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APPENDICES

Appendix A: Experimental data for SDS adsorption study

Weight of carbon black = 2.5 g

Volume of solution = 20 ml

Temperature = 30°C

Table A-1 Data for SDS adsorption at pH of 7 and the amount of calcium = 0 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole/m}^2$)
2,000	51.3373	1,948.6627	0.1624
2,500	55.8924	2,444.1076	0.2037
3,000	66.8250	2,933.1750	0.2444
3,500	69.8561	3,430.1439	0.2858
4,000	89.3017	3,910.6983	0.3259
4,500	102.2670	4,397.7330	0.3665
5,000	125.4046	4,874.5954	0.4062
5,400	149.4912	5,250.5088	0.4375
5,500	160.6004	5,339.3996	0.4449
6,000	202.0067	5,797.9933	0.4832
6,500	244.0564	6,255.9436	0.5213
7,500	458.4799	7,041.5201	0.5868
8,000	481.2496	7,518.7504	0.6266
8,500	625.3794	7,874.6206	0.6562
9,000	672.0238	8,327.9762	0.6940
9,500	711.1370	8,788.8630	0.7324
10,000	876.1729	9,123.8271	0.7603
11,000	1,229.7123	9,770.2877	0.8142
12,000	1,641.8211	10,358.1789	0.8632
13,000	1,909.3370	11,090.6630	0.9242
14,000	2,288.7866	11,711.2134	0.9759
15,000	2,550.1331	12,449.8669	1.0375
16,000	2,905.6876	13,094.3124	1.0912
17,000	3,370.4291	13,629.5709	1.1358
18,000	3,670.1141	14,329.8859	1.1942
19,000	4,070.9806	14,929.0194	1.2441
20,000	4,344.2287	15,655.7713	1.3046
21,000	4,723.7832	16,276.2168	1.3564
22,000	5,090.2334	16,909.7666	1.4091
23,000	5,307.7073	17,692.2927	1.4744
25,000	5,917.1110	19,082.8890	1.5902
26,000	6,497.6141	19,502.3859	1.6252
30,000	8,127.9510	21,872.0490	1.8227
35,000	10,095.3111	24,904.6889	2.0754
40,000	15,080.0891	24,919.9109	2.0767
50,000	25,063.5015	24,936.4985	2.0780
60,000	34,921.2742	25,078.7258	2.0899

Table A-2 Data for SDS adsorption at pH of 7 and the amount of calcium = 100 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole/m}^2$)
8,000	19.9323	7,980.0677	0.6650
8,500	132.5798	8,367.4202	0.6973
9,000	273.6192	8,726.3808	0.7272
9,500	427.7829	9,072.2171	0.7560
10,000	527.8640	9,472.1360	0.7893
11,000	911.3783	10,088.6217	0.8407
12,000	1,283.0336	10,716.9664	0.8931
13,000	1,637.9093	11,362.0907	0.9468
14,000	2,076.5582	11,923.4418	0.9936
15,000	2,397.1088	12,602.8912	1.0502
16,000	2,715.5211	13,284.4789	1.1070
17,000	3,004.8172	13,995.1828	1.1663
18,000	3,382.7993	14,617.2007	1.2181
19,000	3,700.9397	15,299.0603	1.2749
20,000	4,014.3870	15,985.6130	1.3321
21,000	4,398.8147	16,601.1853	1.3834
22,000	4,649.7281	17,350.2719	1.4459
24,000	5,291.5178	18,708.4822	1.5590
25,000	5,828.6271	19,171.3729	1.5976
26,000	6,050.9715	19,949.0285	1.6624
28,000	6,713.7328	21,286.2672	1.7739
29,000	7,105.4812	21,894.5188	1.8245
30,000	7,436.5468	22,563.4532	1.8803
35,000	9,755.8193	25,244.1807	2.1037
40,000	14,932.0054	25,067.9946	2.0890
45,000	19,577.9401	25,422.0599	2.1185
50,000	24,826.5483	25,173.4517	2.0978
55,000	29,731.9443	25,268.0557	2.1057
60,000	34,830.4756	25,169.5244	2.0975

Table A-3 Data for SDS adsorption at pH of 7 and the amount of calcium = 700 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole/m}^2$)
14,000	1,561.3950	12,438.6050	1.0366
16,000	2,254.8746	13,745.1254	1.1454
18,000	3,055.1203	14,944.8797	1.2454
20,000	3,676.6244	16,323.3756	1.3603
22,000	4,377.0690	17,622.9310	1.4686
24,000	4,954.6437	19,045.3563	1.5871
26,000	5,565.3076	20,434.6924	1.7029
28,000	6,206.4893	21,793.5107	1.8161
30,000	7,030.1439	22,969.8561	1.9142
32,000	7,689.4915	24,310.5085	2.0259
34,000	8,954.9214	25,045.0786	2.0871
36,000	10,910.7440	25,089.2560	2.0908
38,000	12,796.1272	25,203.8728	2.1003
40,000	14,676.0291	25,323.9709	2.1103

Table A-4 Data for SDS adsorption at pH of 7 and the amount of calcium = 1,000 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole/m}^2$)
14,000	1,302.8610	12,697.1390	1.0581
16,000	1,962.3016	14,037.6984	1.1698
18,000	2,622.9010	15,377.0990	1.2814
20,000	3,245.7534	16,754.2466	1.3962
22,000	3,864.9600	18,135.0400	1.5113
24,000	4,547.8703	19,452.1297	1.6210
26,000	5,239.7291	20,760.2709	1.7300
28,000	5,896.3645	22,103.6355	1.8420
30,000	6,330.2757	23,669.7243	1.9725
32,000	7,121.5090	24,878.4910	2.0732
36,000	9,836.8656	26,163.1344	2.1803
38,000	11,791.0775	26,208.9225	2.1841
40,000	13,806.4100	26,193.5900	2.1828
45,000	18,783.1385	26,216.8615	2.1847

Table A-5 Data for SDS adsorption at pH of 9 and the amount of calcium = 0 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole}/\text{m}^2$)
2,500	56.0293	2,443.9707	0.2037
2,750	60.5786	2,689.4214	0.2241
3,000	63.6178	2,936.3822	0.2447
3,500	67.8875	3,432.1125	0.2860
4,000	96.0238	3,903.9762	0.3253
4,500	102.0312	4,397.9688	0.3665
5,000	140.8280	4,859.1720	0.4049
5,500	202.5773	5,297.4227	0.4415
6,000	259.9309	5,740.0691	0.4783
6,500	328.6842	6,171.3158	0.5143
7,000	411.0181	6,588.9819	0.5491
7,500	483.9002	7,016.0998	0.5847
8,000	622.8997	7,377.1003	0.6148
8,500	688.1114	7,811.8886	0.6510
9,000	842.0752	8,157.9248	0.6798
9,500	967.9244	8,532.0756	0.7110
10,000	1,095.5654	8,904.4346	0.7420
11,000	1,392.4332	9,607.5668	0.8006
12,000	1,806.4341	10,193.5659	0.8495
13,000	2,116.5720	10,883.4280	0.9070
14,000	2,536.1648	11,463.8352	0.9553
15,000	2,904.5198	12,095.4802	1.0080
16,000	3,204.2029	12,795.7971	1.0663
17,000	3,558.8425	13,441.1575	1.1201
18,000	3,906.0792	14,093.9208	1.1745
19,000	4,422.3030	14,577.6970	1.2148
20,000	4,785.9018	15,214.0982	1.2678
21,000	5,199.3987	15,800.6013	1.3167
22,000	5,677.5809	16,322.4191	1.3602
23,000	5,822.3972	17,177.6028	1.4315
24,000	5,931.7230	18,068.2770	1.5057
25,000	6,142.1100	18,857.8900	1.5715
26,000	6,759.4438	19,240.5562	1.6034
28,000	7,486.0753	20,513.9247	1.7095
30,000	8,409.0762	21,590.9238	1.7992
35,000	11,288.8811	23,711.1189	1.9759
40,000	15,582.1766	24,417.8234	2.0348
50,000	25,299.3060	24,700.6940	2.0584
60,000	35,248.2796	24,751.7204	2.0626

Table A-6 Data for SDS adsorption at pH of 9 and the amount of calcium = 100 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole/m}^2$)
8,000	19.0070	7,980.9930	0.6651
8,500	104.3737	8,395.6263	0.6996
9,000	291.4284	8,708.5716	0.7257
9,500	354.3663	9,145.6337	0.7621
10,000	467.1178	9,532.8822	0.7944
11,000	845.8806	10,154.1194	0.8462
12,000	1,222.0765	10,777.9235	0.8982
13,000	1,530.5485	11,469.4515	0.9558
14,000	1,878.8046	12,121.1954	1.0101
15,000	2,257.7987	12,742.2013	1.0619
16,000	2,585.1636	13,414.8364	1.1179
17,000	2,955.9701	14,044.0299	1.1703
18,000	3,317.9752	14,682.0248	1.2235
19,000	3,634.6928	15,365.3072	1.2804
20,000	4,007.0651	15,992.9349	1.3327
21,000	4,370.6603	16,629.3397	1.3858
22,000	4,635.2217	17,364.7783	1.4471
24,000	5,425.1852	18,574.8148	1.5479
25,000	5,645.7663	19,354.2337	1.6129
26,000	5,883.2819	20,116.7181	1.6764
28,000	6,356.0676	21,643.9324	1.8037
29,000	6,766.0309	22,233.9691	1.8528
30,000	7,243.8115	22,756.1885	1.8963
35,000	10,634.4358	24,365.5642	2.0305
40,000	14,970.8559	25,029.1441	2.0858
45,000	19,983.8700	25,016.1300	2.0847
50,000	25,066.4180	24,933.5820	2.0778
55,000	30,025.5999	24,974.4001	2.0812
60,000	34,848.3160	25,151.6840	2.0960

Table A-7 Data for SDS adsorption at pH of 9 and the amount of calcium = 700 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole/m}^2$)
14,000	1,778.2149	12,221.7851	1.0185
16,000	2,401.0599	13,598.9401	1.1332
18,000	3,051.5739	14,948.4261	1.2457
20,000	3,754.4628	16,245.5372	1.3538
22,000	4,363.5437	17,636.4563	1.4697
24,000	5,019.8891	18,980.1109	1.5817
26,000	5,749.1069	20,250.8931	1.6876
28,000	6,225.4315	21,774.5685	1.8145
30,000	7,095.3513	22,904.6487	1.9087
32,000	7,822.1597	24,177.8403	2.0148
34,000	9,151.1819	24,848.8181	2.0707
36,000	11,049.5967	24,950.4033	2.0792
38,000	12,910.5190	25,089.4810	2.0908
40,000	14,691.7174	25,308.2826	2.1090

Table A-8 Data for SDS adsorption at pH of 9 and the amount of calcium = 1,000 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Different SDS concentration (μM)	SDS adsorption ($\mu\text{mole}/\text{m}^2$)
14,000	1,155.0204	12,844.9796	1.0704
16,000	1,827.1955	14,172.8045	1.1811
18,000	2,515.6501	15,484.3499	1.2904
20,000	3,124.1777	16,875.8223	1.4063
22,000	3,727.5609	18,272.4391	1.5227
24,000	4,373.7727	19,626.2273	1.6355
26,000	5,009.2916	20,990.7084	1.7492
28,000	5,648.7142	22,351.2858	1.8626
30,000	6,251.3139	23,748.6861	1.9791
32,000	6,971.2341	25,028.7659	2.0857
36,000	10,572.4425	25,427.5575	2.1190
38,000	12,542.1501	25,457.8499	2.1215
40,000	14,471.5835	25,528.4165	2.1274
45,000	19,466.3597	25,533.6403	2.1278



Table A-9 Data of the amount of adsorbed calcium from SDS adsorption study at pH of 7 and the initial calcium = 100 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Final calcium concentration (μM)	Calcium adsorption ($\mu\text{mole/m}^2$)
8,000	19.0070	21.1970	0.0066
8,500	104.3737	14.0794	0.0072
9,000	291.4284	11.1960	0.0074
10,000	467.1178	21.5607	0.0065
11,000	845.8806	17.5603	0.0069
13,000	1,530.5485	13.9235	0.0072
15,000	2,257.7987	11.0661	0.0074
16,000	2,585.1636	19.1189	0.0067
17,000	2,955.9701	14.6249	0.0071
20,000	4,007.0651	14.1573	0.0072
21,000	4,370.6603	16.2095	0.0070
24,000	5,425.1852	13.2481	0.0072
25,000	5,645.7663	9.8192	0.0075
28,000	6,356.0676	14.6509	0.0071
<i>Average</i>			<i>0.0071</i>

Table A-10 Data of the amount of adsorbed calcium from SDS adsorption study at pH of 7 and the initial calcium = 700 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Final calcium concentration (μM)	Calcium adsorption ($\mu\text{mole/m}^2$)
14,000	1,561.3950	23.2232	0.0564
16,000	2,254.8746	19.2747	0.0567
18,000	3,055.1203	48.5765	0.0543
20,000	3,676.6244	37.5104	0.0552
22,000	4,377.0690	16.2095	0.0570
24,000	4,954.6437	20.1579	0.0567
26,000	5,565.3076	8.6243	0.0576
28,000	6,206.4893	13.0923	0.0572
30,000	7,030.1439	15.1185	0.0571
32,000	7,689.4915	30.1330	0.0558
34,000	8,954.9214	29.1459	0.0559
<i>Average</i>			<i>0.0564</i>

Table A-11 Data of the amount of adsorbed calcium from SDS adsorption study at pH of 7 and the initial calcium = 1,000 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Final calcium concentration (μM)	Calcium adsorption ($\mu\text{mole/m}^2$)
14,000	1,302.8610	22.5478	0.0780
16,000	1,962.3016	23.8986	0.0768
18,000	2,622.9010	21.4048	0.0740
20,000	3,245.7534	20.5736	0.0752
22,000	3,864.9600	22.6517	0.0732
24,000	4,547.8703	20.9892	0.0731
26,000	5,239.7291	17.2485	0.0727
28,000	5,896.3645	19.5345	0.0751
30,000	6,330.2757	15.3782	0.0747
32,000	7,121.5090	20.9892	0.0789
36,000	9,836.8656	21.4048	0.0759
<i>Average</i>			<i>0.0752</i>

Table A-12 Data of the amount of adsorbed calcium from SDS adsorption study at pH of 9 and the initial calcium = 100 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Final calcium concentration (μM)	Calcium adsorption ($\mu\text{mole/m}^2$)
8,000	19.0070	2.2743	0.0081
9,000	291.4284	7.0025	0.0077
9,500	354.3663	3.5192	0.0080
10,000	467.1178	3.4713	0.0080
11,000	845.8806	6.3202	0.0078
12,000	1,222.0765	4.7282	0.0079
13,000	1,530.5485	3.1481	0.0081
14,000	1,878.8046	6.4040	0.0078
15,000	2,257.7987	2.7292	0.0081
16,000	2,585.1636	6.0249	0.0078
17,000	2,955.9701	2.8549	0.0081
19,000	3,634.6928	1.0853	0.0082
24,000	5,425.1852	4.6755	0.0079
29,000	6,766.0309	3.5407	0.0080
30,000	7,243.8115	1.6200	0.0082
35,000	10,634.4358	8.2270	0.0076
<i>Average</i>			<i>0.0080</i>

Table A-13 Data of the amount of adsorbed calcium from SDS adsorption study at pH of 9 and the initial calcium = 700 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Final calcium concentration (μM)	Calcium adsorption ($\mu\text{mole}/\text{m}^2$)
14,000	1,778.2149	10.3387	0.0575
18,000	3,051.5739	4.9875	0.0579
20,000	3,754.4628	23.4830	0.0564
22,000	4,363.5437	12.3130	0.0573
24,000	5,019.8891	17.1446	0.0569
26,000	5,749.1069	8.4684	0.0576
28,000	6,225.4315	14.9626	0.0571
30,000	7,095.3513	10.2868	0.0575
32,000	7,822.1597	13.0403	0.0572
34,000	9,603.1822	26.6002	0.0561
<i>Average</i>			<i>0.0572</i>

Table A-14 Data of the amount of adsorbed calcium from SDS adsorption study at pH of 9 and the initial calcium = 1,000 μM

Initial SDS concentration (μM)	Final SDS concentration (μM)	Final calcium concentration (μM)	Calcium adsorption ($\mu\text{mole}/\text{m}^2$)
14,000	1,155.0204	19.5345	0.0782
16,000	1,827.1955	9.9751	0.0779
18,000	2,515.6501	12.0532	0.0747
20,000	3,124.1777	7.4813	0.0763
22,000	3,727.5609	3.9485	0.0748
24,000	4,373.7727	15.7938	0.0735
26,000	5,009.2916	9.9751	0.0733
28,000	5,648.7142	7.6891	0.0761
30,000	6,251.3139	22.0283	0.0741
32,000	6,971.2341	10.5985	0.0798
36,000	10,572.4425	8.3126	0.0770
38,000	12,542.1501	9.3516	0.0799
<i>Average</i>			<i>0.0763</i>

Appendix B: Experimental data of calcium adsorption study

Weight of carbon black = 2.5 g
 Volume of solution = 20 ml
 Temperature = 30°C

Table B-1 Data for calcium adsorption at pH of 7 and the amount of SDS = 0 μM

Initial calcium concentration (μM)	Final calcium concentration (μM)	Different calcium concentration (μM)	Adsorption ($\mu\text{mole/m}^2$)
750.6234	1.2468	749.3766	0.0624
1,431.4214	66.3341	1,365.0873	0.1138
3,019.9501	1,082.2942	1,937.6559	0.1615
4,605.9850	2,040.5236	2,565.4614	0.2138
6,172.0698	3,387.7805	2,784.2893	0.2320
9,476.3092	5,829.1770	3,647.1322	0.3039
10,657.7307	6,857.8553	3,799.8754	0.3167
12,541.5628	8,603.4912	3,938.0716	0.3282
14,314.2144	10,224.4389	4,089.7755	0.3408
17,899.0025	13,840.3990	4,058.6035	0.3382
19,588.5287	15,461.3466	4,127.1821	0.3439
23,403.9901	19,401.4962	4,002.4939	0.3335
25,635.9102	21,496.2593	4,139.6509	0.3450
32,493.7656	28,179.5511	4,314.2145	0.3595
35,274.3142	30,922.6932	4,351.6210	0.3626

Table B-2 Data for calcium adsorption at pH of 7 and the amount of SDS = 100 μM

Initial calcium concentration (μM)	Final calcium concentration (μM)	Different calcium concentration (μM)	Adsorption ($\mu\text{mole/m}^2$)
1,214.2144	64.9626	1,149.2518	0.0958
2,341.6459	569.2019	1,772.4440	0.1477
3,439.1146	1,258.1047	2,181.0099	0.1818
4,627.1820	2,119.5262	2,507.6558	0.2090
7,052.3691	4,137.1571	2,915.2120	0.2429
8,044.0565	4,985.7855	3,058.2710	0.2549
11,184.5386	7,796.1762	3,388.3624	0.2824
13,522.4439	9,835.1621	3,687.2818	0.3073
15,461.3466	11,665.8604	3,795.4863	0.3163
21,733.1671	17,790.5237	3,942.6434	0.3286
24,669.5761	20,875.0623	3,794.5138	0.3162
31,458.8529	27,319.4514	4,139.4015	0.3450
36,396.5087	32,369.0773	4,027.4314	0.3356
38,185.7855	34,168.1047	4,017.6808	0.3348
35,274.3142	30,922.6932	4,351.6210	0.3626

Table B-3 Data for calcium adsorption at pH of 7 and the amount of SDS = 200 μM

Initial calcium concentration (μM)	Final calcium concentration (μM)	Different calcium concentration (μM)	Adsorption ($\mu\text{mole/m}^2$)
1,533.6658	219.4514	1,314.2144	0.1095
2,057.3566	467.5810	1,589.7756	0.1325
2,523.6908	797.9052	1,725.7856	0.1438
3,738.1546	1,670.8229	2,067.3317	0.1723
5,407.3150	3,201.4963	2,205.8187	0.1838
6,201.1637	4,102.8678	2,098.2959	0.1749
6,758.1047	4,526.1845	2,231.9202	0.1860
10,457.1904	8,114.0898	2,343.1006	0.1953
13,192.0199	10,728.1047	2,463.9152	0.2053
14,231.0889	11,713.4414	2,517.6475	0.2098

Table B-4 Data for calcium adsorption at pH of 9 and the amount of SDS = 0 μM

Initial calcium concentration (μM)	Final calcium concentration (μM)	Different calcium concentration (μM)	Adsorption ($\mu\text{mole/m}^2$)
750.6234	11.6957	738.9277	0.0616
1,431.4214	21.1970	1,410.2244	0.1175
3,019.9501	90.3990	2,929.5511	0.2441
4,605.9850	780.5486	3,825.4364	0.3188
6,172.0698	1,357.8553	4,814.2145	0.4012
9,476.3092	3,026.9326	6,449.3766	0.5374
10,657.7307	3,700.2494	6,957.4813	0.5798
12,541.5628	4,997.0074	7,544.5554	0.6287
14,314.2144	6,379.0523	7,935.1621	0.6613
17,899.0025	9,326.6832	8,572.3193	0.7144
19,588.5287	10,543.6408	9,044.8879	0.7537
23,403.9901	14,598.5037	8,805.4864	0.7338
22,743.1421	13,780.5486	8,962.5935	0.7469
25,149.6259	15,805.4862	9,344.1397	0.7787
29,351.6209	20,099.7506	9,251.8703	0.7710
30,966.3342	21,596.0099	9,370.3243	0.7809
35,274.3142	25,851.8703	9,422.4439	0.7852
37,698.2544	28,121.4463	9,576.8081	0.7981

Table B-5 Data for calcium adsorption at pH of 9 and the amount of SDS = 100 μM

Initial calcium concentration (μM)	Final calcium concentration (μM)	Different calcium concentration (μM)	Adsorption ($\mu\text{mole/m}^2$)
3,439.1146	427.3691	3,011.7455	0.2510
4,627.1820	990.9601	3,636.2219	0.3030
7,052.3691	2,607.1186	4,445.2505	0.3704
9,064.8371	3,983.8404	5,080.9967	0.4234
11,184.5386	5,885.4115	5,299.1271	0.4416
13,522.4439	7,855.6109	5,666.8330	0.4722
15,461.3466	9,640.7684	5,820.5782	0.4850
21,733.1671	15,739.1521	5,994.0150	0.4995
24,669.5761	18,513.7157	6,155.8604	0.5130
26,477.5561	20,456.3591	6,021.1970	0.5018
28,986.9077	22,917.7057	6,069.2020	0.5058
31,458.8529	25,405.2369	6,053.6160	0.5045
32,705.7357	26,752.3572	5,953.3785	0.4961
36,396.5087	30,058.3541	6,338.1546	0.5282
38,185.7855	32,113.4663	6,072.3192	0.5060

Table B-6 Data for calcium adsorption at pH of 9 and the amount of SDS = 200 μM

Initial calcium concentration (μM)	Final calcium concentration (μM)	Different calcium concentration (μM)	Adsorption ($\mu\text{mole/m}^2$)
2,523.6908	202.6185	2,321.0723	0.1934
2,852.8678	390.8978	2,461.9700	0.2052
3,738.1546	820.4489	2,917.7057	0.2431
4,301.7456	1,211.7207	3,090.0249	0.2575
5,407.3150	1,988.2045	3,419.1105	0.2849
6,201.1637	2,618.4539	3,582.7098	0.2986
7,198.6699	3,327.9302	3,870.7397	0.3226
7,722.3608	3,789.9501	3,932.4107	0.3277
8,744.8046	4,748.1297	3,996.6749	0.3331
10,457.1904	6,188.1297	4,269.0607	0.3558
13,192.0199	8,824.9302	4,367.0897	0.3639
14,231.0889	9,763.0923	4,467.9966	0.3723

Appendix C: Experimental data of zeta potential study

Weight of carbon black = 1.5 mg
 Volume of suspension = 40 ml
 Temperature = 30°C

Table C-1 The data of zeta potential measurement of carbon black at pH of 7 and the amount of calcium = 0 μM and SDS = variable

SDS Concentration (μM)		1,000	2,000	4,000	8,000	12,000	14,000	16,000	18,000	20,000	24,000
(-) Zeta potential (mV)	1	23.6	25.4	26.0	30.7	32.4	40.0	38.6	39.6	40.7	41.3
	2	22.2	26.4	29.0	30.8	32.8	36.5	37.1	40.4	39.2	38.0
	3	24.9	26.0	26.4	30.2	38.6	38.0	39.5	38.6	39.4	39.9
	4	22.4	25.2	27.2	29.3	37.1	39.6	39.7	40.1	39.2	38.3
	5	23.1	24.2	28.6	32.5	37.4	37.6	39.7	38.8	40.0	40.2
	6	26.9	24.9	27.3	28.4	35.3	37.0	37.8	40.3	41.8	39.9
	7	22.4	25.0	24.7	29.6	36.5	41.0	39.0	40.0	38.2	40.2
	8	23.5	24.3	26.9	28.4	36.1	37.8	37.6	40.2	38.1	38.7
	9	26.3	24.9	27.3	31.2	33.9	39.2	40.2	39.7	39.7	41.4
	10	22.2	25.5	27.7	28.2	34.0	36.8	38.7	41.7	41.5	39.5
	11	24.4	25.3	28.6	30.2	35.5	40.5	39.1	37.8	40.3	40.1
	12	24.0	24.8	25.8	28.7	34.1	38.8	38.9	38.8	38.7	40.7
Average zeta potential (mV)		23.8	25.2	27.1	29.9	35.3	38.6	38.8	39.7	39.7	39.9
Standard deviation		1.50	0.60	1.22	1.27	1.84	1.44	0.89	0.99	1.14	1.03

Table C-2 The data of zeta potential measurement of carbon black at pH of 7 and the amount of calcium = 100 μM and SDS = variable

SDS Concentration (μM)		1,500	2,500	9,500	12,000	16,000	20,000
(-) Zeta potential (mV)	1	22.2	22.0	28.7	33.0	34.2	36.3
	2	20.0	22.4	28.7	33.8	35.7	36.3
	3	21.3	24.3	29.4	33.6	32.1	34.7
	4	21.1	22.9	30.6	33.0	33.1	37.2
	5	19.9	26.4	29.5	35.2	32.6	35.9
	6	19.5	25.6	28.3	32.4	35.8	37.3
	7	20.4	21.3	31.9	33.9	32.9	36.3
	8	19.5	22.6	26.5	33.4	35.1	37.4
	9	21.1	23.5	30.2	34.2	32.2	39.4
	10	20.7	21.5	29.1	32.6	34.5	35.5
	11	18.0	22.7	28.8	32.9	33.6	35.3
	12	19.7	21.6	27.8	35.1	32.7	37.3
Average zeta potential (mV)		20.3	23.1	29.1	33.6	33.7	36.6
Standard deviation		1.10	1.62	1.38	0.90	1.32	1.25

Table C-3 The data of zeta potential measurement of carbon black at pH of 7 and the amount of calcium = 1,000 μM and SDS = variable

SDS Concentration (μM)		16,000	18,000	20,000	22,000	24,000
(-) Zeta potential (mV)	1	30.9	30.8	31.0	32.6	32.3
	2	28.8	32.0	30.8	33.2	33.6
	3	29.0	31.7	32.0	33.7	33.8
	4	29.9	32.6	33.5	32.5	33.2
	5	30.4	31.7	32.3	33.5	34.8
	6	31.2	32.9	33.4	30.6	35.0
	7	31.1	31.6	31.7	31.9	33.6
	8	30.6	30.2	32.0	32.7	34.8
	9	31.3	31.2	31.8	32.6	32.6
	10	32.1	32.7	33.5	32.9	33.3
	11	31.7	29.8	31.1	31.4	32.8
	12	29.6	32.1	30.6	32.9	31.7
Average zeta potential (mV)		30.6	31.6	32.0	32.5	33.5
Standard deviation		1.00	0.93	1.00	0.84	0.99

Table C-4 The data of zeta potential measurement of carbon black at pH of 9 and the amount of calcium = 0 μM and SDS = variable

SDS Concentration (μM)		1,000	2,000	4,000	8,000	12,000	14,000	16,000	18,000	20,000	24,000
(-) Zeta potential (mV)	1	26.7	27.6	28.6	32.5	38.4	39.4	40.4	41.7	38.6	39.4
	2	26.2	27.1	29.1	29.6	38.6	41.1	36.8	37.1	40.9	39.9
	3	27.9	27.3	28.7	30.3	36.4	41.4	40.3	41.5	38.8	40.2
	4	27.1	29.0	28.9	31.8	36.7	39.0	41.4	38.2	41.2	41.2
	5	26.3	28.3	30.0	32.7	37.7	39.1	41.7	41.6	40.0	43.7
	6	26.3	26.8	28.0	32.7	37.1	40.2	40.1	41.8	39.9	40.3
	7	27.1	28.1	27.7	31.2	37.2	39.0	41.0	39.7	39.7	40.7
	8	26.8	26.9	28.9	30.9	37.2	37.3	38.8	40.2	41.2	39.6
	9	26.7	27.4	29.5	33.8	40.2	39.2	39.0	40.3	40.3	38.9
	10	27.6	27.2	26.9	31.3	36.6	41.1	38.3	40.1	40.2	41.4
	11	26.3	26.5	28.2	31.0	35.8	40.6	41.5	40.8	38.2	39.8
	12	27.0	28.7	29.8	32.9	39.6	39.7	42.1	41.7	41.3	38.7
Average zeta potential (mV)		26.8	27.6	28.7	31.7	37.6	39.8	40.1	40.4	40.0	40.3
Standard deviation		0.52	0.75	0.89	1.22	1.33	1.18	1.60	1.49	1.05	1.35

Table C-5 The data of zeta potential measurement of carbon black at pH of 9 and the amount of calcium = 100 μM and SDS = variable

SDS Concentration (μM)		1,000	2,500	3,000	9,500	12,000	16,000	22,000
(-) Zeta potential (mV)	1	20.4	21.4	25.1	32.7	37.7	35.7	39.3
	2	21.0	26.2	24.0	30.0	36.4	36.1	39.3
	3	19.5	24.2	23.1	29.6	37.1	35.6	38.4
	4	20.6	25.4	24.9	33.2	36.8	36.3	41.9
	5	20.2	25.9	25.0	35.2	34.3	38.5	38.8
	6	19.6	25.7	24.8	33.4	37.4	36.3	41.7
	7	20.0	22.3	24.5	34.8	34.6	37.1	40.9
	8	19.2	26.4	23.7	29.9	37.3	35.4	41.3
	9	22.0	23.5	21.9	29.0	35.2	38.1	41.1
	10	22.0	21.5	25.1	34.5	38.4	39.4	42.8
	11	20.1	23.1	26.1	30.3	37.5	36.4	37.9
	12	19.7	22.4	26.8	32.5	36.7	37.3	41.2
Average zeta potential (mV)		20.4	24.0	24.6	32.1	36.6	36.9	40.4
Standard deviation		0.91	1.87	1.30	2.22	1.28	1.26	1.57

Table C-6 The data of zeta potential measurement of carbon black at pH of 9 and the amount of calcium = 1,000 μM and SDS = variable

SDS Concentration (μM)		16,000	18,000	20,000	22,000	24,000
(-) Zeta potential (mV)	1	34.3	35.8	34.8	36.1	34.4
	2	31.3	35.5	35.9	34.4	35.4
	3	31.7	34.8	34.4	33.1	36.0
	4	34.1	35.3	35.5	32.8	35.2
	5	31.0	35.4	33.1	36.4	32.7
	6	31.7	35.0	34.7	33.3	35.7
	7	34.7	34.2	35.0	33.9	33.3
	8	33.9	35.5	34.3	34.9	34.6
	9	34.1	33.1	33.3	36.6	35.7
	10	34.5	35.0	35.4	33.7	35.8
	11	33.1	32.2	35.4	34.7	34.5
	12	32.0	36.4	36.0	35.8	36.2
Average zeta potential (mV)		33.0	34.9	34.8	34.6	35.0
Standard deviation		1.33	1.13	0.89	1.28	1.05

Table C-7 The data of zeta potential measurement of carbon black at pH of 7 and the amount of SDS = 0 μM and calcium = variable

Calcium concentration (μM)		100	200	400	800	1,000	2,000
(-) Zeta potential (mV)	1	19.1	15.3	11.1	9.9	11.7	8.2
	2	20.6	14.5	9.8	10.3	11.6	9.4
	3	21.2	15.2	11.7	10.1	10.3	8.7
	4	19.0	15.8	9.9	9.5	11.7	9.3
	5	18.1	16.9	10.6	10.3	9.4	8.8
	6	19.5	16.4	11.2	10.6	10.0	9.6
	7	19.9	17.1	12.0	11.1	10.0	9.8
	8	20.2	16.1	10.1	9.6	9.6	9.3
	9	19.6	14.1	11.5	10.5	11.5	8.8
	10	19.4	14.9	11.4	10.4	10.2	9.6
	11	21.0	15.2	12.2	10.1	10.1	10.0
	12	20.7	13.0	11.2	9.9	11.1	9.2
Average zeta potential (mV)		19.86	15.38	11.06	10.18	10.60	9.21
Standard deviation		0.88	1.13	0.77	0.43	0.82	0.51

Table C-8 The data of zeta potential measurement of carbon black at pH of 7 and the amount of SDS = 100 μM and calcium = variable

Calcium concentration (μM)		100	200	400	800	1000	2,000
(-) Zeta potential (mV)	1	16.7	14.0	12.5	11.1	11.2	9.5
	2	16.3	13.5	12.1	12.1	11.2	10.3
	3	16.8	14.0	12.6	12.3	12.1	10.6
	4	16.3	14.0	12.5	10.4	11.3	11.1
	5	17.0	13.8	11.7	12.1	12.0	9.9
	6	16.9	15.0	13.0	10.7	10.5	10.1
	7	16.7	15.1	12.4	12.0	10.9	10.7
	8	18.9	15.0	11.3	11.5	11.5	9.5
	9	17.7	13.8	12.1	10.7	10.7	10.2
	10	16.1	13.4	11.8	12.2	12.2	10.6
	11	17.0	14.1	13.1	11.9	12.3	10.8
	12	16.0	13.0	12.4	12.0	10.1	10.7
Average zeta potential (mV)		16.87	14.06	12.29	11.58	11.33	10.33
Standard deviation		0.76	0.64	0.50	0.65	0.68	0.49

Table C-9 The data of zeta potential measurement of carbon black at pH of 9 and the amount of SDS = 0 μM and calcium = variable

Calcium concentration (μM)		100	200	400	800	1000	2,000
(-) Zeta potential (mV)	1	19.8	14.2	12.9	10.3	11.7	10.2
	2	20.5	13.5	13.1	11.0	11.6	10.4
	3	20.8	14.1	12.6	11.1	11.2	9.4
	4	21.6	13.1	12.5	11.3	11.7	9.2
	5	22.6	13.6	15.4	11.1	9.4	8.9
	6	21.2	14.6	13.2	12.2	10.0	9.6
	7	21.7	13.2	13.8	11.7	10.0	9.8
	8	21.0	15.1	13.1	10.4	14.1	9.3
	9	21.5	13.4	12.2	11.0	10.6	10.2
	10	19.6	13.2	11.4	10.0	10.2	9.6
	11	20.0	12.6	12.2	12.0	10.1	11.0
	12	21.5	13.0	13.1	10.4	11.1	9.5
Average zeta potential (mV)		20.98	13.63	12.96	11.04	10.98	9.76
Standard deviation		0.85	0.70	0.94	0.67	1.19	0.56

Table C-10 The data of zeta potential measurement of carbon black at pH of 9 and the amount of SDS = 100 μM and calcium = variable

Calcium concentration (μM)		100	200	400	800	1000	2,000
(-) Zeta potential (mV)	1	22.1	15.5	13.0	12.4	11.4	10.2
	2	22.2	14.8	14.3	12.7	11.3	10.6
	3	23.6	16.0	12.7	12.3	10.1	11.2
	4	24.6	16.7	12.4	12.6	10.8	10.2
	5	23.6	17.4	12.9	11.7	11.6	11.3
	6	22.1	16.4	14.0	12.0	10.3	11.4
	7	22.2	15.9	13.2	13.2	10.5	10.1
	8	23.2	16.1	14.1	12.2	11.2	10.8
	9	23.3	15.8	13.4	11.5	11.6	9.9
	10	22.5	15.4	12.6	12.1	12.0	10.4
	11	23.4	16.5	13.0	11.1	12.3	11.7
	12	22.9	17.0	13.8	11.3	10.0	10.3
Average zeta potential (mV)		22.98	16.13	13.28	12.09	11.09	10.68
Standard deviation		0.75	0.69	0.61	0.59	0.72	0.57

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