

Supplementary Materials

Extraction of Lanthanides(III) from Aqueous Nitric Acid Solutions with Tetra(n-octyl)diglycolamide into Methyltrioctylammonium Bis(trifluoromethanesulfonyl)imide Ionic Liquid and its Mixtures with Molecular Organic Diluents

Table S1. The effect of HNO₃ concentration in the aqueous phase on the transfer of Tf₂N⁻ ions into the aqueous phase.

[HNO ₃], M	[Tf ₂ N ⁻], M
0.3	0.000135
1.0	0.00038
2.0	0.00045
3.0	0.0009
4.0	0.00145
5.0	0.00255
6.0	0.00395
7.0	0.0064

Table S2. The effect of HNO₃ concentrations in the aqueous phase on the extraction of Ln(III) with 0.01 M solutions of TODGA in [N₁₈₈₈][Tf₂N].

[HNO ₃], M	logD _{Ln}					
	Tb(III)	Eu(III)	Nd(III)	Pr(III)	Ce(III)	La(III)
0.10	3.75	3.50	2.79	2.42	1.87	1.18
0.30	3.80	3.55	2.91	2.58	2.08	1.25
0.50	3.80	3.50	2.89	2.54	2.07	1.23
1.00	3.55	3.27	2.65	2.26	1.87	1.05
2.00	2.68	2.41	1.77	1.43	0.97	0.19
3.00	2.18	1.91	1.28	0.92	0.51	-0.31
4.00	1.85	1.57	0.91	0.56	0.12	-0.65
5.00	1.59	1.29	0.59	-0.01	-0.47	-1.02

Table S3. The effect of NO₃⁻ concentrations in the aqueous phase on the extraction of Ln(III) with 0.01 M solutions of TODGA in [N₁₈₈₈][Tf₂N]. [H⁺] = 2 M.

[NO ₃ ⁻], M	logD _{Ln}				
	Eu(III)	Nd(III)	Pr(III)	Ce(III)	La(III)
2.00	2.41	1.77	1.43	0.97	0.19
3.00	2.45	1.79	1.45	1.01	0.21
4.00	2.47	1.80	1.49	1.02	0.22
5.00	2.37	1.71	1.38	0.92	0.15
6.00	2.30	1.60	1.29	0.79	0.02

Table S4. The effect of H^+ concentrations in the aqueous phase on the extraction of Ln(III) with 0.01 M solutions of TODGA in $[N_{1888}][Tf_2N]$. $[NO_3^-] = 4$ M.

Log[H ⁺]	logD _{Ln}					
	Tb(III)	Eu(III)	Nd(III)	Pr(III)	Ce(III)	La(III)
-1.00					3.08	2.15
-0.52				3.05	2.68	1.82
-0.30			3.11	2.85	2.45	1.59
0.00			2.68	2.36	1.91	1.13
0.176	3.08	2.82	2.14	1.84	1.36	0.57
0.30	2.75	2.47	1.80	1.49	1.02	0.22
0.477	2.22	1.92	1.24	0.95	0.47	-0.30
0.60	1.85	1.57	0.90	0.56	0.12	-0.65

Table S5. The effect of TODGA concentration in $[N_{1888}][Tf_2N]$ on the extraction of lanthanides(III) from 3 M HNO₃ solutions.

log[TODGA]	logD _{Ln}							
	Ho(III)	Yb(III)	Lu(III)	Sm(III)	Nd(III)	Pr(III)	Ce(III)	La(III)
-2.52	0.72	0.48	0.32	0.23	-0.18	-0.55		
-2.30	1.37	1.14	0.96	0.86	0.43	0.05	-0.32	
-2.15	1.83	1.59	1.43	1.28	0.87	0.46	0.09	-0.73
-2.00	2.28	2.04	1.86	1.69	1.28	0.92	0.50	-0.30
-1.82				2.22	1.82	1.37	1.04	0.21
-1.70					2.15	1.71	1.37	0.53
-1.52						2.22	1.89	1.02

Table S6. The extraction of lanthanides(III) from 3 M HNO₃ solutions with 0.01 M TODGA solutions in [N₁₈₈₈][Tf₂N], [C₄mim][Tf₂N], and dichloroethane (DCE).

Ln	$\log D_{Ln}$		
	[N ₁₈₈₈][Tf ₂ N]	[C ₄ mim][Tf ₂ N]	DCE
La	−0.30	0.58	−0.72
Ce	0.50	0.86	−0.30
Pr	0.92	0.89	−0.09
Nd	1.28	0.81	0.04
Sm	1.80	0.79	0.28
Eu	1.91	0.77	0.48
Gd	1.82	0.69	0.55
Tb	2.18	0.78	1.01
Dy	2.28	0.77	1.27
Ho	2.28	0.73	1.47
Er	2.25	0.68	1.59
Tm	2.17	0.62	1.65
Yb	2.04	0.55	1.67
Lu	1.86	0.46	1.72

Table S7. The extraction of lanthanides(III) from 4 M NH_4NO_3 solutions with 0.01 M TODGA solutions in DCE and DCE containing 0.01 M $[\text{N}_{1888}][\text{Tf}_2\text{N}]$.

Ln	$\log D_{\text{Ln}}$	
	DCE	DCE containing 0.01 M $[\text{N}_{1888}][\text{Tf}_2\text{N}]$
La	−0.20	0.77
Ce	0.10	1.08
Pr	0.29	1.27
Nd	0.34	1.39
Sm	0.42	1.80
Eu	0.46	2.01
Gd	0.42	1.90
Tb	0.69	2.51
Dy	0.89	2.77
Ho	1.06	2.98
Er	1.20	3.06
Tm	1.25	3.12
Yb	1.28	3.15
Lu	1.30	3.22

Table S8. The extraction of lanthanides(III) from 1 M HNO₃ solutions with 0.01 M TODGA solutions in nitrobenzene (NB), octanol (OC), dichloroethane (DCE), nonane containing 1.1 M TBP (N/TBP), and chloroform (CL) in the presence of 0.01 M [N₁₈₈₈][Tf₂N].

Ln	logD_{Ln}				
	NB	OC	DCE	N/TBP	CL
La	−0.23	−0.86	−0.61	−0.29	−1.18
Ce	0.19	−0.57	−0.26	−0.12	−0.71
Pr	0.41	−0.32	−0.11	−0.02	−0.41
Nd	0.58	−0.13	0.03	0.06	−0.21
Sm	1.13	0.56	0.46	0.34	0.14
Eu	1.38	0.85	0.71	0.59	0.26
Gd	1.28	0.71	0.65	0.54	0.22
Tb	1.89	1.40	1.21	1.04	0.49
Dy	2.11	1.62	1.44	1.26	0.67
Ho	2.26	1.81	1.60	1.40	0.78
Er	2.31	1.88	1.67	1.52	0.84
Tm	2.35	1.91	1.72	1.55	0.85
Yb	2.39	1.90	1.71	1.59	0.85
Lu	2.41	1.88	1.75	1.60	0.85

Table S9. The effect of HNO₃ concentrations in the aqueous phase on the extraction of Eu(III) with 0.01 M solutions of TODGA (L) in DCE, nonane containing 1.1 M TBP, and DCE in the presence of 0.1 M [N₁₈₈₈][Tf₂N].

log[HNO₃]	logD_{Eu}			
	L + IL/DCE	L + IL/nonane-TBP	L/nonane-TBP	L/DCE
−2.000	0.41	−0.52		
−1.520	1.04	0.00		
−1.000	1.60	0.56		
−0.520	1.93	0.98		
−0.300	2.05	1.15	−0.75	−1.30
0.000	2.00	1.43	0.01	−0.56
0.300	1.69	1.71	0.68	0.26
0.477	1.45	1.91	1.18	0.48
0.600	1.16	2.00	1.47	0.52
0.700	0.94	2.17	1.75	0.41
0.778	0.63	2.24	1.89	0.18

Table S10. The extraction of lanthanides(III) from 3 M HNO₃ solutions with 0.01 M TODGA solutions in DCE, nonane containing 1.1 M TBP, and DCE in the presence of 0.1 M [N₁₈₈₈][Tf₂N].

Ln	$\log D_{Ln}$			
	L/nonane-TBP	L + IL/nonane-TBP	L/DCE	L + IL/DCE
La	0.08	0.54	−0.72	−0.80
Ce	0.18	0.65	−0.30	−0.45
Pr	0.27	0.68	−0.09	−0.03
Nd	0.39	0.76	0.04	0.48
Sm	0.97	1.60	0.28	1.15
Eu	1.18	1.91	0.48	1.45
Gd	1.03	1.82	0.55	1.38
Tb	1.76	2.48	1.01	2.04
Dy	1.97	2.68	1.27	2.28
Ho	2.22	2.87	1.47	2.50
Er	2.26	2.92	1.59	2.57
Tm	2.34	3.01	1.65	2.66
Yb	2.38	3.04	1.67	2.65
Lu	2.43	3.05	1.72	2.62