

Supplementary information:

Advances in the separation of graphite from lithium iron phosphate from end-of-life batteries shredded fine fraction using simple froth flotation

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Table S1 . Detailed XRF results of the different fractions obtained after dry-sieving.

Size fraction	wt% Cu	(wt%) error	Fe (wt%)	error	Al (wt%)	error	P (wt%)	error	C (wt%)	error	Bal (wt%)	error
<32 μm	28.20	0.38	0.01	18.45	0.11	0.11	0.01	7.93	0.15	48.62	23.43	0.19
32-63 μm	20.20	0.40	0.01	22.35	0.24	0.20	0.02	9.90	0.07	38.02	28.37	0.41
63-125 μm	18.20	0.48	0.04	30.82	0.19	0.37	0.09	13.95	0.10	14.60	39.13	0.24
125-250 μm	25.50	1.06	0.13	30.93	0.13	0.89	0.09	14.06	0.18	13.12	39.27	0.59
250-500 μm	5.60	10.02	1.20	19.81	1.92	10.85	1.03	10.56	0.15	20.34	25.16	1.35
>500 μm	2.40	32.52	2.49	4.70	0.83	37.92	3.41	4.86	0.06	12.55	5.97	3.78

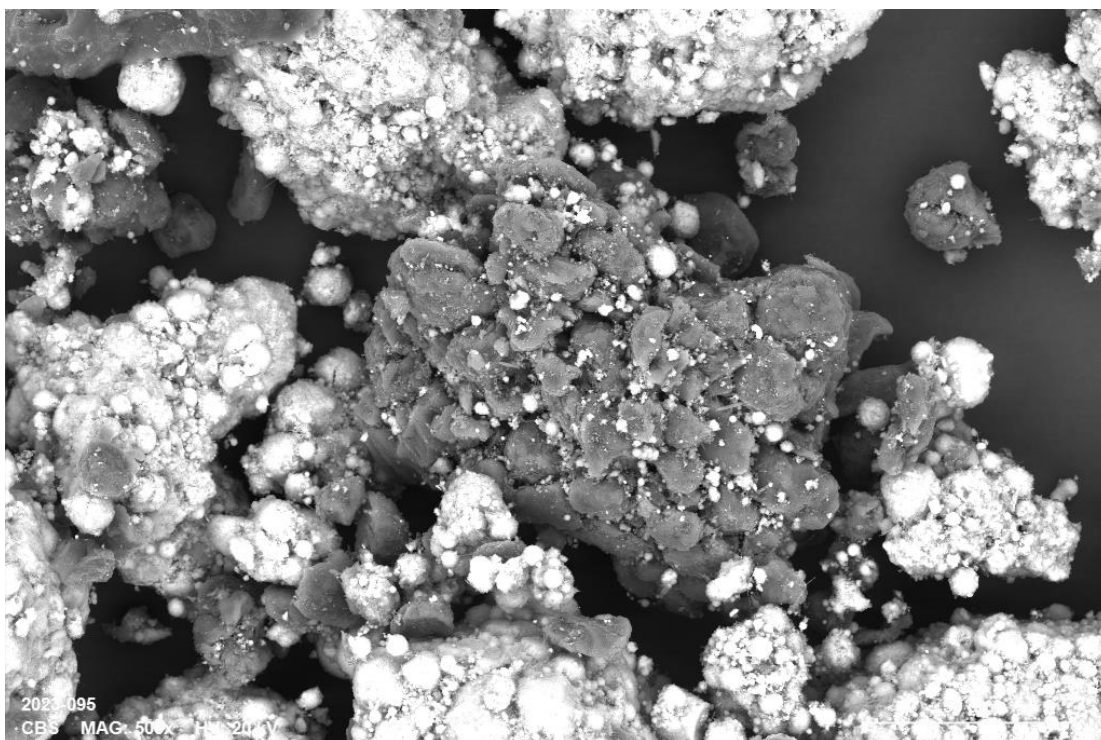


Figure S1: SEM image taken at magnification X500 of black mass <125 μm .

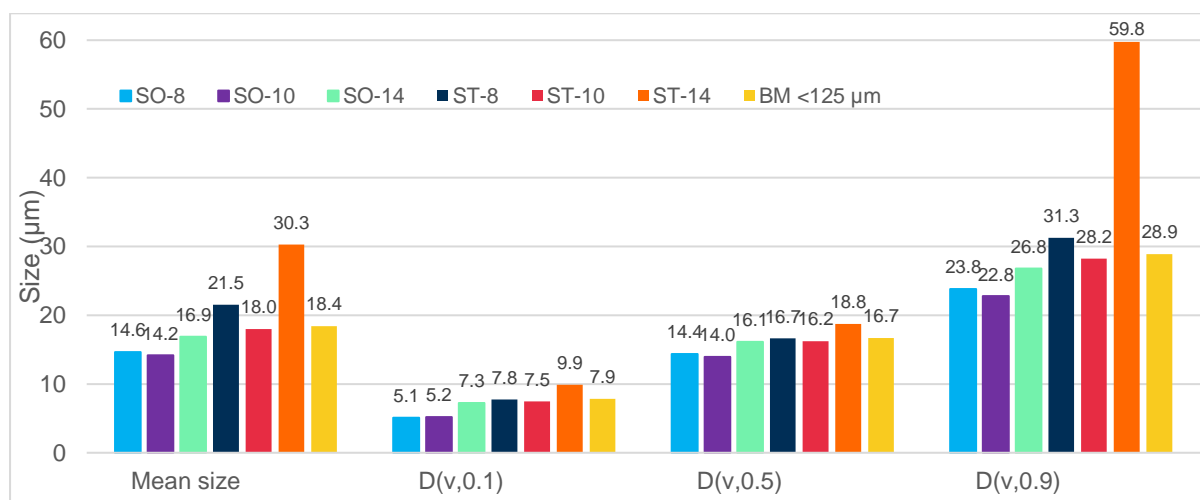


Figure S2: Particle size distribution analysis of the pretreated samples. SO stands for sonication, ST stands for stirred. The number present after the abbreviation depicts the pH value (e.g. SO-8 stands for sonication and pH = 8).

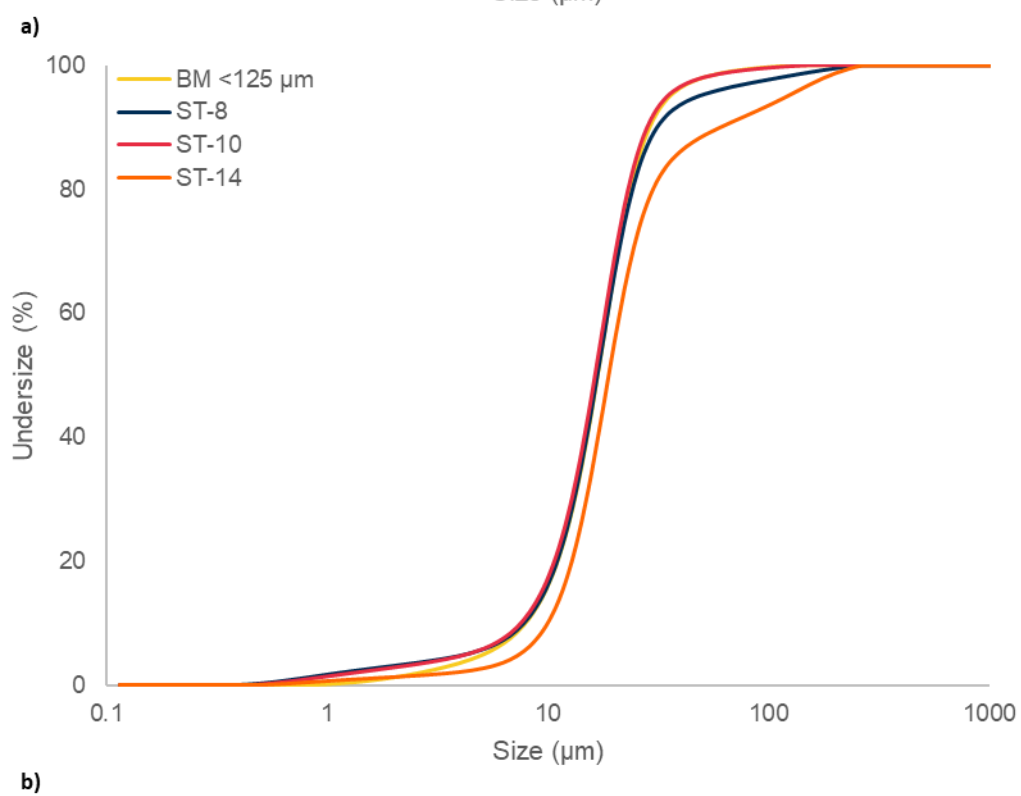
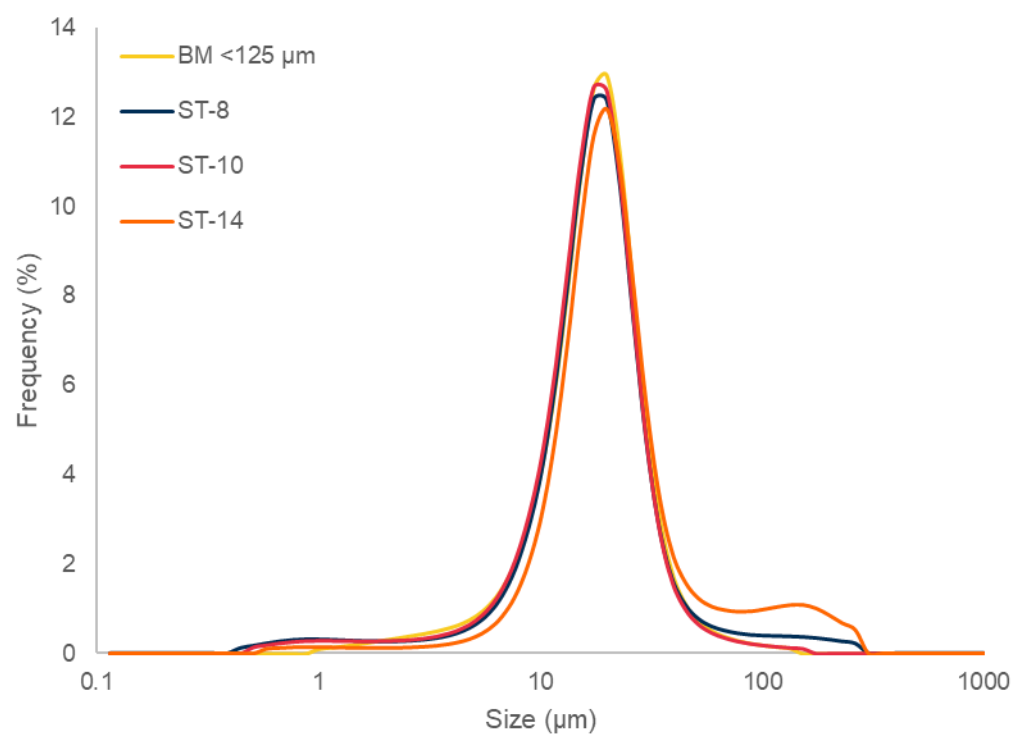


Figure S3: Particle size distribution of stirred samples: a) frequency; b) undersize.

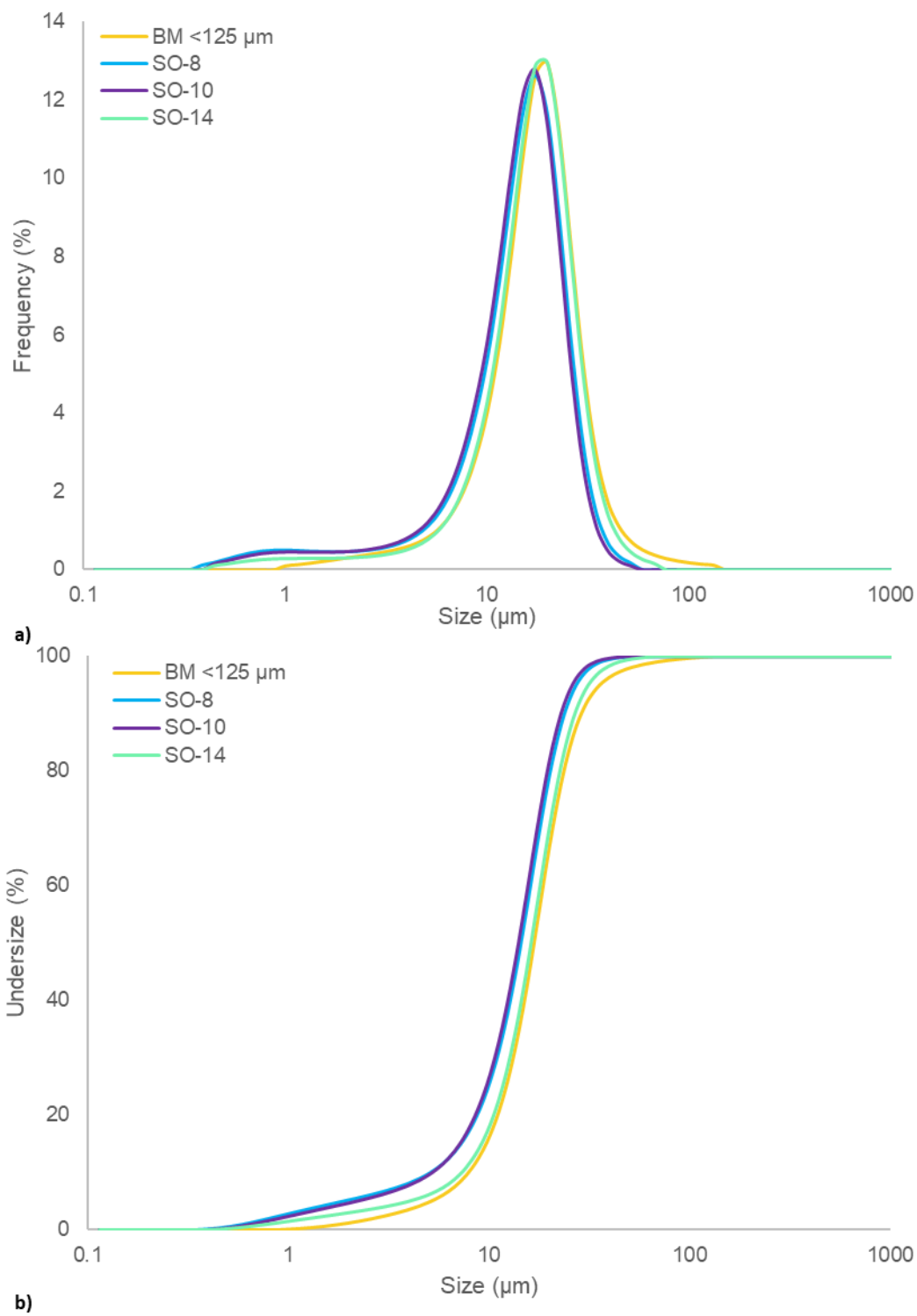


Figure S4: Particle size distribution of sonicated samples: a) frequency; b) undersize.

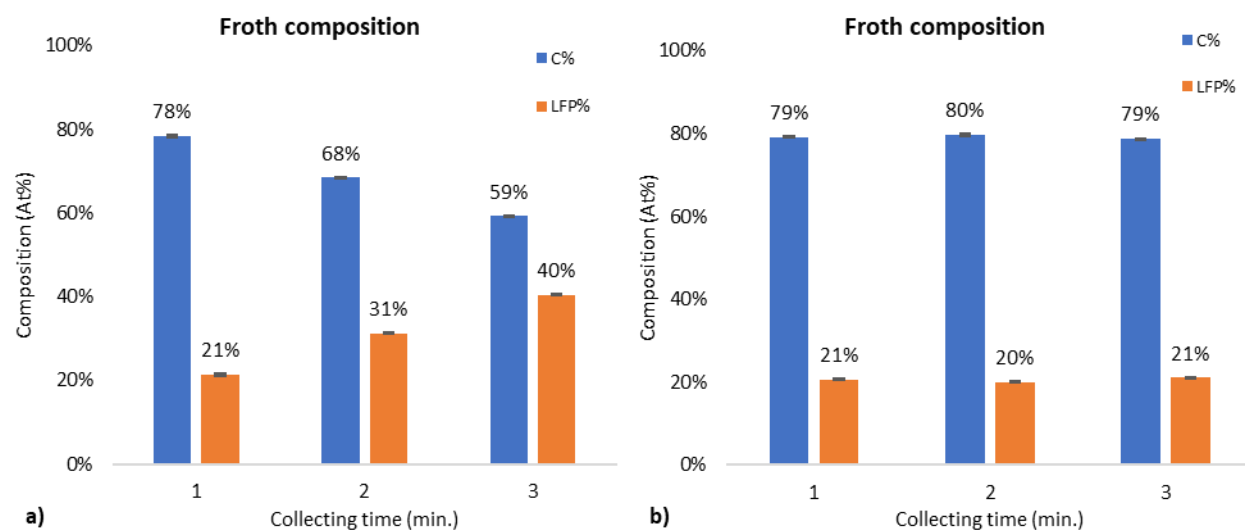


Figure S5: Composition of the froth collected at regular interval for a) the stirred sample and b) the sonicated sample.

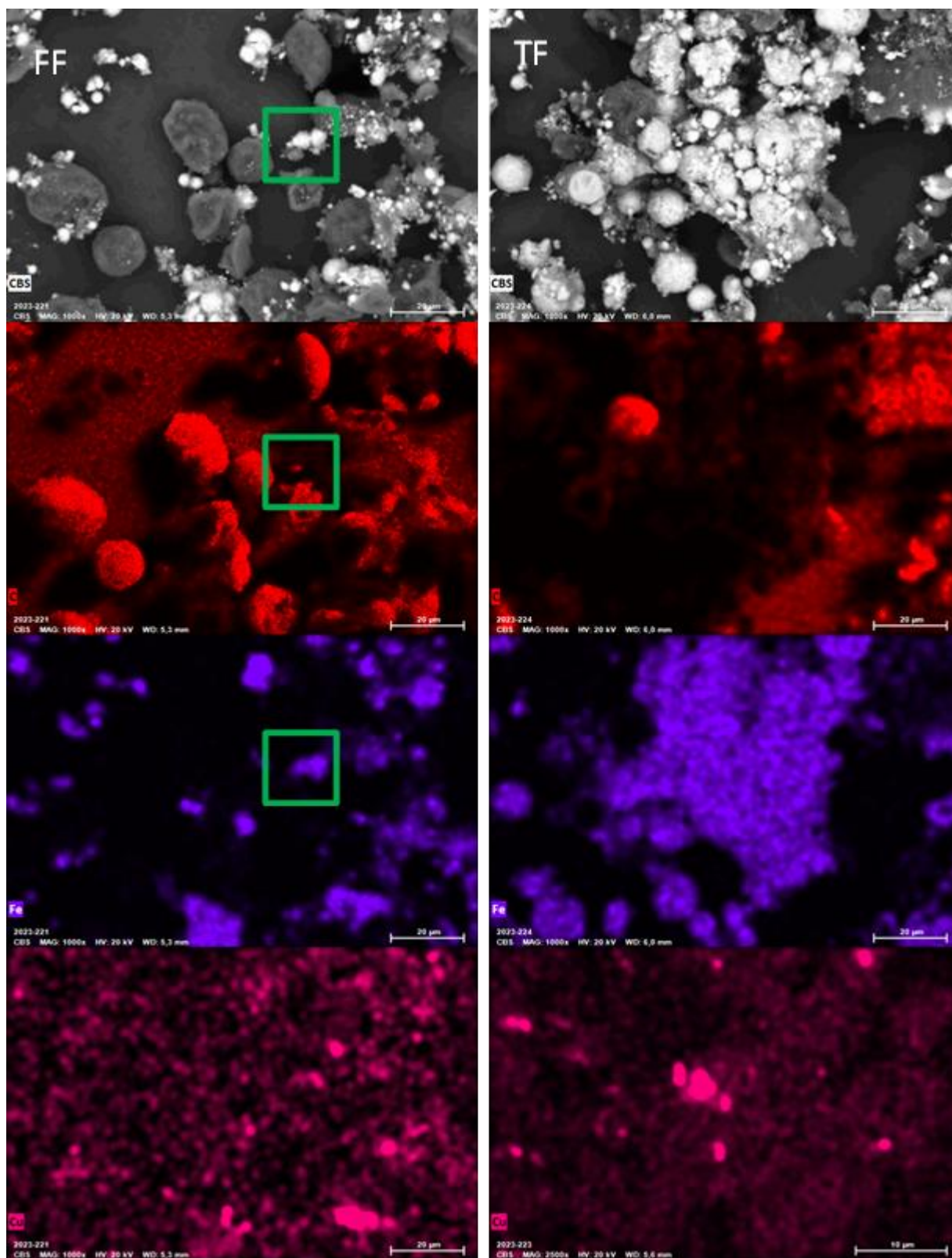


Figure S6: SEM images taken at magnification 1000X of the “FF” fraction (left) and “TF” fraction (right); EDS mapping of C (red), Fe (purple) and Cu (pink) are depicted below; the green box highlights the presence of LFP still partially attached to C/graphite.

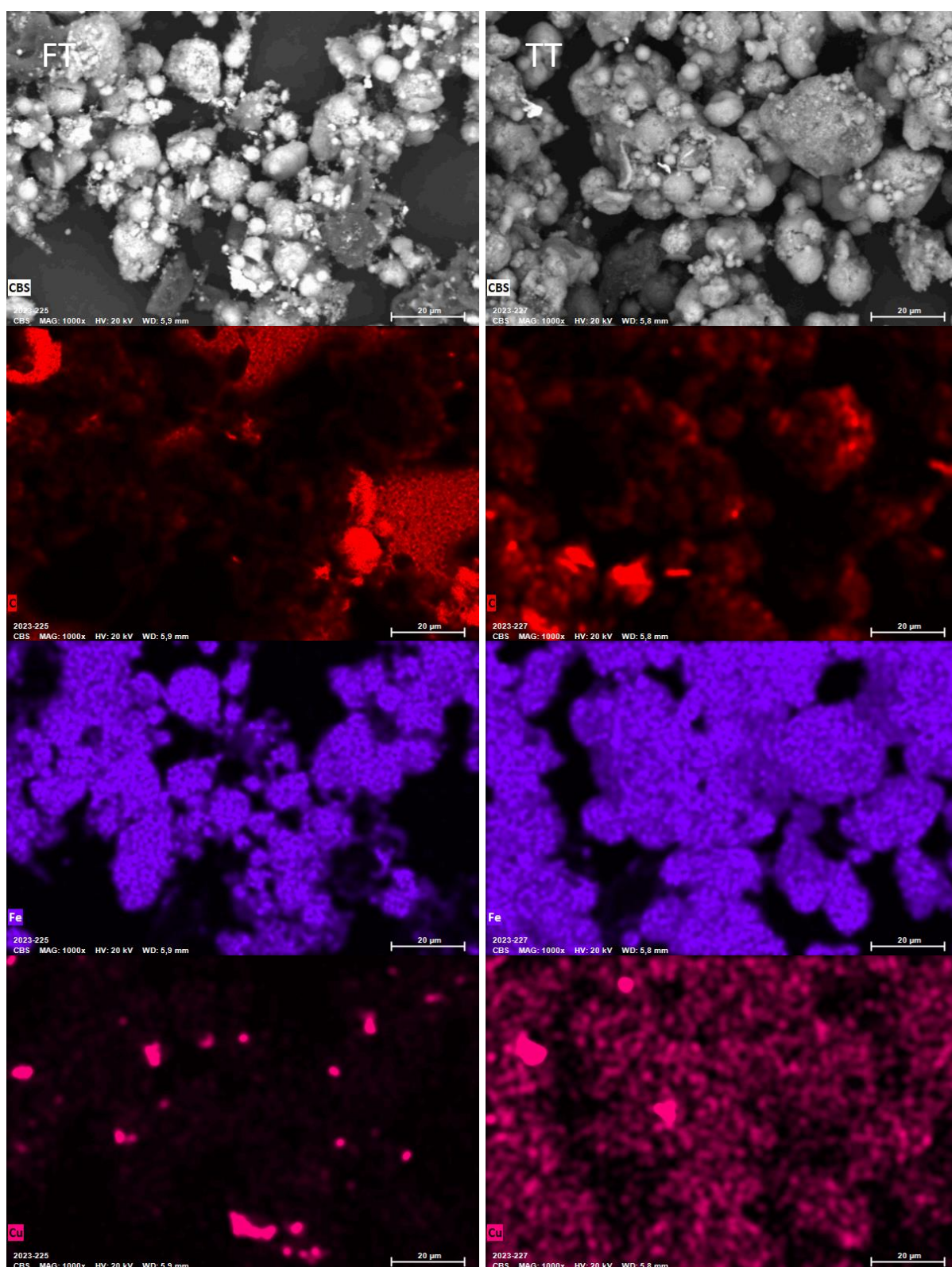


Figure S7: SEM images taken at magnification 1000X of the “*TF*” fraction (left) and “*TT*” fraction (right); EDS mapping of C (red), Fe (purple) and Cu (pink) are depicted below.

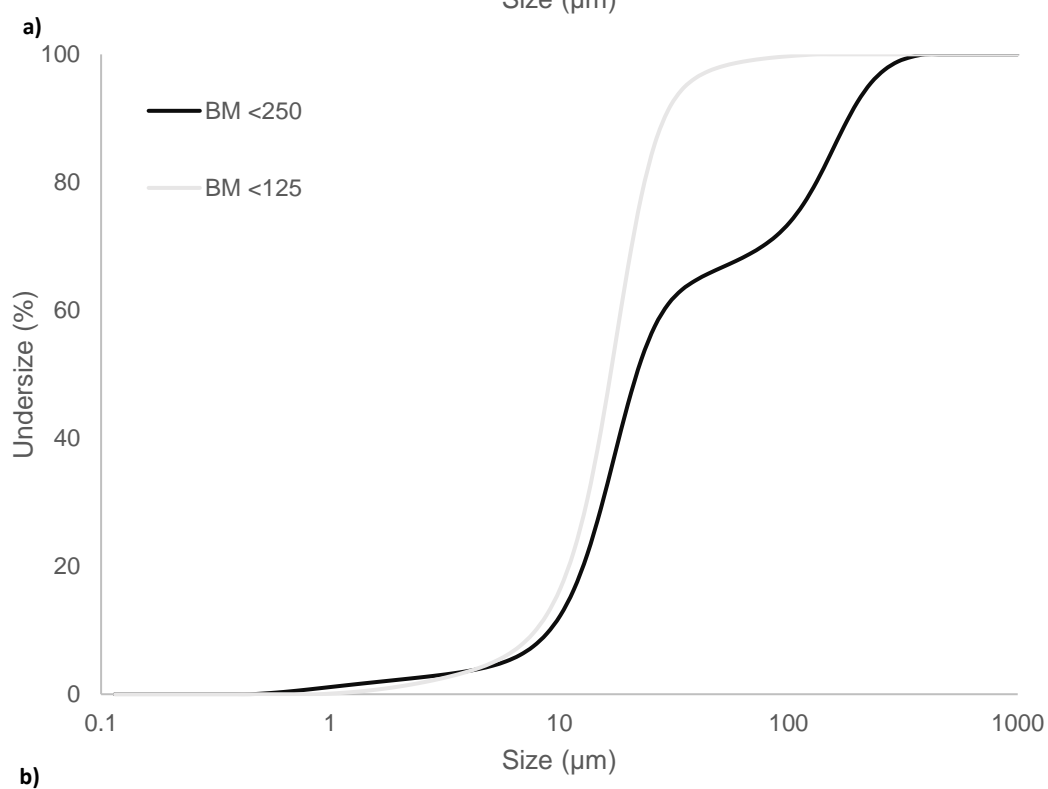
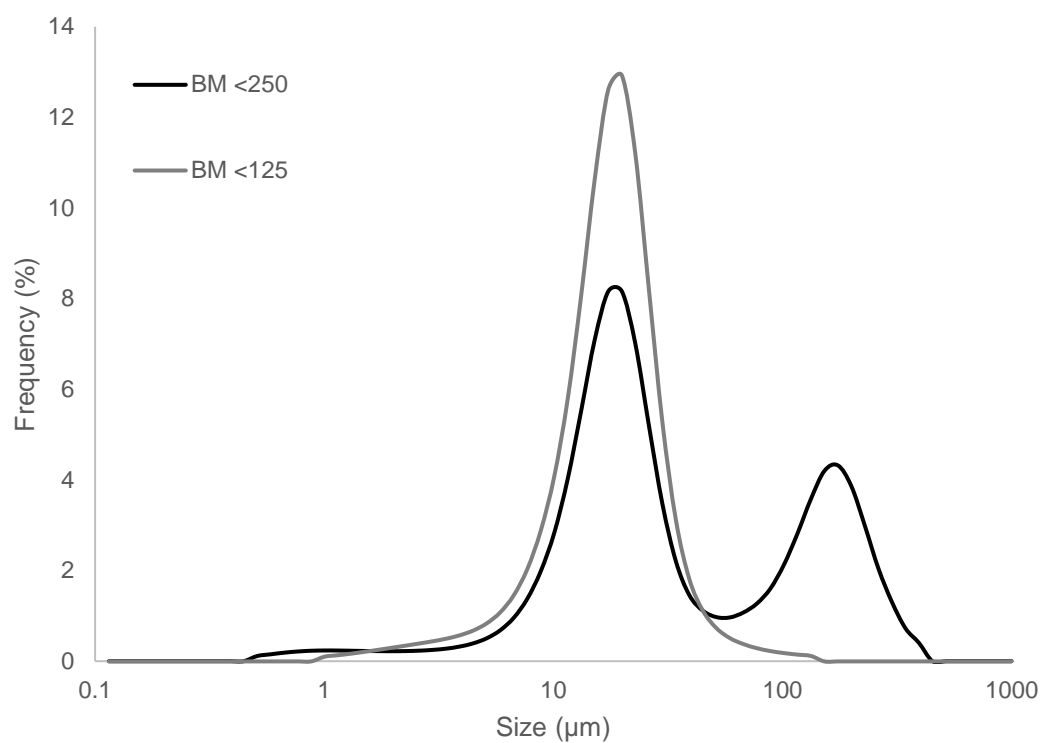


Figure S8: Particle size distribution analysis of the black mass fraction <250 μm compared to the fraction < 125 μm; a) frequency; b) undersize.

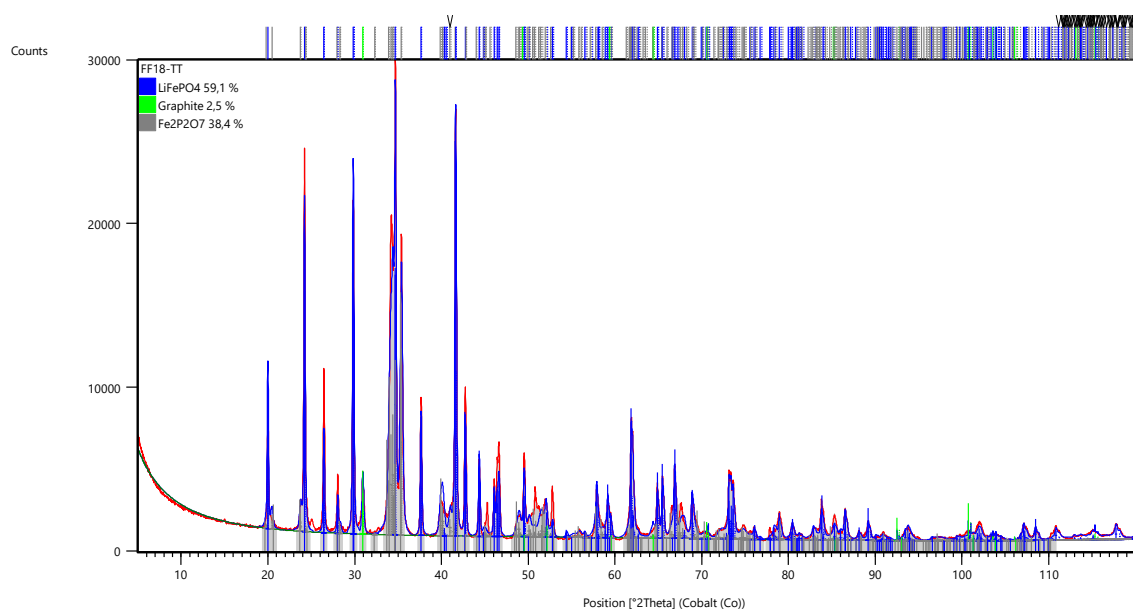


Figure S9: Powder X-ray Diffractogram and Rietveld refinement of the “TT” fraction of the double flotation procedure showing the fractions of LiFePO_4 , $\text{Fe}_2\text{P}_2\text{O}_7$ and graphite.

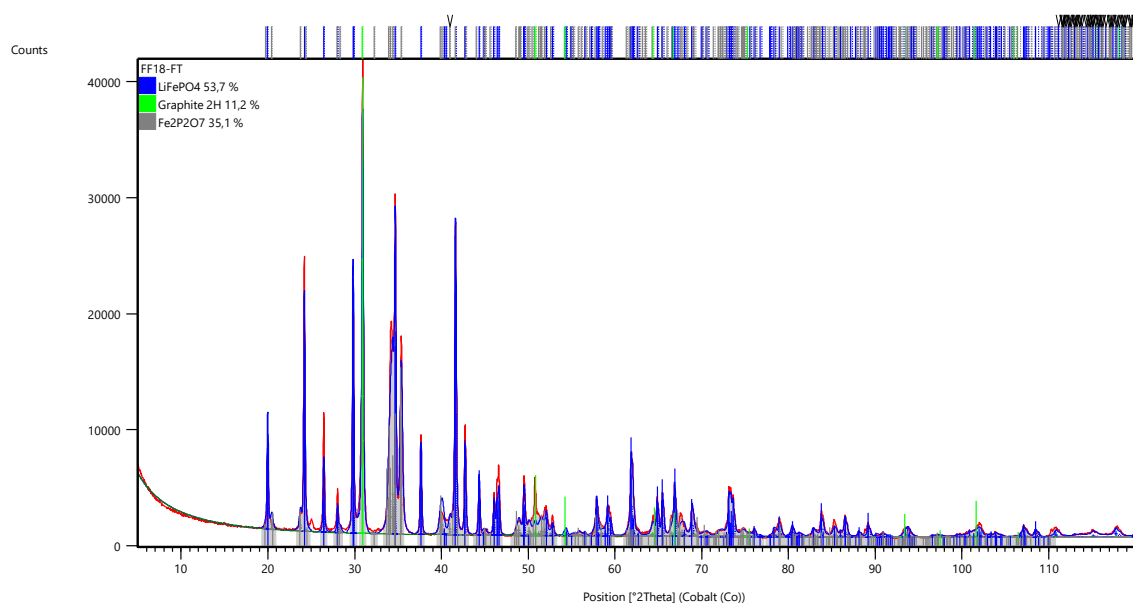


Figure S10: Powder X-ray Diffractogram and Rietveld refinement of the “FT” fraction of the double flotation procedure showing the fractions of LiFePO_4 , $\text{Fe}_2\text{P}_2\text{O}_7$ and graphite.

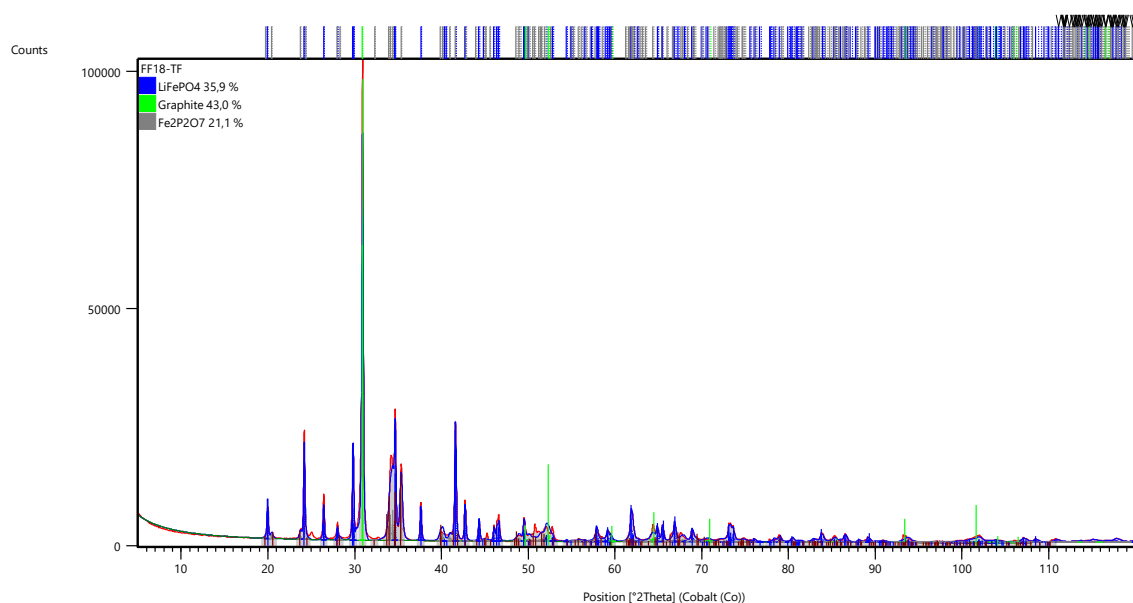


Figure S11: Powder X-ray Diffraction and Rietveld refinement of the “TF” fraction of the double flotation procedure showing the fractions of LiFePO_4 , $\text{Fe}_2\text{P}_2\text{O}_7$ and graphite.

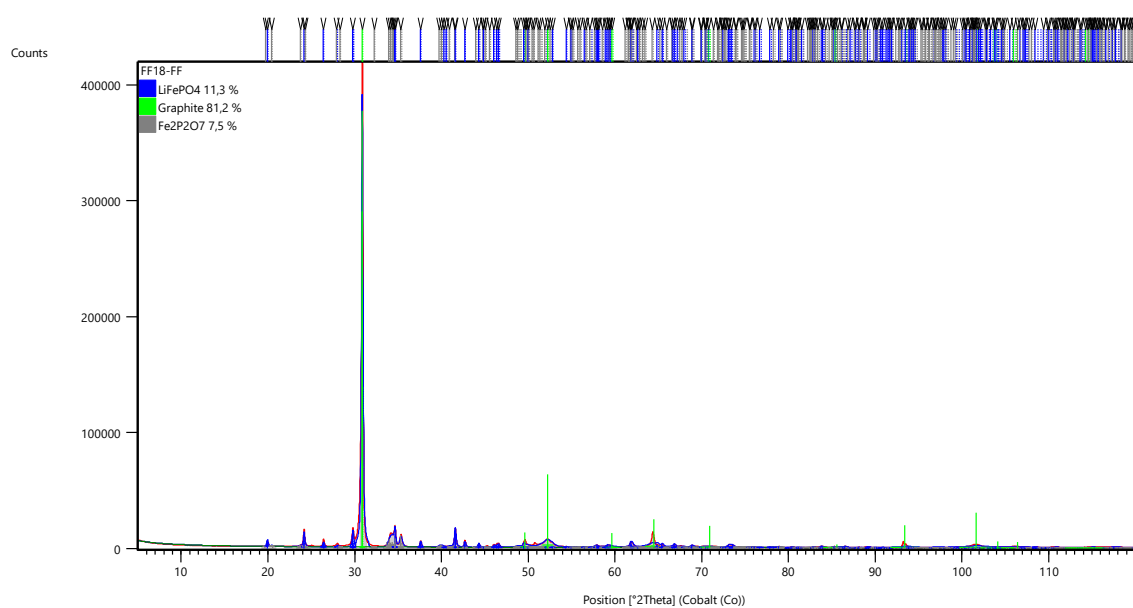


Figure S12: Powder X-ray Diffraction and Rietveld refinement of the “FF” fraction of the double flotation procedure showing the fractions of LiFePO_4 , $\text{Fe}_2\text{P}_2\text{O}_7$ and graphite.

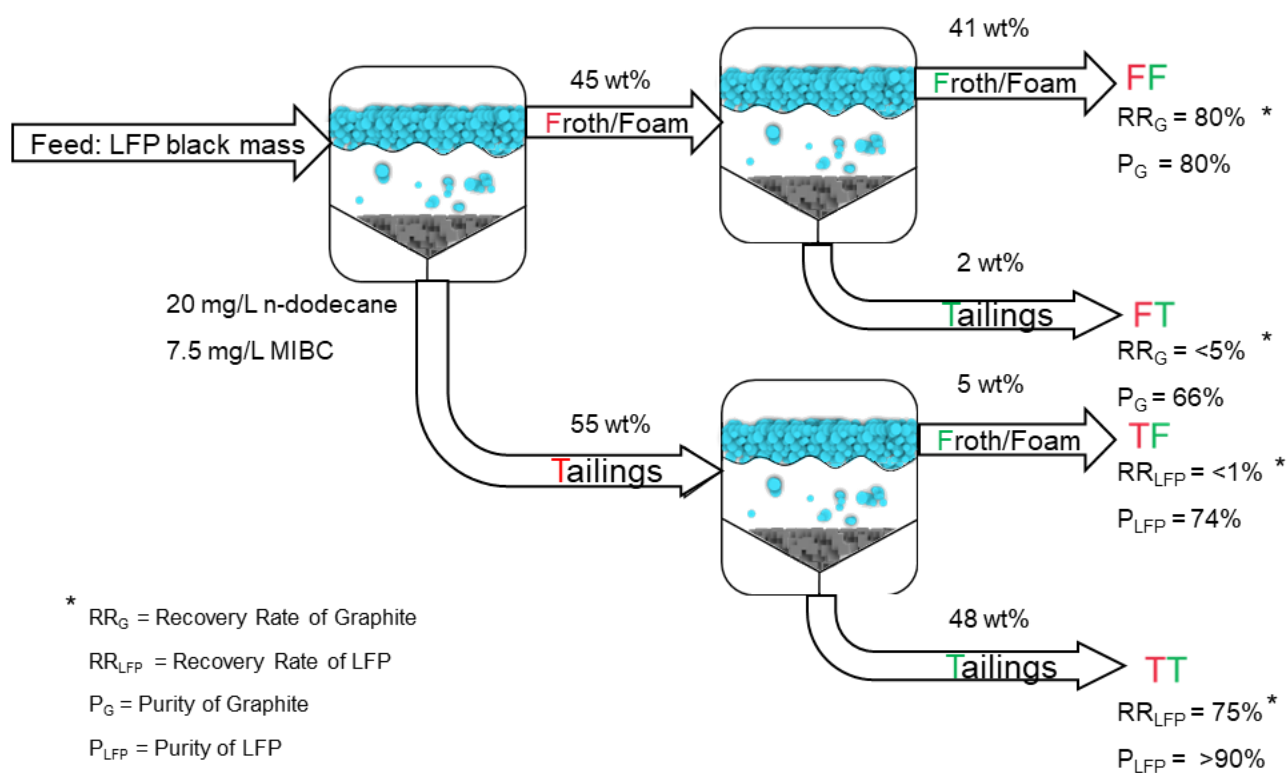


Figure S13: Overall flowsheet of the double flotation process with mass balances, recoveries and grades of the materials in each fraction.