	1.0	1.2	1.1	4.0	0.4	0.8	1.1	2.0	2.6	n.d.	2.0	1.0
Furnace														
EF PM _{10-2.5} /PM _{tot}	0.7	1.3	2.0	1.0	0.8	1.5	0.6	1.8	1.1	1.5	2.7	n.d.	1.4	1.0
EF PM _{2.5-1} /PM _{tot}	0.5	1.3	3.5	0.5	0.4	1.2	0.3	1.5	0.9	2.0	2.9	n.d.	1.1	1.0
Emissions														
EF PM _{10-2.5} /PM _{tot}	0.3	0.9	0.9	0.7	0.3	0.8	0.5	0.8	0.8	0.7	2.2	n.d.	1.2	1.0
EF PM _{2.5-1} /PM _{tot}	0.1	1.0	0.9	0.6	0.1	0.6	0.2	0.8	0.7	0.7	2.4	n.d.	1.2	1.0