Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Fine-tuning gold nanorod dimensions and plasmonic properties using the Hofmeister effects

Roger M. Pallares,[a,b] Xiaodi Su*,[b] Suo Hon Lim[b] and Nguyễn T.K. Thanh *,[c]

* Corresponding authors, Email: ntk.thanh@ucl.ac.uk and xd-su@imre.a-star.edu.sg
[a] Department of Chemistry, University College London, London, WC1H 0AJ, United Kingdom
[b] Institute of Materials Research and Engineering, A*STAR (Agency for Science, Technology and Research), 3 Research Link, Singapore, 117602
[c] UCL Healthcare Biomagnetic and Nanomaterials Laboratories, 21 Albemarle Street, London W1S 4BS and Biophysics Group, Department of Physics and Astronomy, University College London, London, WC1E 6BT, United Kingdom

SUPPLEMENTARY INFORMATION

Table S1. Summary of Hofmeister salts added into the growth solution.

Salt	*Solution concentration (M)*	*Volume added (µl)*	*Added salt concentration (mM)*
$NaNO_3$	2.6	40	10
		80	20
		120	30
		160	40
		200	50
NaBr	2.6	20	5
		40	10
		60	15
		80	20
		100	25
		120	30
NaCl	2.6	40	10
		80	20
		120	30
		160	40
		200	50
$NaHSO_4$	2.6	40	10
		80	20
		120	30
		160	40
		200	50

Table S2. Summary of the optical and morphological properties of Au NRs synthesized after the addition of Hofmeister salts into the growth solution.

Salt	C (mM)	L-LSPR band maximum (nm)	Aspect ratio	Length (nm)	Width (nm)	Shape impurities* (%)
-	0	884	4.1 ± 0.70	43.0 ± 9.4	10.6 ± 1.2	3
$NaNO_3$	10	881	4.0 ± 0.64	42.2 ± 7.6	10.6 ± 1.2	5
	20	884	4.1 ± 0.76	42.2 ± 9.8	10.2 ± 1.4	2
	30	915	4.3 ± 0.74	42.4 ± 9.0	9.8 ± 1.2	5
	40	945	4.7 ± 0.69	43.4 ± 7.6	9.2 ± 1.2	3
	50	960	4.8 ± 0.79	42.6 ± 7.8	8.8 ± 1.0	6
NaBr	5	860	3.9 ± 0.76	38.8 ± 9.8	10.0 ± 1.4	4
	10	832	3.6 ± 0.69	37.2 ± 9.2	10.4 ± 1.4	3
	15	816	3.6 ± 0.64	39.8 ± 9.0	11.2 ± 1.6	6
	20	796	3.4 ± 0.60	36.6 ± 7.6	10.8 ± 1.2	5
	25	795	3.4 ± 0.63	36.8 ± 9.4	10.8 ± 2.0	6
	30	777	3.3 ± 0.66	36.8 ± 10.4	11.2 ± 2.6	9
NaCl	10	894	4.2 ± 0.75	42.8 ± 9.2	10.2 ± 1.4	7
	20	900	4.0 ± 0.74	42.4 ± 8.6	10.6 ± 1.2	9
	30	909	4.5 ± 0.77	43.2 ± 9.2	9.6 ± 1.2	4
	40	917	4.5 ± 0.75	43.4 ± 10.0	9.6 ± 1.4	11
	50	928	4.7 ± 0.77	45.6 ± 9.6	9.8 ± 1.2	5
$NaHSO_4$	10	893	4.2 ± 0.71	43.0 ± 8.2	10.2 ± 1.2	3
	20	896	4.3 ± 0.73	43.4 ± 8.8	10.2 ± 1.2	5
	30	918	4.4 ± 0.79	43.4 ± 9.2	9.8 ± 1.2	7
	40	926	4.5 ± 0.85	43.6 ± 10.0	9.6 ± 1.4	13
	50	933	4.6 ± 0.89	45.0 ± 10.0	9.8 ± 1.2	10

*Shape impurities (%) are defined as the percentage of non-rod shaped nanoparticles in the sample.

Table S3. *p*-values obtained by Welch t-test (unequal variances t-test), to study if the differences between aspect ratios are statistical significant. The Hofmeister salts have been abbreviated as B ($NaBr$), N ($NaNO_3$), C ($NaCl$) and S ($NaHSO_4$). The number next to the salt is the concentration (mM) added to the growth solution.

AR/AR		3.3	3.4		3.6		3.9	4.0		4.1		4.2		4.3		4.4	4.5			4.6	4.7		4.8
	[salt]/[salt]	B 30	B 25	B 20	B 15	B 10	B 5	N 10	C 20	0	N 20	C 10	S 10	N 30	S 20	S 30	C 30	C 40	S 40	S 50	N 40	C 50	N 50
3.3	B 30		0.0250	0.0202																			
3.4	B 25				0.0000	0.0000																	
	B 20				0.0000	0.0000																	
3.6	B 15						0.0000																
	B 10						0.0000																
3.9	B 5							0.0011	0.0007														
4.0	N 10									0.0051	0.0009												
	C 20									0.0041	0.0006												
4.1	0											0.0102	0.0052										
	N 20											0.0036	0.0013										
4.2	C 10													0.0073	0.0026								
	S 10													0.0034	0.0006								
4.3	N 30															0.0021							
	S 20															0.0002							
4.4	S 30																0.0158	0.0256	0.0007				
4.5	C 30																			0.0158			
	C 40																			0.0256			
	S 40																			0.0007			
4.6	S 50																				0.0023	0.0019	
4.7	N 40																						0.0021
	C 50																						0.0017
4.8	N 50																						

Table S4. Cohen's *d*-values calculated to study the standardised differences between aspect ratios. The Hofmeister salts have been abbreviated as B ($NaBr$), N ($NaNO_3$), C ($NaCl$) and S ($NaHSO_4$). The number next to the salt is the concentration (mM) added to the growth solution.

AR/AR		3.3	3.4		3.6		3.9	4.0		4.1		4.2		4.3		4.4	4.5			4.6	4.7		4.8
	[salt]/[salt]	B 30	B 25	B 20	B 15	B 10	B 5	N 10	C 20	0	N 20	C 10	S 10	N 30	S 20	S 30	C 30	C 40	S 40	S 50	N 40	C 50	N 50
3.3	B 30		0.16	0.16																			
3.4	B 25				0.16	0.15																	
	B 20				0.16	0.15																	
3.6	B 15						0.14																
	B 10						0.14																
3.9	B 5							0.14	0.13														
4.0	N 10									0.15	0.14												
	C 20									0.14	0.13												
4.1	0											0.14	0.14										
	N 20											0.13	0.13										
4.2	C 10													0.13	0.14								
	S 10													0.14	0.14								
4.3	N 30															0.13							
	S 20															0.13							
4.4	S 30																0.13	0.13	0.12				
4.5	C 30																			0.12			
	C 40																			0.12			
	S 40																			0.12			
4.6	S 50																				0.13	0.13	
4.7	N 40																						0.13
	C 50																						0.13
4.8	N 50																						

Table S5. Summary of the morphological properties of CTAB micelles after the addition of Hofmeister salts into the growth solution.

			NaNO3		NaCl		NaHSO4	
	[Salt]	0 mM	30 mM	50 mM	30 mM	50 mM	30 mM	50 mM
Sphere	%	97.9	94	84	96.5	96.2	96	94.6
	Diameter (nm)	2.6	2.8	3.2	2.8	2.8	2.8	2.8
	st dev	1.2	1.4	2	1.4	1.4	1.4	1.4
Ellipsoidal	%	2.1	6	8.1	3.5	3.8	4	5.4
	AR	1.7	1.7	2	1.9	2	1.9	1.8
	st dev	0.1	0.3	0.4	0.3	0.3	0.3	0.3
	Length (nm)	8.2	8.6	10.6	9.4	10.2	9.6	9.6
	st dev	1.4	1.4	2.6	1.8	1.6	1.6	1.4
	Width (nm)	4.8	5	5.4	5	5.2	5	5.2
	st dev	0.8	0.6	1.2	0.6	0.6	0.6	0.6
Rod	%	0	0	7.9	0	0	0	0
	AR	0	0	4.6	0	0	0	0
	st dev			1.5				
	Length (nm)			22.8				
	st dev			9				
	Width (nm)			5				
	st dev			0.8				

Comparison between zeta potential decreases and shape impurities

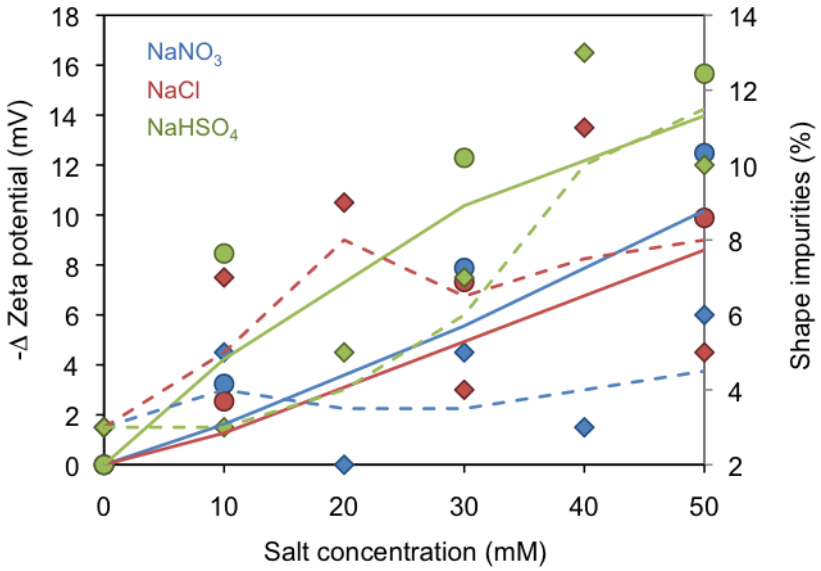

Fig. S1 Micelle zeta potential (circle) after the addition of hofmeister salts in the growth solution and percentage of shape impurities (diamond) after the growth of the rods in those solutions. The moving averages of both zeta potentials and impurities are represented in solid and dashed lines, respectively.