Supplementary Information (SI) for RSC Sustainability.
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Supporting Information

Ultrasonic Decoating of Solid Oxide Cell Particles for Raw Material Recycling

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Crushing and Sieving

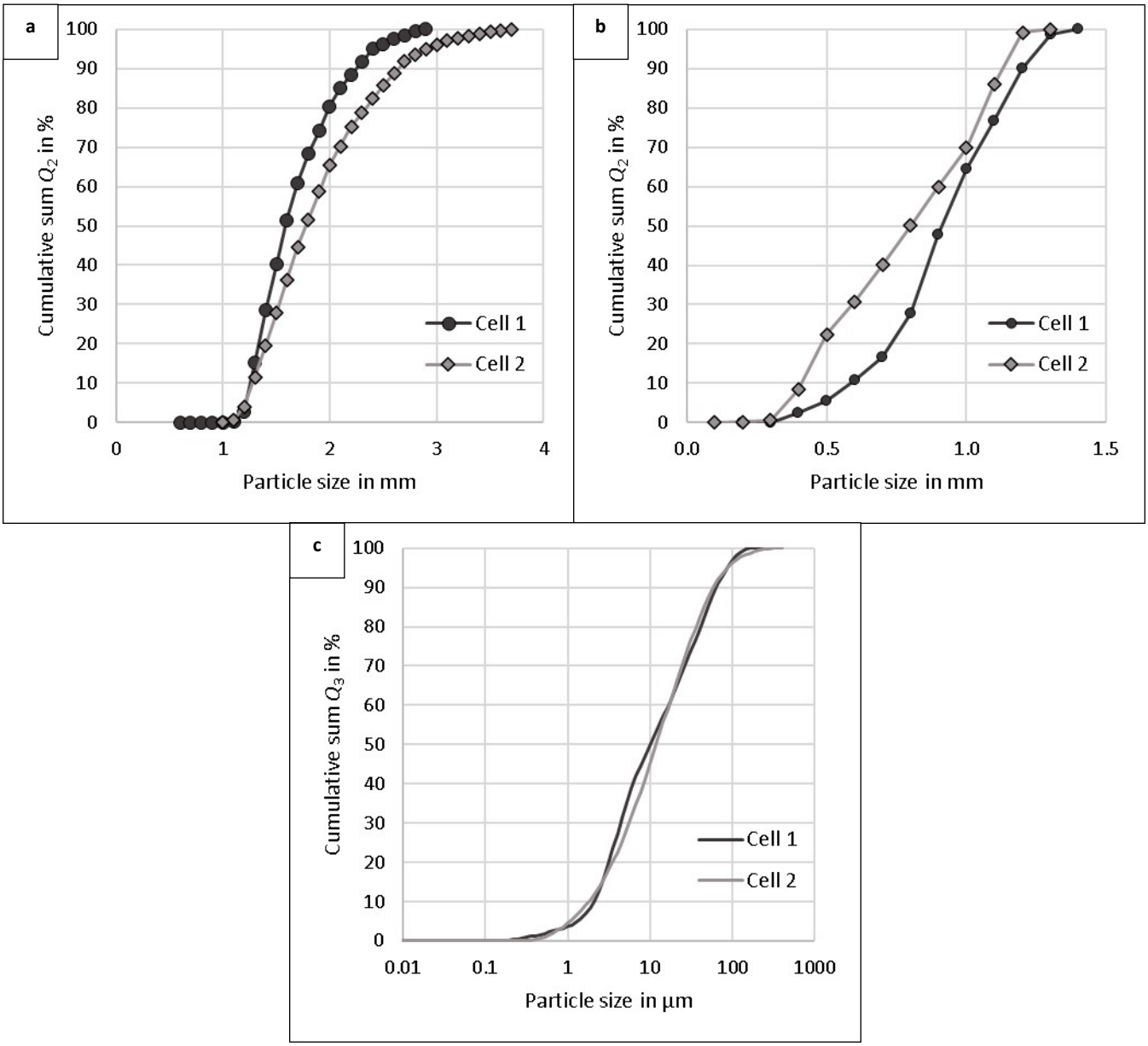

Figure S1 Particle size distribution for both cells of a) the particle size fraction coarser than 1 mm, measured by static image analysis, b) a subsample of the particle size fraction between 1 mm and 315 µm, measured by static image analysis and c) of a subsample of the particle size fraction finer than 100 µm, measured by laser diffraction analysis

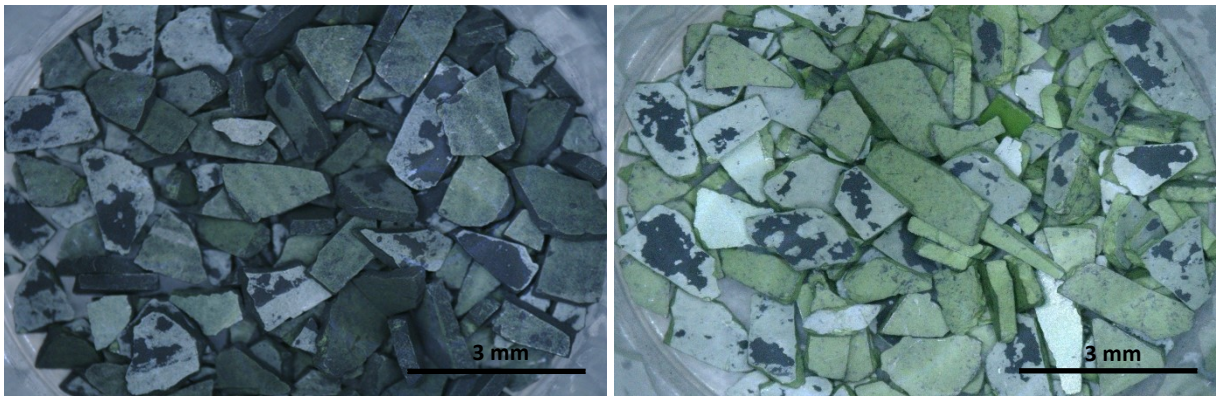

Figure S2 Light microscope image of particles from cell 1 after sieving (315 µm – 1 mm): on the left, the particles were left without washing; on the right, the particles were washed.

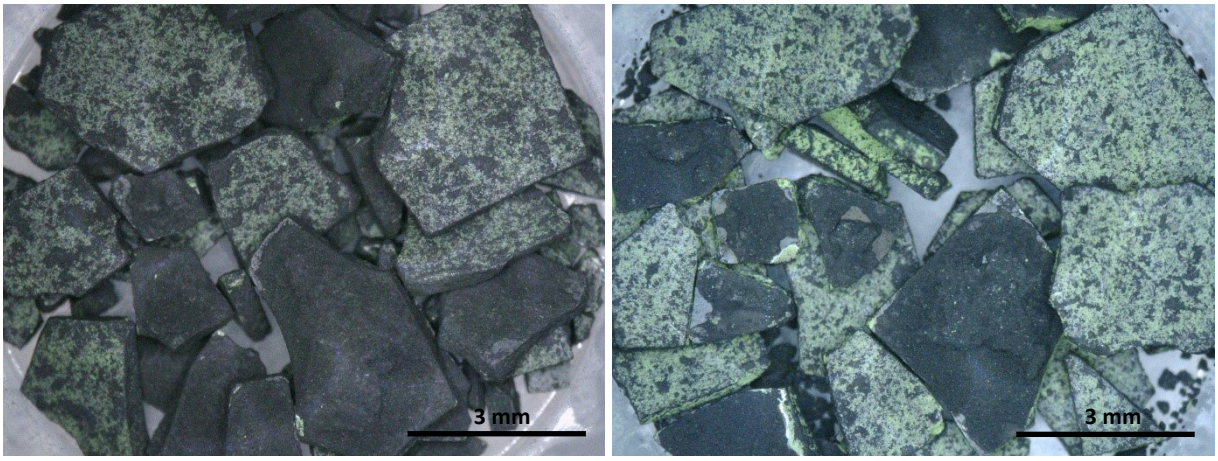

Figure S3 Light microscope image of particles from cell 2 after sieving (>315 µm): on the left, the particles were left without washing; on the right, the particles were washed.

Table S1 Mass fraction of the elements, measured by ICP-OES for each particle size fraction after sieving (cell 1) from two samples, including the standard deviation and the resulting average

	Mass fraction of measured elements						
Sample	Co in %	Cu in %	Fe in %	La in %	Mn in %	Ni in %	Sr in %
+1 mm	0.0768 ±0.0002	0.0032 ±0.0003	0.3194 ±0.0017	0.5002 ±0.0031	0.0017 ±0.0002	40.1876 ±0.3609	0.237 ±0.0009
	0.0692 ±0.0002	0.0032 ±0.0002	0.2819 ±0.0014	0.4483 ±0.0007	0.0014 ±0	41.2888 ±0.2334	0.1989 ±0.0027
Average +1 mm	0.0730	0.0032	0.3007	0.4743	0.0015	40.7371	0.2180
+315 µm -1 mm	0.0572 ±0.0004	0.0034 ±0.0002	0.2345 ±0.0009	0.3588 ±0.0009	0.0014 ±0	43.6585 ±0.2045	0.1649 ±0.0036
	0.0466 ±0.0003	0.0034 ±0.0003	0.1961 ±0.0012	0.2902 ±0.0018	0.0013 ±0.0001	40.8659 ±0.3622	0.1418 ±0.0012
Average +315 µm -1 mm	0.0518	0.0034	0.2152	0.3243	0.0013	42.2568	0.1534
+200 µm -315 µm	0.165 ±0.0003	0.0039 ±0.0002	0.639 ±0.0021	1.116 ±0.0026	0.0034 ±0	44.2541 ±0.1989	0.4787 ±0.0027
	0.1626 ±0.0003	0.0034 ±0.0001	0.6287 ±0.0015	1.1002 ±0.0025	0.0034 ±0	43.9143 ±0.2271	0.1992 ±0.0032
Average +200 µm -315 µm	0.1638	0.0037	0.6338	1.1081	0.0034	44.0839	0.3389
+100 µm -200 µm	0.4023 ±0.001	0.0473 ±0.0003	1.5502 ±0.006	2.7986 ±0.0119	0.0054 ±0	41.6441 ±0.1232	1.2002 ±0.0154
	0.3704 ±0.0016	0.0262 ±0.0001	1.4436 ±0.0039	2.5964 ±0.0094	0.0049 ±0.0001	41.24 ±0.0445	1.1234 ±0.0109
Average +100 µm -200 µm	0.3864	0.0367	1.4969	2.6974	0.0051	41.4418	1.1618
-100 µm	1.9462 ±0.002	0.0179 ±0.0004	7.3337 ±0.0662	13.65 ±0.0622	0.0269 ±0.0003	26.4103 ±0.0793	5.775 ±0.0657
	1.965 ±0.0092	0.0155 ±0.0005	7.4305 ±0.0301	13.7866 ±0.107	0.0262 ±0	26.6263 ±0.106	5.8181 ±0.0547
Average -100 µm	1.9557	0.0167	7.3823	13.7185	0.0265	26.5187	5.7965

Table S2 Mass fraction of the stoichiometrically calculated components from cell 1 after sieving for the two samples based on the elements measured by ICP-OES (Table S1)

	Mass fraction of calculated components		**Total mass in fraction in g**
Sample	LSCF in %	NiO in %	Mass in fraction in g
+1 mm	1.481	51.142	6.243
	1.303	52.544	
Average +1 mm	1.392	51.842	
+315 µm -1 mm	1.071	55.559	7.06
	0.890	52.005	
Average +315 µm -1 mm	0.924	53.776	
+200 µm -315 µm	3.083	56.317	0.8095
	2.691	55.885	
Average +200 µm -315 µm	2.887	56.101	
+100 µm -200 µm	7.606	52.996	0.4799
	7.074	52.482	
Average +100 µm -200 µm	7.340	52.738	
-100 µm	36.515	33.609	1.7088
	36.907	33.884	
Average -100 µm	36.712	33.747	

Table S3 Mass fraction of the elements, measured by ICP-OES for each particle size fraction after sieving (cell 2) from two samples, including the standard deviation and the resulting average

	Mass fraction of measured elements						
Sample	Co in %	Cu in %	Fe in %	La in %	Mn in %	Ni in %	Sr in %
+1 mm	0.9599 ±0.0039	0.0058 ±0.0006	1.2087 ±0.0014	3.0476 ±0.0081	0.0021 ±0	37.049 ±0.1281	1.2865 ±0.0111
	1.1376 ±0.0028	0.0029 ±0.0009	1.4546 ±0.0087	3.6528 ±0.0171	0.0017 ±0.0001	35.642 ±0.0551	1.5776 ±0.0061
Average +1 mm	1.0482	0.0044	1.3309	3.3483	0.0019	36.3498	1.4320
+315 µm -1 mm	0.5711 ±0.0018	0.0022 ±0.0001	0.6719 ±0.0037	1.7226 ±0.0128	0.0011 ±0	38.7085 ±0.0365	0.7133 ±0.0063
	0.6016 ±0.0029	0.0062 ±0.0002	0.6829 ±0.0016	1.7868 ±0.003	0.0019 ±0.0002	38.7527 ±0.0975	0.7407 ±0.0028
Average +315 µm -1 mm	0.5864	0.0042	0.6774	1.7547	0.0015	38.7306	0.7270
+200 µm -315 µm	0.983 ±0.0036	0.0036 ±0.0001	2.6994 ±0.0134	5.2448 ±0.0131	0.0018 ±0.0001	33.2416 ±0.0718	2.24 ±0.0328
	1.0273 ±0.0016	0.0032 ±0.0002	2.8618 ±0.0054	5.5335 ±0.0159	0.0042 ±0.0002	33.0643 ±0.0444	2.3991 ±0.0083
Average +200 µm -315 µm	1.0053	0.0034	2.7811	5.3900	0.0030	33.1525	2.3196
+100 µm -200 µm	1.5981 ±0.0008	0.0208 ±0.0005	4.3157 ±0.0392	8.4322 ±0.0747	0.0031 ±0.0001	28.4709 ±0.0146	3.6318 ±0.0226
	1.61 ±0.0037	0.011 ±0.0005	4.3076 ±0.0087	8.4487 ±0.0167	0.0024 ±0.0002	29.1245 ±0.0493	2.5035 ±0.0306
Average +100 µm -200 µm	1.6041	0.0159	4.3116	8.4405	0.0027	28.7985	3.0677
-100 µm	3.471 ±0.0082	0.0159 ±0.0002	9.2918 ±0.1054	18.0153 ±0.0264	-	16.4055 ±0.0225	7.7614 ±0.0344
	3.4406 ±0.0129	0.1416 ±0.0014	9.2738 ±0.0501	17.8812 ±0.0165	-	16.4592 ±0.0635	7.7405 ±0.0112
Average -100 µm	3.4558	0.0788	9.2828	17.9483	-	16.4323	7.7510

Table S4 Mass fraction of the stoichiometrically calculated components from cell 2 after sieving for the two samples based on the elements measured by ICP-OES (Table S3)

	Mass fraction of calculated components			**Total mass in fraction in g**
Sample	LSCF in %	LSC in %	NiO in %	
+1 mm	5.901	2.418	47.148	11.0468
	7.138	2.865	45.358	
Average +1 mm	6.517	2.640	46.258	
+315 µm -1 mm	3.249	1.468	49.260	4.8565
	3.308	1.577	49.316	
Average +315 µm -1 mm	3.278	1.522	49.288	
+200 µm -315 µm	13.263	1.015	42.303	0.4929
	14.085	1.033	42.077	
Average +200 µm -315 µm	13.676	1.024	42.189	
+100 µm -200 µm	21.237	1.744	36.232	0.5086
	20.299	1.264	37.063	
Average +100 µm -200 µm	20.768	1.504	36.649	
-100 µm	45.576	3.775	20.877	2.3057
	45.463	3.660	20.946	
Average -100 µm	45.519	3.718	20.912	

Table S5 Calculated recovery rates for each particle size fraction of both cells after sieving

	Mass fraction	**Recovery in %**				
		LSCF	**LSC**	**Perovskites**	**NiO**	**Byproduct**
Cell 1	+1 mm	11.035	-	11.035	39.441	39.848
		9.703	-	9.703	38.389	39.775
	Average +1 mm	10.370	-	10.370	38.914	39.811
	+315 µm -1 mm	9.021	-	9.021	47.163	45.251
		7.498	-	7.498	44.146	45.168
	Average +315 µm -1 mm	7.7873	-	7.7873	45.649	45.235
	+200 µm -315 µm	2.978	-	2.978	5.481	5.094
		2.599	-	2.599	5.439	5.074
	Average +200 µm -315 µm	2.789	-	2.789	5.460	5.084
	+100 µm -200 µm	4.355	-	4.355	3.058	2.884
		4.051	-	4.051	3.028	2.867
	Average +100 µm -200 µm	4.203	-	4.203	3.043	2.876
	-100 µm	75.249	-	75.249	6.962	7.016
		74.450	-	74.450	6.905	6.972
	Average -100 µm	74.851	-	74.851	6.934	6.994
Cell 2	+1 mm	37.520	68.202	43.069	62.150	60.847
		31.018	57.558	35.818	59.790	59.729
	Average +1 mm	34.253	62.857	39.426	60.978	60.291
	+315 µm -1 mm	7.643	16.501	9.245	28.580	27.801
		7.508	15.365	8.929	28.547	27.752
	Average +315 µm -1 mm	7.576	15.933	9.087	28.563	27.777
	+200 µm -315 µm	3.303	1.098	2.904	2.488	2.538
		3.111	1.078	2.743	2.475	2.514
	Average +200 µm -315 µm	3.207	1.088	2.824	2.481	2.526
	+100 µm -200 µm	5.139	1.911	4.556	2.249	2.397
		4.912	1.385	4.274	2.199	2.353
	Average +100 µm -200 µm	5.026	1.648	4.4150	2.224	2.375
	-100 µm	50.000	18.760	44.350	5.763	7.048
		49.876	18.188	44.145	5.744	7.016
	Average -100 µm	49.938	18.474	44.248	5.754	7.031

Ultrasonic decoating

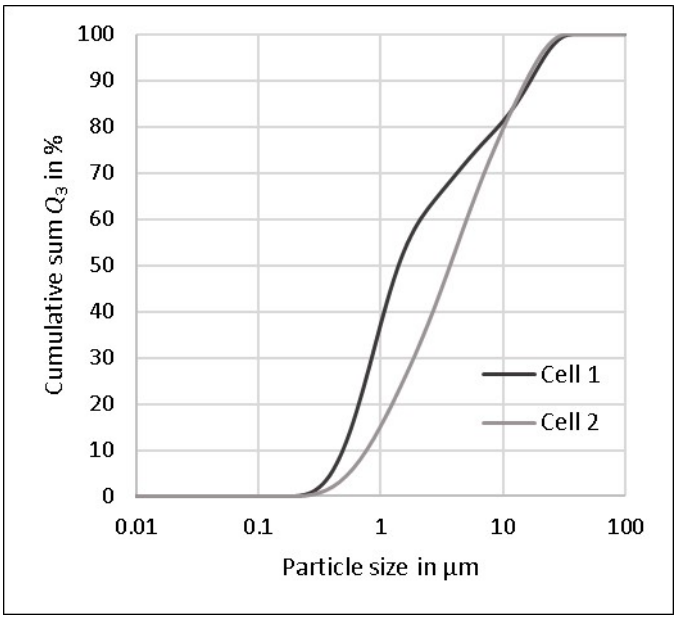

Figure S4 Particle size distribution for both cells of the product concentrate (fine particles) after 40 s of ultrasonic stressing, measured by laser diffraction analysis

Table S6 Measured masses for the feed, the byproduct concentrate, and the product concentrate after decoating for cell 1 and cell 2

	Sample	**Feed mass in mg**	**Byproduct concentrate mass in mg**	**Product concentrate mass in mg**
Cell 1	10s _1	202.61±0.01	199.31±0.01	2.71±0.01
	10s _2	201.00±0.01	194.46±0.01	2.58±0.01
	10s _3	200.32±0.01	197.87±0.01	2.60±0.01
	20s _1	203.01±0.01	198.92±0.01	3.46±0.01
	20s _2	200.89±0.01	196.74±0.01	3.48±0.01
	20s _3	202.40±0.01	190.99±0.01	3.59±0.01
	30s _1	201.58±0.01	186.87±0.01	3.30±0.01
	30s _2	200.91±0.01	194.83±0.01	3.67±0.01
	30s _3	203.60±0.01	181.38±0.01	3.82±0.01
	40s _1	202.53±0.01	190.47±0.01	4.30±0.01
	40s _2	203.28±0.01	198.26±0.01	4.60±0.01
	40s _3	201.30±0.01	193.74±0.01	4.29±0.01
Cell 2	10s _1	201.19±0.01	182.25±0.01	11.23±0.01
	10s _2	205.01±0.01	187.12±0.01	11.88±0.01
	10s _3	201.89±0.01	163.10±0.01	11.51±0.01
	20s _1	203.02±0.01	170.87±0.01	14.33±0.01
	20s _2	208.88±0.01	142.47±0.01	14.88±0.01
	20s _3	203.79±0.01	180.39±0.01	17.82±0.01
	30s _1	202.82±0.01	122.67±0.01	15.56±0.01
	30s _2	203.10±0.01	172.66±0.01	19.21±0.01
	30s _3	200.34±0.01	172.50±0.01	16.77±0.01
	40s _1	203.21±0.01	132.12±0.01	16.52±0.01
	40s _2	200.20±0.01	137.27±0.01	20.00±0.01
	40s _3	202.89±0.01	167.08±0.01	18.23±0.01

Table S7 Mass fraction of the elements measured by ICP-OES for each sample (cell 1) after different decoating times (10 s, 20 s, 30 s, 40 s) for the carrier particles (support) and the fine particles, including their standard deviation

	Mass fraction of measured elements						
Sample	La in %	Sr in %	Co in %	Fe in %	Mn in %	Cu in %	Ni in %
10s _1_support	0.0526 ±0.002	0.0301 ±0.0041	0.0091 ±0.001	0.0697 ±0.0023	0.0007 ±0.0015	0.005 ±0.0042	45.0396 ±0.0056
10s _2_support	0.0715 ±0.002	0.0383 ±0.0047	0.0122 ±0.0011	0.0779 ±0.0022	0.0008 ±0.0015	0.0057 ±0.0043	43.3572 ±0.3495
10s _3_support	0.0548 ±0.0019	0.0306 ±0.004	0.0101 ±0.0011	0.0687 ±0.0022	0.001 ±0.0015	0.0024 ±0.0042	43.942 ±0.1099
20s _1_support	0.02 ±0.0017	0.0165 ±0.0042	0.0047 ±0.001	0.051 ±0.0021	0.0007 ±0.0014	0.0082 ±0.0045	43.58 ±0.3582
20s _2_support	0.0131 ±0.0017	0.0134 ±0.004	0.0032 ±0.001	0.046 ±0.0021	0.0007 ±0.0015	0.0033 ±0.0041	44.3078 ±0.0208
20s _3_support	0.0228 ±0.0018	0.0182 ±0.0041	0.005 ±0.001	0.0543 ±0.0023	0.0008 ±0.0015	0.0031 ±0.0042	44.856 ±0.0959
30s _1_support	0.048 ±0.0017	0.029 ±0.0041	0.0088 ±0.0011	0.0667 ±0.0026	0.0008 ±0.0015	0.0024 ±0.0042	44.9982 ±0.3685
30s _2_support	0.0097 ±0.0017	0.0119 ±0.0042	0.0032 ±0.001	0.0444 ±0.0023	0.0007 ±0.0015	0.0026 ±0.0042	44.0708 ±0.1053
30s _3_support	0.0348 ±0.0018	0.0221 ±0.0042	0.007 ±0.001	0.0616 ±0.0026	0.0009 ±0.0015	0.0036 ±0.0042	46.0473 ±0.2673
40s _1_support	0.016 ±0.0016	0.0145 ±0.004	0.0042 ±0.001	0.0506 ±0.0022	0.0007 ±0.0015	0.0026 ±0.0041	43.9823 ±0.0042
40s _2_support	0.0089 ±0.0017	0.0118 ±0.0041	0.0031 ±0.001	0.0451 ±0.0021	0.0007 ±0.0015	0.0025 ±0.0043	44.4621 ±0.2509
40s _3_support	0.0086 ±0.0017	0.0106 ±0.004	0.0029 ±0.001	0.044 ±0.0022	0.0007 ±0.0015	0.0027 ±0.0041	45.4886 ±0.3066
10s _fine	25.3931 ±0.1198	9.9732 ±0.0214	3.903 ±0.0265	18.2135 ±0.1255	0.4617 ±0.038	0.1217 ±0.0087	8.6031 ±0.0022
20s _fine	23.0022 ±0.1432	8.9981 ±0.1519	3.1592 ±0.0137	16.1111 ±0.0453	0.0477 ±0.0022	0.0577 ±0.0048	10.2079 ±0.0825
30s _fine	21.7733 ±0.1393	8.5292 ±0.0223	2.9936 ±0.0019	15.5858 ±0.1057	0.052 ±0.0055	0.0766 ±0.005	11.2063 ±0.0228
40s _fine	17.7702 ±0.0857	6.9322 ±0.0868	2.4325 ±0.0121	12.6403 ±0.0167	0.044 ±0.0042	0.0831 ±0.0116	15.8093 ±0.1303

Table S8 Mass fraction of the stoichiometrically calculated components from cell 1 after different decoating times (10 s, 20 s, 30 s, 40 s) for the carrier particles (support) and the fine particles based on the elements measured by ICP-OES (Table S7)

	Mass fraction of calculated components	
Sample	LSCF in %	NiO in %
10s _1_support	0.236	57.315
10s _2_support	0.284	55.174
10s _3_support	0.239	55.918
20s _1_support	0.147	55.457
20s _2_support	0.125	56.384
20s _3_support	0.159	57.081
30s _1_support	0.225	57.262
30s _2_support	0.117	56.082
30s _3_support	0.192	58.597
40s _1_support	0.140	55.969
40s _2_support	0.118	56.580
40s _3_support	0.113	57.886
10s _fine	76.581	10.948
20s _fine	67.844	12.990
30s _fine	64.908	14.261
40s _fine	52.759	20.118

Table S9 Calculated minimum and maximum perovskite mass fraction as well as measured average (avg) for the product concentrate for cell 1 after decoating based on the assumption that all losses occurred in the product concentrate (min), all losses occurred in the byproduct concentrate (max)

Sample	**Calculated Perovskite mass fraction**
10s _fine_min	34.58
10s _fine_avg	76.58
10s _fine_max	89.65
20s _fine_min	22.18
20s _fine_avg	67.84
20s _fine_max	73.79
30s _fine_min	11.26
30s _fine_avg	64.91
30s _fine_max	71.95
40s _fine_min	21.35
40s _fine_avg	52.76
40s _fine_max	60.44

Table S10 Mass fraction of the elements measured by ICP-OES for each sample (cell 2) after different decoating times (10 s, 20 s, 30 s, 40 s) for the carrier particles (support) and the fine particles, including their standard deviation

	Mass fraction of measured elements						
Sample	La in %	Sr in %	Co in %	Fe in %	Mn in %	Cu in %	Ni in %
10s _1_support	1.0758 ±0.0023	0.2929 ±0.0059	0.4534 ±0.0013	0.1127 ±0.0022	0.0014 ±0.0001	0.0016 ±0.0001	50.1469 ±0.0623
10s _2_support	1.1238 ±0.009	0.6565 ±0.0021	0.6792 ±0.0005	0.5158 ±0.0038	0.0018± 0.0	0.0014 ±0.0001	49.9857 ±0.1365
10s _3_support	1.1997 ±0.0078	0.4494 ±0.0068	0.5506 ±0.0029	0.2862 ±0.0038	0.0016± 0.0001	0.0015 ±0.0001	50.0775 ±0.0357
20s _1_support	0.8201 ±0.0036	0.4692 ±0.003	0.6278 ±0.0012	0.2484 ±0.0038	0.0014± 0.0	0.001 ±0.0	50.2828 ±0.1583
20s _2_support	0.9308 ±0.0046	0.4755 ±0.0041	0.4511 ±0.0023	0.433 ±0.0036	0.0015± 0.0001	0.0016 ±0.0001	50.1048 ±0.1781
20s _3_support	0.5764 ±0.0028	0.4716 ±0.0024	0.5602 ±0.0016	0.3191 ±0.0022	0.0014± 0.0	0.0012 ±0.0	50.2147 ±0.0907
30s _1_support	1.0315 ±0.0019	0.5152 ±0.0021	0.627 ±0.0025	0.3302 ±0.0043	0.0016± 0.0001	0.0011 ±0.0	49.7104 ±0.1377
30s _2_support	0.4481 ±0.0021	0.4943 ±0.0037	0.5759 ±0.0008	0.3594 ±0.002	0.0017± 0.0001	0.0184 ±0.0	50.0509 ±0.1295
30s _3_support	0.3102 ±0.0014	0.5065 ±0.0018	0.6057 ±0.0007	0.3423 ±0.0016	0.0016± 0.0	0.0083 ±0.0001	49.8524 ±0.1614
40s _1_support	0.5279 ±0.0053	0.2903 ±0.0016	0.3804 ±0.0008	0.1797 ±0.0013	0.0013± 0.0	0.0017 ±0.0001	50.7041 ±0.1396
40s _2_support	0.3492 ±0.0018	0.4369 ±0.0022	0.4258 ±0.0015	0.3835 ±0.0017	0.0018± 0.0001	0.0035 ±0.0001	50.6073 ±0.1772
40s _3_support	0.3289 ±0.0037	0.3488 ±0.0024	0.3985 ±0.0012	0.261 ±0.002	0.0015± 0.0	0.0024 ±0.0	50.6655 ±0.1698
10s _1_fine	24.2074 ±0.2026	9.8521 ±0.0327	5.3697 ±0.0196	14.9798 ±0.0799	0.0169± 0.0007	0.0551 ±0.0017	6.3419 ±0.0121
10s _2_fine	24.6943 ±0.1798	10.0774 ±0.0214	5.1547 ±0.0087	15.6046 ±0.0676	0.0324± 0.0009	0.0647 ±0.0014	5.8118 ±0.0095
10s _3_fine	25.6371 ±0.0882	10.3566 ±0.0559	5.2325 ±0.0228	16.3118 ±0.1534	0.0234 ±0.001	0.033 ±0.0018	5.3647 ±0.0185
20s _1_fine	23.5499 ±0.179	9.8321 ±0.0497	5.4006 ±0.0256	14.7312 ±0.1065	0.0269 ±0.0013	0.3599 ±0.0097	6.7056 ±0.0127

20s _2_fine	25.2942 ±0.206	10.4189 ±0.1148	5.4752 ±0.0177	15.7389 ±0.0731	0.0172 ±0	0.0386 ±0.0173	6.0078 ±0.0184
20s _3_fine	23.5568 ±0.0449	9.698 ±0.1353	5.8924 ±0.0048	13.7373 ±0.1489	0.0458 ±0.0026	0.1486 ±0.0023	7.6502 ±0.0221
30s _1_fine	25.5506 ±0.0218	10.3862 ±0.1117	4.948 ±0.0097	16.4324 ±0.0766	0.0191 ±0.0007	0.0338 ±0.0012	4.3314 ±0.0069
30s _2_fine	22.2035 ±0.0296	8.9572 ±0.016	5.9099 ±0.0286	12.4815 ±0.0417	0.0249 ±0.0009	1.9452 ±0.0399	9.4602 ±0.0326
30s _3_fine	23.0704 ±0.1247	9.3228 ±0.1212	6.5823 ±0.031	12.2714 ±0.0215	0.0235 ±0.0005	0.1122 ±0.0019	8.5535 ±0.0087
40s _1_fine	23.6856 ±0.0119	9.9627 ±0.0622	5.9178 ±0.0007	14.275 ±0.133	0.0236 ±0.0007	0.0429 ±0.0136	7.2405 ±0.0188
40s _2_fine	23.112 ±0.0311	9.7565 ±0.0728	6.1166 ±0.0185	13.1637 ±0.07	0.0262 ±0.0005	0.0551 ±0.0017	7.8597 ±0.0088
40s _3_fine	21.4466 ±0.1064	8.4776 ±0.0756	6.1182 ±0.0094	11.2907 ±0.1289	0.0202 ±0.0006	0.0284 ±0.0011	10.5324 ±0.0051

Table S11 Mass fraction of the stoichiometrically calculated components from cell 2 after different decoating times (10 s, 20 s, 30 s, 40 s) for the carrier particles (support) and the fine particles based on the elements measured by ICP-OES (Table S10)

	Mass fraction of calculated components			
Sample	LSCF in %	LSC in %	Perovskites in %	Byproduct in %
10s _1_support	1.310	1.753	3.062	96.938
10s _2_support	1.462	1.750	3.213	96.787
10s _3_support	1.561	1.891	3.452	96.548
20s _1_support	1.188	1.198	2.386	97.614
20s _2_support	1.270	1.413	2.683	97.317
20s _3_support	0.735	0.962	1.698	98.302
30s _1_support	1.244	1.741	2.985	97.015
30s _2_support	0.633	0.721	1.353	98.647
30s _3_support	0.655	0.323	0.978	99.022
40s _1_support	0.648	0.970	1.618	98.382
40s _2_support	0.514	0.611	1.124	98.876
40s _3_support	0.538	0.485	1.023	98.977
10s _1_fine	69.281	2.563	71.844	28.156
10s _2_fine	72.278	1.059	73.337	26.663
10s _3_fine	75.507	0.485	75.992	24.008
20s _1_fine	67.984	2.876	70.860	29.140
20s _2_fine	72.971	2.166	75.137	24.863
20s _3_fine	63.598	6.089	69.688	30.312
30s _1_fine	75.657	0.000	75.657	24.343
30s _2_fine	57.643	7.576	65.219	34.781
30s _3_fine	56.791	10.475	67.265	32.735
40s _1_fine	65.851	5.384	71.235	28.765
40s _2_fine	61.029	7.680	68.709	31.291
40s _3_fine	52.206	9.852	62.058	37.942

Table S12 Calculated recovery for each sample after different decoating times (10 s, 20 s, 30 s, 40 s) for the support particles and fine particles from cell 1

Sample	**Feed mass in mg**	**Recovery in %**					
		Perovskites (LSCF)		**NiO**		**Byproduct**	
10_1_support	202.6	16.596	17.683	98.097	98.593	99.537	99.110
10_2_support	201	19.623		99.004		97.841	
10_3_support	200.3	16.831		98.679		99.950	
20_1_support	203	10.307	9.916	98.606	98.158	99.235	97.994
20_2_support	200.9	8.736		98.113		99.196	
20_3_support	202.4	10.703		97.755		95.551	
30_1_support	201.6	14.868	11.732	97.360	97.345	93.798	94.072
30_2_support	200.9	8.129		98.044		98.240	
30_3_support	203.6	12.200		96.630		90.178	
40_1_support	202.5	9.391	8.459	96.901	96.117	95.261	97.184
40_2_support	203.3	8.196		96.317		98.789	
40_3_support	201.3	7.789		95.133		97.500	
10_fine_min	603.9	79.847		0.996		0.050	
10_fine_avg		82.208		1.407		0.890	
10_fine_max		83.404		1.903		2.159	
20_fine_min	606.3	88.775		1.394		0.765	
20_fine_avg		89.929		1.842		2.006	
20_fine_max		91.264		2.245		4.449	
30_fine_min	606.1	84.090		1.956		1.760	
30_fine_avg		87.532		2.655		5.928	
30_fine_max		91.871		3.370		9.822	
40_fine_min	607.1	90.609		3.099		1.211	
40_fine_avg		91.387		3.883		2.816	
40_fine_max		92.211		4.867		4.739	

Table S13 Calculated recovery for each sample after different decoating times (10 s, 20 s, 30 s, 40 s) for the support particles and fine particles from cell 2

Sample	Feed mass in mg	Recovery in %									
		LSCF		LSC		Perovskites		NiO		Byproduct	
10_1_support	201.2	37.226		93.468		51.976		94.722		98.285	
10_2_support	205	32.003	33.117	97.198	96.468	49.102	49.732	95.187	95.198	98.314	98.369
10_3_support	201.9	30.121		98.738		48.118		95.685		98.507	
20_1_support	203	22.094		90.728		40.095		94.203		97.756	
20_2_support	208.9	15.621	15.813	92.955	86.457	35.904	34.341	94.837	94.031	98.068	97.644
20_3_support	203.8	9.725		75.687		27.025		93.052		97.108	
30_1_support	202.8	5.765		100.000		30.481		96.416		97.962	
30_2_support	203.1	11.492	13.356	67.281	75.745	26.124	29.719	91.014	93.041	96.411	97.127
30_3_support	200.3	22.812		59.955		32.554		91.694		97.010	
40_1_support	203.2	13.090		80.013		30.642		93.163		97.448	
40_2_support	200.2	1.026	12.657	64.968	68.187	17.796	27.221	92.737	91.919	96.589	96.773
40_3_support	202.9	23.854		59.581		33.225		89.856		96.280	
10_1_fine	201.2	62.774		6.532		48.024		5.278		1.715	
10_2_fine	205	67.997	66.883	2.802	3.532	50.898	50.268	4.813	4.802	1.686	1.631
10_3_fine	201.9	69.879		1.262		51.882		4.315		1.493	
20_1_fine	203	77.906		9.272		59.905		5.797		2.244	
20_2_fine	208.9	84.379	84.187	7.045	13.543	64.096	65.659	5.163	5.969	1.932	2.356
20_3_fine	203.8	90.275		24.313		72.975		6.948		2.892	
30_1_fine	202.8	94.235		0.000		69.519		3.584		2.038	
30_2_fine	203.1	88.508	86.644	32.719	24.255	73.876	70.281	8.986	6.959	3.589	2.873
30_3_fine	200.3	77.188		40.045		67.446		8.306		2.990	
40_1_fine	203.2	86.910		19.987		69.358		6.837		2.552	
40_2_fine	200.2	98.974	87.343	35.032	31.813	82.204	72.779	7.263	8.081	3.411	3.227
40_3_fine	202.9	76.146		40.419		66.775		10.144		3.720	

Process evaluation and reuse potential

Table S14 Calculated maximum, minimum and average recovery for the total byproduct concentrate and product concentrate (after comminution, sieving, and decoating) based on each sample after different decoating times (10 s, 20 s, 30 s, 40 s) for the support particles and fine particles from cell 1

Concentrate	Calculated sample	Perovskites (LSCF)		Byproduct	
		Mass fraction in %	Recovery in %	Mass fraction in %	Recovery in %
Byproduct concentrate	10_support_min	0.236	3.958	99.716	90.880
	10_support_avg	0.253	4.327	99.747	92.204
	10_support_max	0.284	5.375	99.764	93.030
	20_support_min	0.125	2.084	99.841	88.752
	20_support_avg	0.144	2.426	99.856	91.166
	20_support_max	0.159	2.932	99.875	92.364
	30_support_min	0.117	1.939	99.775	83.762
	30_support_avg	0.178	2.871	99.822	87.517
	30_support_max	0.225	3.342	99.883	91.438
	40_support_min	0.113	1.858	99.860	88.484
	40_support_avg	0.124	2.070	99.876	90.412
	40_support_max	0.140	2.572	99.887	91.949
Product concentrate	10_fine_min	36.505	93.494	56.974	7.018
	10_fine_avg	41.182	94.872	60.411	7.822
	10_fine_max	48.069	98.093	64.113	9.025
	20_fine_min	34.892	95.624	58.711	7.683
	20_fine_avg	40.913	96.871	62.864	8.860
	20_fine_max	48.620	100.000	68.349	11.157
	30_fine_min	33.636	94.506	61.434	8.607
	30_fine_avg	40.596	96.343	70.614	12.509
	30_fine_max	53.557	100.000	75.986	16.157
	40_fine_min	34.388	95.944	59.977	8.097
	40_fine_avg	39.429	97.177	64.677	9.614
	40_fine_max	44.607	100.000	68.790	11.426

Table S15 Calculated maximum, minimum and average recovery for the total byproduct concentrate and product concentrate (after comminution, sieving, and decoating) based on each sample after different decoating times (10 s, 20 s, 30 s, 40 s) for the support particles and fine particles from cell 2

Concentrate	**Calculated sample**	**Perovskites (LSCF+LSC)**		**Byproduct**	
		Mass fraction in %	**Recovery in %**	**Mass fraction in %**	**Recovery in %**
Byproduct concentrate	10_support_min	3.062	24.908	96.548	90.765
	10_support_avg	3.242	27.727	96.758	91.452
	10_support_max	3.452	31.068	96.938	92.185
	20_support_min	1.698	13.990	97.317	89.678
	20_support_avg	2.255	19.146	97.745	90.778
	20_support_max	2.683	23.966	98.302	91.774
	30_support_min	0.978	13.523	97.015	89.033
	30_support_avg	1.772	16.569	98.228	90.298
	30_support_max	2.985	19.459	99.022	91.676
	40_support_min	1.023	9.212	98.382	88.913
	40_support_avg	1.255	15.176	98.745	89.968
	40_support_max	1.618	19.860	98.977	91.195
Product concentrate	10_fine_min	54.835	69.004	42.254	8.395
	10_fine_avg	56.276	72.273	43.724	8.548
	10_fine_max	57.746	75.362	45.165	8.652
	20_fine_min	53.980	75.155	39.655	8.801
	20_fine_avg	57.168	80.854	42.832	9.222
	20_fine_max	60.345	87.970	46.020	9.754
	30_fine_min	53.629	79.058	39.772	8.898
	30_fine_avg	56.693	83.431	43.307	9.702
	30_fine_max	60.228	88.509	46.371	10.407
	40_fine_min	53.230	78.711	39.706	9.372
	40_fine_avg	56.278	84.824	43.722	10.032
	40_fine_max	60.294	93.487	46.770	10.529