Supplemental

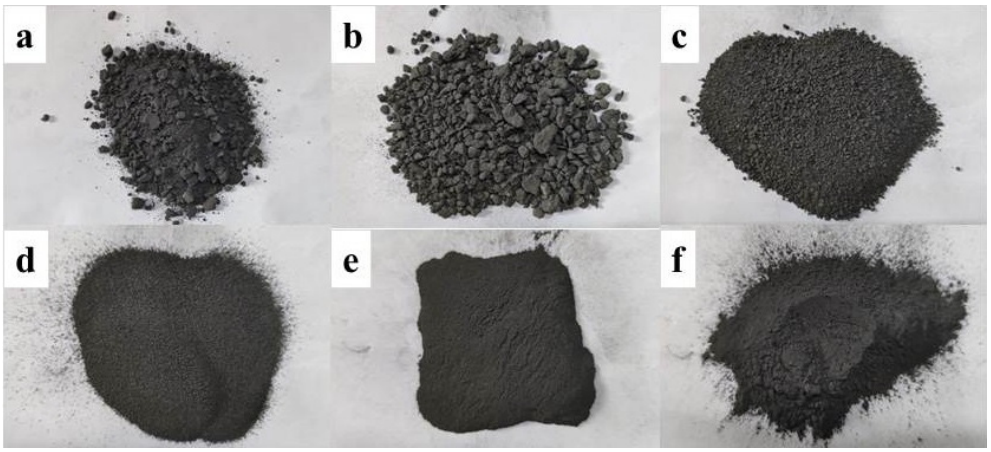


Figure S1:Secondary aluminum dross sieving size range

（a: raw AD, b: >2mm,c: 0.425-2mm,d: 0.15-0.425mm,e: 0.08-0.15mm,f: <0.08mm）

Table S1 element distribution of different particle sizes aluminum dross after different steel bar grinding time

Time	element	>2 mm	0.425-2mm	0.15-0.425mm	0.08-0.15mm	<0.08mm
3min	Al(%)	34.2	35.5	38.2	39.3	39.1
	Si(%)	10.5	10.5	8.06	6.86	6.25
5min	Al(%)	29.8	38.1	38.9	39.7	39.2
	Si(%)	13.5	8.65	8.1	6.81	5.95
10min	Al(%)	36.9	38.5	37.6	39.2	39
	Si(%)	10.2	9.09	8.56	6.64	6.37

Table S2 element distribution of different particle sizes aluminum dross after different steel ball grinding time

Time	element	>2 mm	0.425-2mm	0.15-0.425mm	0.08-0.15mm	<0.08mm
3min	Al(%)	25.00	45.86	50.84	27.45	4.11
	Si(%)	5.77	7.57	6.02	12.42	16.44
5min	Al(%)	15.38	55.67	32.32	26.90	32.69
	Si(%)	19.23	6.80	6.40	11.17	21.15
10min	Al(%)	5.56	44.05	35.39	33.01	46.81
	Si(%)	5.56	7.57	8.71	9.09	23.40

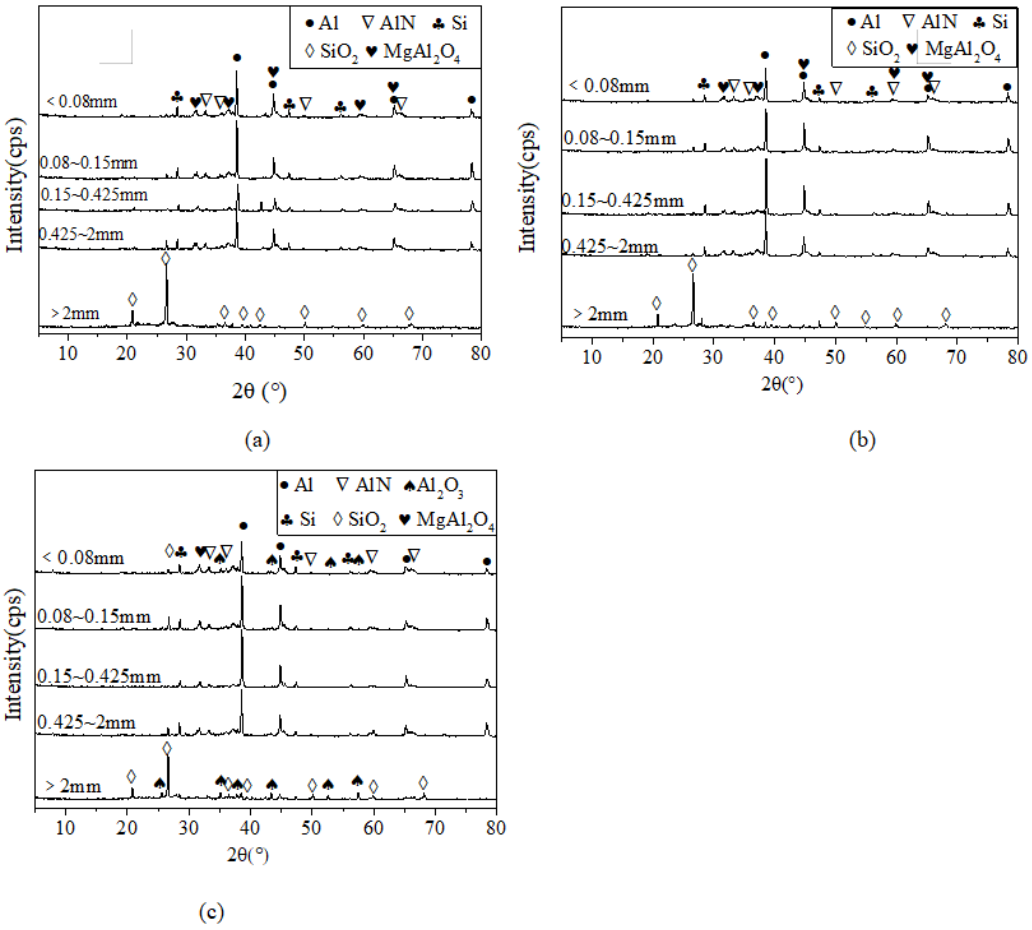
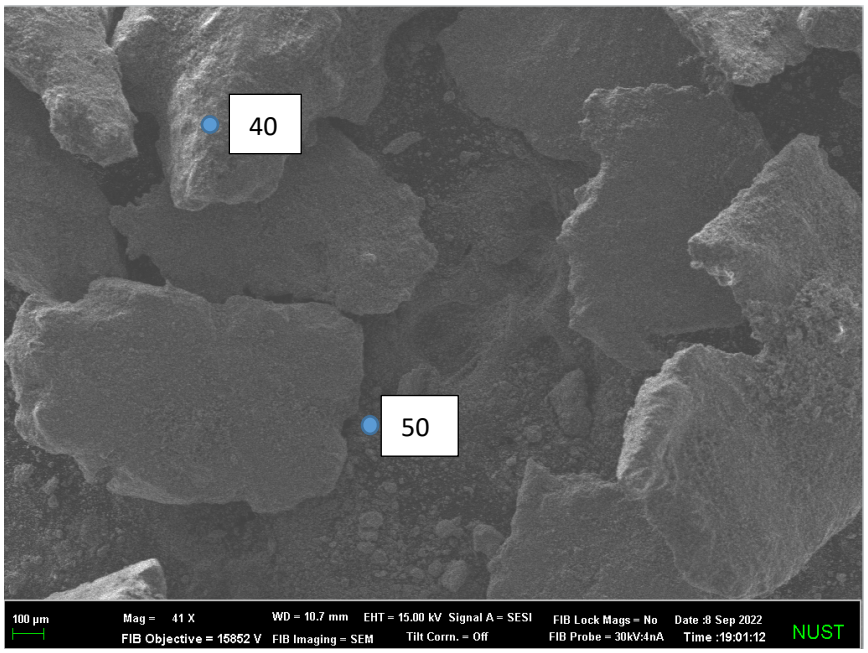
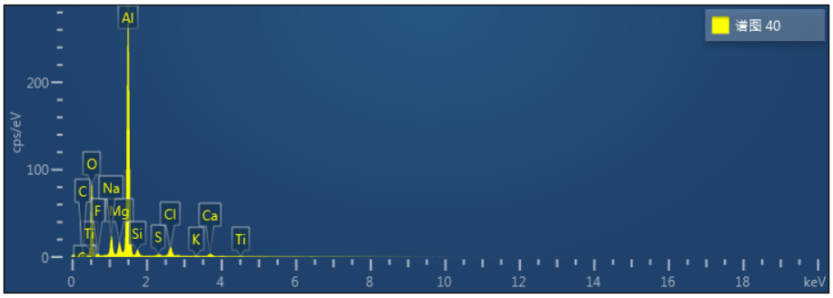
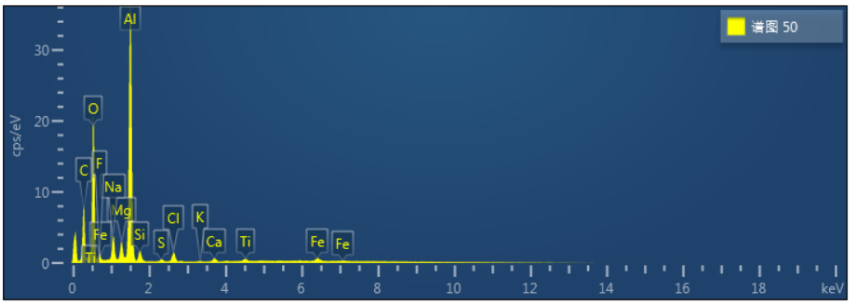


Figure S2 Results of XRD analyses of different particle sizes of AD after steel bar grinding: (a): 3 min; (b): 5 min; (c): 10 min



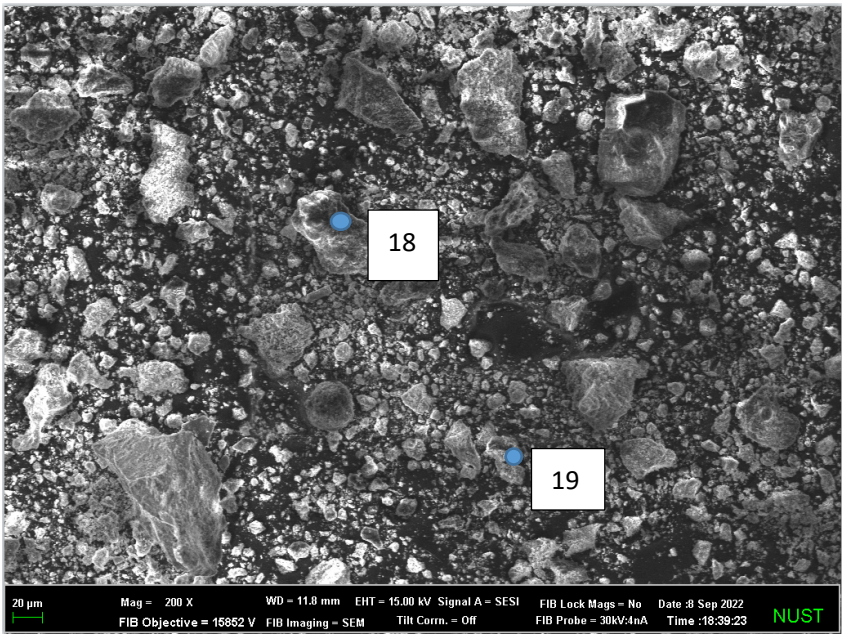


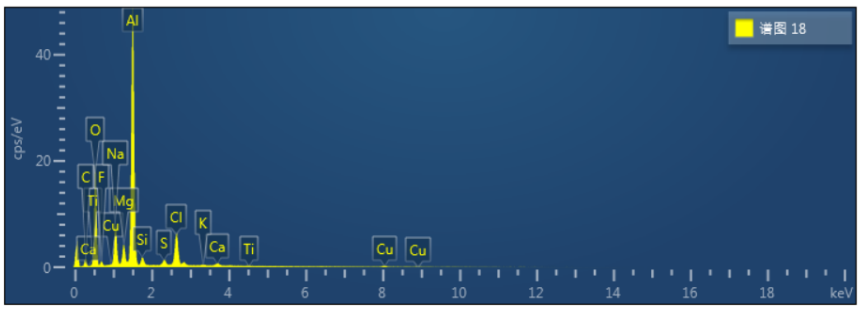
元素	wt%	wt% Sigma
C	5.52	0.89
O	31.14	0.37
F	1.53	0.12
Na	4.15	0.09
Mg	2.34	0.07
Al	48.25	0.50
Si	1.79	0.07
S	0.52	0.05
Cl	3.07	0.08
K	0.30	0.05
Ca	1.24	0.06
Ti	0.14	0.06
总量:	100.00	



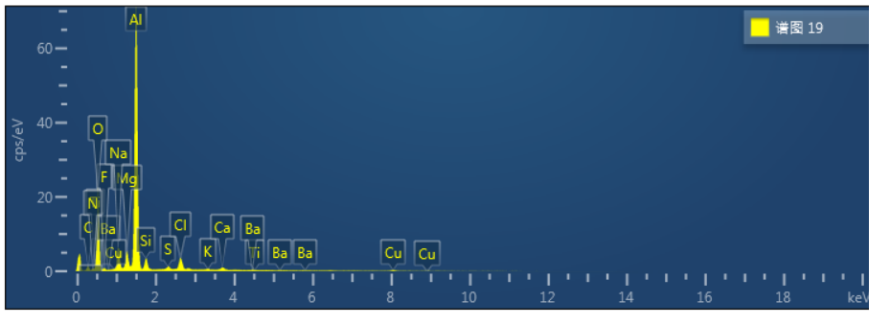
元素	wt%	wt% Sigma
C	29.28	0.69
O	32.94	0.39
F	1.86	0.15
Na	2.75	0.07
Mg	1.70	0.05
Al	24.57	0.27
Si	1.20	0.04
S	0.29	0.03
Cl	1.41	0.05
K	0.14	0.03
Ca	0.79	0.05
Ti	0.81	0.07
Fe	2.27	0.17
总量:	100.00	

(a)



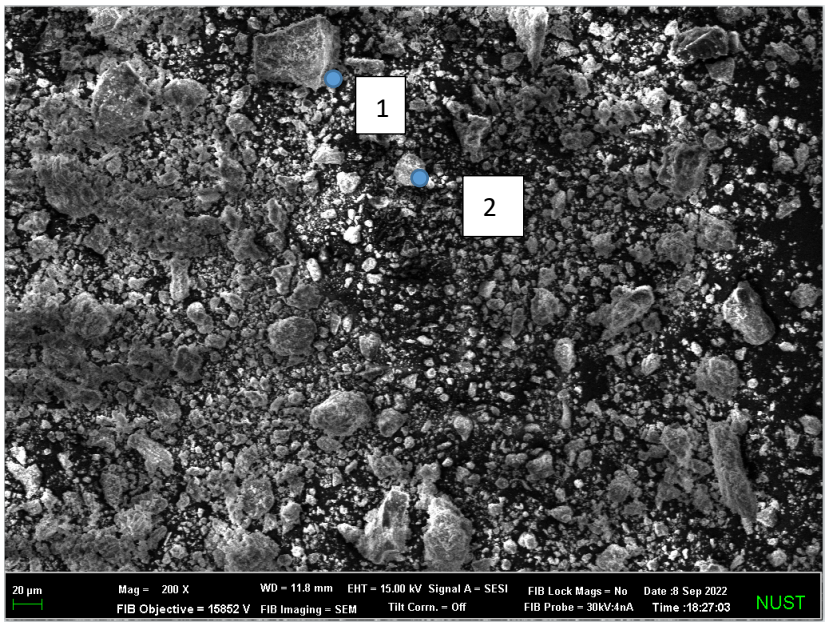


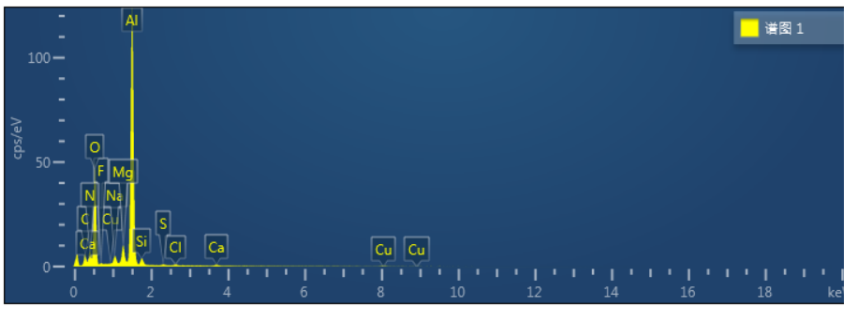
元素	wt%	wt% Sigma
C	10.96	0.94
O	31.06	0.40
F	1.99	0.13
Na	6.28	0.12
Mg	2.66	0.07
Al	35.81	0.42
Si	1.47	0.06
S	1.09	0.05
Cl	7.48	0.13
K	0.22	0.05
Ca	0.77	0.06
Ti	0.21	0.07
Cu	0.00	0.15
总量:	100.00	



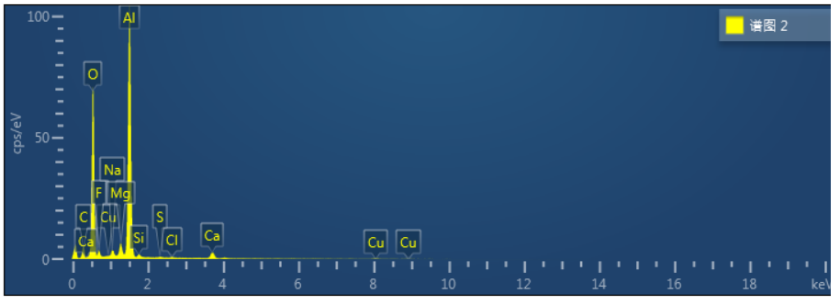
元素	wt%	wt% Sigma
C	7.25	1.06
N	2.08	0.67
O	30.74	0.52
F	1.16	0.20
Na	3.89	0.10
Mg	2.68	0.08
Al	43.40	0.63
Si	2.71	0.08
S	0.69	0.05
Cl	3.35	0.09
K	0.34	0.06
Ca	0.97	0.07
Ti	0.00	0.09
Cu	0.00	0.14
Ba	0.73	0.21
总量:	100.00	

(b)





元素	wt%	wt% Sigma
N	10.85	0.45
O	38.51	0.29
F	0.74	0.14
Na	1.52	0.07
Mg	2.84	0.07
Al	42.98	0.29
Si	1.62	0.06
S	0.19	0.04
Cl	0.28	0.04
Ca	0.42	0.05
Cu	0.05	0.15
总量:	100.00	



元素	wt%	wt% Sigma
O	48.16	0.21
F	3.86	0.19
Na	1.16	0.07
Mg	2.02	0.06
Al	41.49	0.19
Si	0.62	0.05
S	0.17	0.04
Cl	0.17	0.04
Ca	2.35	0.07
Cu	0.00	0.16
总量:	100.00	

(c)

Figure S3 SEM-EDS of different particle size :(a): ＞0.425mm; (b): 0.08-0.425mm; (c): ＜0.08mm

Table S3 Subentry metallic Al content of different particle sizes aluminum dross after steel bar grinding time

grinding time	Dp>2	Dp0.425-2	Dp0.15-0.425	Dp0.08-0.15	Dp<0.08	sum
3min(%)	0.87	19.13	7.91	3.02	0.18	31.11
5min(%)	0.77	10.50	10.85	4.55	0.28	26.94
10min(%)	0.61	12.87	10.57	5.70	0.31	30.06

Table S4 recoverable metallic Al fraction by steel ball grinding

grinding time	0.425-2mm	0.15-0.425mm
3min(%)	21.87%	5.89%
5min(%)	23.20%	6.69%
10min(%)	25.40%	7.99%

Table S5 recoverable metal Al fraction by steel bar grinding

grinding time	0.425-2mm	0.15-0.425mm
3min(%)	20.04%	3.06%

5min(%)	15.93%	3.04%
10min(%)	17.70%	4.49%

Table S6 Al recovery rate of total Al by steel ball grinding

grinding time	0.425-2mm	0.15-0.425mm
3min(%)	46.5%	33.3%
5min(%)	54.3%	35.2%
10min(%)	64.9%	37.7%

Table S7 Al recoverable rate of total Al by steel bar grinding

grinding time	0.425-2mm	0.15-0.425mm
3min(%)	44.1%	11.3%
5min(%)	56.9%	8.8%
10min(%)	43.3%	14.9%

Table S8AlN fraction of different particle size by steel bar grinding

grinding time	>2 mm	0.425-2mm	0.15-0.425mm	0.08-0.15mm	<0.08m	sum
3min	0.17	1.81	14.49	6.10	0.25	22.83
5min	0.13	1.61	15.45	7.11	0.38	24.68
10min	0.08	1.35	17.33	9.45	0.28	28.49