

Synthesis and characterization of isotopically labeled silver nanoparticles for tracing studies

Adam Laycock, Björn Stolpe, Isabella Römer, Agnieszka Dybowska, Eugenia Valsami-Jones,
Jamie R. Lead, Mark Rehkämper

Supplementary Material

Student's t-test data

Particles sizes and Proportional difference from the mean (PDMS) determined by DLS

* Best data = the two largest outliers were removed prior to statistical evaluation

PDMS = (MS - SamS) / MS

MS = Mean particle size for all particles with the same target size

SamS = Measured particle size of sample

Pristine Particles:

Particle Batch

	All Data			Best Data	
	Diameter (nm)	PDMS	PDI	Diameter (nm)	PDMS
AgNP1 - 30nm					
Nat-AgNP1-May12-F	41.6	0.28	0.25		
107-AgNP1-May12-F	29.3	-0.10	0.22	29.3	-0.05
Nat-AgNP1-May12-IC	35.5	0.09	0.26	35.5	0.15
107-AgNP1-May12-IC	31.2	-0.04	0.16	31.2	0.01
Nat-AgNP1-Oct12-F	26.5	-0.19	0.13	26.5	-0.14
107-AgNP1-Oct12-F	31.2	-0.04	0.18	31.2	0.01
Average	32.6			30.7	
SD	4.9			2.9	
AgNP2 - 20nm					
Nat-AgNP2-May12-F	20.7	0.06	0.33	20.7	0.02
107-AgNP2-May12-F	16.7	-0.15	0.25	16.7	-0.17
Nat-AgNP2-May12-IC	17.2	-0.12	0.28	17.2	-0.15
107-AgNP2-May12-IC	16.3	-0.17	0.27		
Nat-AgNP2-Oct12-F	22.6	0.16	0.15	22.6	0.12
107-AgNP2-Oct12-F	23.9	0.22	0.20	23.9	0.18
Average	19.6			20.2	
SD	3.0			2.9	
AgNP3 - 17nm					
Nat-AgNP3-May12-F	17.1	-0.18	0.20	17.1	-0.12
107-AgNP3-May12-F	24.3	0.16	0.24	24.3	0.25
Nat-AgNP3-May12-IC	18.2	-0.13	0.23	18.2	-0.07
107-AgNP3-May12-IC	20.6	-0.02	0.29	20.6	0.06
Nat-AgNP3-Oct12-F	17.2	-0.18	0.25	17.2	-0.12
107-AgNP3-Oct12-F	28.1	0.34	0.44		
Average	20.9			19.5	
SD	4.1			2.7	

Aged Particles

Particle Batch	Storage (months)	All Data			Best Data	
		Diameter (nm)	PDMS	PDI	Diameter (nm)	PDMS
AgNP1 - 30nm						
Nat-AgNP1-May12-F	12	41.5	0.24	0.25		
107-AgNP1-May12-F	12	29.7	-0.11	0.20	29.7	-0.05
Nat-AgNP1-May12-IC	12	35.3	0.06	0.23	35.3	0.13
107-AgNP1-May12-IC						
Nat-AgNP1-Oct12-F	6	26.8	-0.20	0.11	26.8	-0.15
107-AgNP1-Oct12-F	6	33.7	0.01	0.22	33.7	0.07
Average		33.4			31.4	
SD		5.6			3.3	
AgNP2 - 20nm						
Nat-AgNP2-May12-F	12	19.7	0.02	0.25	19.7	0.02
107-AgNP2-May12-F	12	14.6	-0.24	0.34	14.6	-0.24
Nat-AgNP2-May12-IC	8	16.8	-0.13	0.35	16.8	-0.13
107-AgNP2-May12-IC	12	17.5	-0.09	0.18	17.5	-0.09
Nat-AgNP2-Oct12-F	6	22.9	0.19	0.10	22.9	0.19
107-AgNP2-Oct12-F	6	24.1	0.25	0.18	24.1	0.25
Average		19.3			19.3	
SD		3.4			3.4	
AgNP3 - 17nm						
Nat-AgNP3-May12-F						
107-AgNP3-May12-F						
Nat-AgNP3-May12-IC	12	16.8	-0.32	0.31	16.8	-0.14
107-AgNP3-May12-IC	12	24.1	-0.03	0.21	24.1	0.24
Nat-AgNP3-Oct12-F	6	32.5	0.31	0.52	32.5	0.67
107-AgNP3-Oct12-F	6	26.1	0.05	0.39		
Average		24.9			24.5	
SD		5.6			6.4	

Nat AgNPs vs. 107AgNPs for AgNP1, 2 & 3
Using particle size

	All Data	Best Data
AgNP1		
Nat-May12-F	41.6	
Nat-May12-IC	35.5	35.5
Nat-Oct12-F	26.5	26.5
Average	34.5	31.0
SD	6.2	4.5
107-May12-F	29.3	29.3
107-May12-IC	31.2	31.2
107-Oct12-F	31.2	31.2
Average	30.6	30.6
SD	0.9	0.9
t-test p-value	0.46	0.94

Nat AgNPs vs. 107AgNPs for AgNP1, 2 & 3
Using proportional difference from the mean

	All Data	Best Data
AgNP1		
Nat-May12-F	0.28	
Nat-May12-IC	0.09	0.15
Nat-Oct12-F	-0.19	-0.14
Average	0.06	0.01
SD	0.19	0.15
107-May12-F	-0.10	-0.05
107-May12-IC	-0.04	0.01
107-Oct12-F	-0.04	0.01
Average	-0.06	-0.01
SD	0.03	0.03
t-test p-value	0.46	0.94

	All Data
AgNP2	
Nat-May12-F	20.7
Nat-May12-IC	17.2
Nat-Oct12-F	22.6
Average	20.2
SD	2.2
107-May12-F	16.7
107-May12-IC	16.3
107-Oct12-F	23.9
Average	19.0
SD	3.5
t-test p-value	0.71

	All Data
AgNP2	
Nat-May12-F	0.06
Nat-May12-IC	-0.12
Nat-Oct12-F	0.16
Average	0.03
SD	0.11
107-May12-F	-0.15
107-May12-IC	-0.17
107-Oct12-F	0.22
Average	-0.03
SD	0.18
t-test p-value	0.71

	All Data	Best Data
AgNP3		
Nat-May12-F	17.1	17.1
Nat-May12-IC	18.2	18.2
Nat-Oct12-F	17.2	17.2
Average	17.5	17.5
SD	0.5	0.5
107-May12-F	24.3	24.3
107-May12-IC	20.6	20.6
107-Oct12-F	28.1	
Average	24.3	22.5
SD	3.1	1.9
t-test p-value	0.08	0.22

	All Data	Best Data
AgNP3		
Nat-May12-F	-0.18	-0.12
Nat-May12-IC	-0.13	-0.07
Nat-Oct12-F	-0.18	-0.12
Average	-0.16	-0.10
SD	0.02	0.03
107-May12-F	0.16	0.25
107-May12-IC	-0.02	0.06
107-Oct12-F	0.34	
Average	0.16	0.15
SD	0.15	0.09
t-test p-value	0.08	0.22

Nat Ag vs. 107AgNPs for each synthesis occasion
Using proportional difference from the mean

	All Data	Best Data
May12-F		
AgNP1	0.28	
AgNP2	0.06	0.02
AgNP3	-0.18	-0.12
Average	0.05	-0.05
SD	0.19	0.07
107AgNP1	-0.10	-0.05
107AgNP2	-0.15	-0.17
107AgNP3	0.16	0.25
Average	-0.03	0.01
SD	0.14	0.18
t-test p-value	0.66	0.72

	All Data	Best Data
May12-IC		
AgNP1	0.09	0.15
AgNP2	-0.12	-0.15
AgNP3	-0.13	-0.07
Average	-0.05	-0.02
SD	0.10	0.13
107AgNP1	-0.04	0.01
107AgNP2	-0.17	0.00
107AgNP3	-0.02	0.06
Average	-0.07	0.02
SD	0.07	0.02
t-test p-value	0.82	0.68

	All Data	Best Data
Oct12-F		
AgNP1	-0.19	-0.14
AgNP2	0.16	0.12
AgNP3	-0.18	-0.12
Average	-0.07	-0.05
SD	0.16	0.12
107AgNP1	-0.04	0.01
107AgNP2	0.22	0.18
107AgNP3	0.34	
Average	0.17	0.10
SD	0.16	0.08
t-test p-value	0.20	0.32

Nat AgNPs vs. 107AgNPs for all factors
Using proportional difference from the mean

	All Data	Best Data
Nat Ag		
NatAgNP1-May12-F	0.28	
NatAgNP1-May12-IC	0.09	0.15
NatAgNP1-Oct12-F	-0.19	-0.14
NatAgNP2-May12-F	0.06	0.02
NatAgNP2-May12-IC	-0.12	-0.15
NatAgNP2-Oct12-F	0.16	0.12
NatAgNP3-May12-F	-0.18	-0.12
NatAgNP3-May12-IC	-0.13	-0.07
NatAgNP3-Oct12-F	-0.18	-0.12
Average	-0.02	-0.04
SD	0.16	0.11
107 Ag		
107AgNP1-May12-F	-0.10	-0.05
107AgNP1-May12-IC	-0.04	0.01
107AgNP1-Oct12-F	-0.04	0.01
107AgNP2-May12-F	-0.15	-0.17
107AgNP2-May12-IC	-0.17	0.00
107AgNP2-Oct12-F	0.22	0.18
107AgNP3-May12-F	0.16	0.25
107AgNP3-May12-IC	-0.02	0.06
107AgNP3-Oct12-F	0.34	
Average	0.02	0.04
SD	0.17	0.12
t-test p-value	0.57	0.26

Synthesis at FENAC vs. Imperial

Using proportional difference from the mean

	All Data	Best Data
FENAC		
NatAgNP1-May12	0.28	
NatAgNP2-May12	0.06	0.02
NatAgNP3-May12	-0.18	-0.12
NatAgNP1-Oct12	-0.19	-0.14
NatAgNP2-Oct12	0.16	0.12
NatAgNP3-Oct12	-0.18	-0.12
107AgNP1-May12	-0.10	-0.05
107AgNP2-May12	-0.15	-0.17
107AgNP3-May12	0.16	0.25
107AgNP1-Oct12	-0.04	0.01
107AgNP2-Oct12	0.22	0.18
107AgNP3-Oct12	0.34	
Average	0.03	-0.05
SD	0.19	0.07
Imperial		
NatAgNP1-May12	0.09	0.15
NatAgNP2-May12	-0.12	-0.15
NatAgNP3-May12	-0.13	-0.07
107AgNP1-May12	-0.04	0.01
107AgNP2-May12	-0.17	0.00
107AgNP3-May12	-0.02	0.06
Average	-0.06	0.00
SD	0.09	0.09
t-test p-value	0.18	0.96

Synthesis by AL vs. BS

Using proportional difference from the mean

	All Data	Best Data
AL		
NatAgNP1-May12-F	0.28	
NatAgNP2-May12-F	0.06	0.02
NatAgNP3-May12-F	-0.18	-0.12
107AgNP1-May12-F	-0.10	-0.05
107AgNP2-May12-F	-0.15	-0.17
107AgNP3-May12-F	0.16	0.25
NatAgNP1-May12-IC	0.09	0.15
NatAgNP2-May12-IC	-0.12	-0.15
NatAgNP3-May12-IC	-0.13	-0.07
107AgNP1-May12-IC	-0.04	0.01
107AgNP2-May12-IC	-0.17	0.00
107AgNP3-May12-IC	-0.02	0.06
Average	-0.03	-0.05
SD	0.14	0.07
BS		
NatAgNP1-Oct12	-0.19	-0.14
NatAgNP2-Oct12	0.16	0.12
NatAgNP3-Oct12	-0.18	-0.12
107AgNP1-Oct12	-0.04	0.01
107AgNP2-Oct12	0.22	0.18
107AgNP3-Oct12	0.34	
Average	0.05	0.01
SD	0.20	0.13
t-test p-value	0.45	0.76

**NatAg Vs 107Ag for all factors
Using PDIs**

	All Data
Nat Ag	
NatAgNP1-May12-F	0.25
NatAgNP1-May12-IC	0.26
NatAgNP1-Oct12-F	0.13
NatAgNP2-May12-F	0.33
NatAgNP2-May12-IC	0.28
NatAgNP2-Oct12-F	0.15
NatAgNP3-May12-F	0.20
NatAgNP3-May12-IC	0.23
NatAgNP3-Oct12-F	0.25
Average	0.23
SD	0.06
107Ag	
107AgNP1-May12-F	0.22
107AgNP1-May12-IC	0.16
107AgNP1-Oct12-F	0.18
107AgNP2-May12-F	0.25
107AgNP2-May12-IC	0.27
107AgNP2-Oct12-F	0.20
107AgNP3-May12-F	0.24
107AgNP3-May12-IC	0.29
107AgNP3-Oct12-F	0.44
Average	0.25
SD	0.08
t-test p-value	0.59

**Pristine Vs Aged
Using PDIs**

	All Data
Pristine	
Nat-AgNP1-May12-F	0.25
107-AgNP1-May12-F	0.22
Nat-AgNP1-May12-IC	0.26
107-AgNP1-May12-IC	0.16
Nat-AgNP1-Oct12-F	0.13
107-AgNP1-Oct12-F	0.18
Nat-AgNP2-May12-F	0.33
107-AgNP2-May12-F	0.25
Nat-AgNP2-May12-IC	0.28
107-AgNP2-May12-IC	0.27
Nat-AgNP2-Oct12-F	0.15
107-AgNP2-Oct12-F	0.20
Nat-AgNP3-May12-F	0.20
107-AgNP3-May12-F	0.24
Nat-AgNP3-May12-IC	0.23
107-AgNP3-May12-IC	0.29
Nat-AgNP3-Oct12-F	0.25
107-AgNP3-Oct12-F	0.44
Average	0.24
SD	0.07
Aged	
Nat-AgNP1-May12-F	0.25
107-AgNP1-May12-F	0.20
Nat-AgNP1-May12-IC	0.23
Nat-AgNP1-Oct12-F	0.11
107-AgNP1-Oct12-F	0.22
Nat-AgNP2-May12-F	0.25
107-AgNP2-May12-F	0.34
Nat-AgNP2-May12-IC	0.35
107-AgNP2-May12-IC	0.18
Nat-AgNP2-Oct12-F	0.10
107-AgNP2-Oct12-F	0.18
Nat-AgNP3-May12-IC	0.31
107-AgNP3-May12-IC	0.21
Nat-AgNP3-Oct12-F	0.52
107-AgNP3-Oct12-F	0.39
Average	0.27
SD	0.12
t-test p-value	0.65