Supporting Information

Table S1. The molar enthalpy of solutions of dimetheyldithiocarbamate and 1, 10-phenanthroline in absolute enthanol and enthalpy of mixture of liquid-phase at 298.15 K

No.	Q/mJ	$\Delta_{mix}H^{\theta}_{m}$ /kJ·mol^{-1}	m /mg	Q/mJ	$\Delta_{sol}H^{\theta}_{m}(2)$ /kJ·mol^{-1}	m /mg	Q/mJ	$\Delta_{sol}H^{\theta}_{m}(3)$ /kJ·mol^{-1}
1	37.403	2.338	22.91	6167.680	38.581	31.71	3351.540	20.950
2	38.631	2.414	22.98	6163.363	38.866	31.77	3393.602	21.173
3	39.297	2.456	22.86	6172.958	38.310	31.76	3343.271	20.866
4	38.738	2.421	22.93	6170.722	38.232	31.73	3356.008	20.965
5	37.882	2.368	22.90	6165.759	38.251	31.68	3315.208	20.746
6	38.449	2.403	22.80	6159.201	39.006	31.73	3379.615	21.123
$(\bar{x} \pm \sigma_a)^a$	38.400 ± 0.273	2.400 ± 0.017			38.541 ± 0.136			20.970 ± 0.065

[a] $\sigma_a=\sqrt{\sum_{i=1}^{6}(x_1-\bar{x})^2/n(n-1)}$, in which n is the experimental number; x_i, a simple value in a set of measurements; $\bar{x}$, the mean value of a set of measurement results.

Table S2. The molar enthalpies of solution for $LnCl_3 \cdot nH_2O$ in absolute alcohol at 298.15 K

Complexes	No.	m/mg	Q/mJ	$\Delta_{sol}H^{\theta}_{m}$ (l)/kJ·mol^{-1}
	1	87.82	-3206.978	-12.046
	2	87.79	-3307.909	-12.415
	3	87.74	-3149.542	-11.827
$EuCl_3 \cdot 3.94H_2O$	4	87.76	-3223.853	-12.103
	5	87.74	-3274.025	-12.294
	6	87.76	-3180.979	-11.942
	$(\bar{x} \pm \sigma_a)^a$			-12.014 ± 0.090
	1	79.22	-5374.383	-22.332
	2	78.78	-5283.494	-22.078
	3	79.18	-5318.801	-22.113
$GdCl_3 \cdot 3.63H_2O$	4	79.18	-5415.149	-22.514
	5	79.20	-5326.451	-22.139
	6	79.20	-5398.974	-22.441
	$(\bar{x} \pm \sigma_a)^a$			-22.270 ± 0.076
	1	85.44	-7418.096	-28.908
	2	85.42	-7418.411	-28.916
	3	85.40	-7442.580	-29.017
$TbCl_3 \cdot 3.75H_2O$	4	85.45	-7444.628	-29.008

	5	85.43	-7419.024	-28.915
	6	85.49	-7411.139	-28.864
	($\bar{x}$ ±σ$_a$)[a]			-28.938 ± 0.025
	1	80.74	-4951.588	-20.629
	2	80.74	-4967.070	-20.694
	3	80.68	-4904.065	-20.446
$DyCl_3 \cdot 3.74H_2O$	4	80.74	-4891.714	-20.380
	5	80.75	-4937.714	-20.569
	6	80.70	-4878.078	-20.332
	($\bar{x}$ ±σ$_a$)[a]			-20.508 ± 0.354

[a] $\sigma_a=\sqrt{\sum_{i=1}^{6}(x_1-\bar{x})^2/n(n-1)}$, in which n is the experimental number; x_i, a simple value in a set of measurements; $\bar{x}$, the mean value of a set of measurement results.

Table S3. Thermokinetic data of liquid-phase of formation reaction

RE^{3+}	295.15K			298.15K			301.15K			304.15K		
	t/s	H_t/H_0	$10^3 dH_t(dt)^{-1}$ /(J·s^{-1})	t/s	H_t/H_0	$10^3 dH_t(dt)^{-1}$ /(J·s^{-1})	t/s	H_t/H_0	$10^3 dH_t(dt)^{-1}$ /(J·s^{-1})	t/s	H_t/H_0	$10^3 dH_t(dt)^{-1}$ /(J·s^{-1})
	210	0.4935	0.5279	210	0.6039	0.4570	210	0.6159	0.4558	210	0.6037	0.4694
	220	0.5206	0.5112	220	0.6293	0.4397	220	0.6442	0.4359	220	0.6324	0.4494
	230	0.5469	0.4946	230	0.6569	0.4202	230	0.6711	0.4162	230	0.6599	0.4295
	240	0.5724	0.4781	240	0.6817	0.4021	240	0.6969	0.3969	240	0.6861	0.4097
	250	0.5969	0.4618	250	0.7055	0.3842	250	0.7214	0.3771	250	0.7111	0.3903
Eu^{3+}	260	0.6207	0.4457	260	0.7282	0.3666	260	0.7447	0.3589	260	0.7348	0.3712
	270	0.6436	0.4298	270	0.7498	0.3493	270	0.7667	0.3405	270	0.7574	0.3524
	280	0.6651	0.4144	280	0.7704	0.3377	280	0.7876	0.3257	280	0.7787	0.3386
	290	0.6857	0.3992	290	0.7899	0.3154	290	0.8073	0.2992	290	0.7989	0.3094
	300	0.7054	0.3844	300	0.8084	0.2988	300	0.8259	0.2869	300	0.8180	0.2978
	210	0.4962	0.7889	210	0.5675	0.7955	210	0.4544	1.0305	390	0.4020	1.1244
	220	0.5197	0.7638	220	0.5899	0.7632	220	0.4793	0.9937	400	0.4149	1.1055
	230	0.5424	0.7356	230	0.6110	0.7285	230	0.5036	0.9575	410	0.4276	1.0868
	240	0.5643	0.7089	240	0.6307	0.7081	240	0.5272	0.9220	420	0.4402	1.0681
Gd^{3+}	250	0.5854	0.6838	250	0.6491	0.6762	250	0.5501	0.8870	430	0.4527	1.0496
	260	0.6058	0.6572	260	0.6663	0.6503	260	0.5723	0.8529	440	0.4650	1.0312
	270	0.6253	0.6321	270	0.6822	0.6261	270	0.5938	0.8244	450	0.4772	1.0129
	280	0.6441	0.6070	280	0.6969	0.6034	280	0.6146	0.7792	460	0.4892	0.9948
	290	0.6621	0.5819	290	0.7105	0.5823	290	0.6346	0.7620	470	0.5010	0.9841
	300	0.6794	0.5583	300	0.7230	0.5626	300	0.6539	0.7234	480	0.5127	0.9591
Tb^{3+}	300	0.6026	0.8893	300	0.5830	0.9603	300	0.6127	0.9412	300	0.6506	0.8454
	310	0.6198	0.8563	310	0.6005	0.9259	310	0.6291	0.9117	310	0.6689	0.8077
	320	0.6363	0.8234	320	0.6174	0.8925	320	0.6448	0.8787	320	0.6863	0.7714

	330	0.6521	0.7936	330	0.6337	0.8600	330	0.6599	0.8468	330	0.7031	0.7363
	340	0.6674	0.7622	340	0.6495	0.8284	340	0.6744	0.8161	340	0.7191	0.7022
	350	0.6821	0.7324	350	0.6647	0.7977	350	0.6882	0.7864	350	0.7347	0.6690
	360	0.6962	0.7058	360	0.6794	0.7678	360	0.7016	0.7578	360	0.7496	0.6369
	370	0.7098	0.6775	370	0.6936	0.7389	370	0.7143	0.7301	370	0.7639	0.6059
	380	0.7228	0.6509	380	0.7072	0.7108	380	0.7265	0.7035	380	0.7770	0.5771
	390	0.7353	0.6242	390	0.7203	0.6836	390	0.7382	0.6780	390	0.7906	0.5472
Dy^{3+}	240	0.5106	0.4188	130	0.3556	0.5337	200	0.5206	0.4273	200	0.5178	0.4526
	250	0.5338	0.4046	140	0.3990	0.5064	210	0.5533	0.4052	210	0.5470	0.4318
	260	0.5562	0.3921	150	0.4418	0.4790	220	0.5848	0.3835	220	0.5751	0.4114
	270	0.5779	0.3780	160	0.4837	0.4516	230	0.6151	0.3622	230	0.6022	0.3915
	280	0.5988	0.3654	170	0.5247	0.4283	240	0.6441	0.3415	240	0.6282	0.3721
	290	0.6189	0.3513	180	0.5645	0.3973	250	0.6718	0.3212	250	0.6532	0.3530
	300	0.6383	0.3388	190	0.6031	0.3705	260	0.6983	0.3015	260	0.6772	0.3345
	310	0.6570	0.3262	200	0.6403	0.3486	270	0.7234	0.2824	270	0.6999	0.3132
	320	0.6749	0.3121	210	0.6761	0.3126	280	0.7473	0.2638	280	0.7217	0.3024
	330	0.6921	0.2996	220	0.7103	0.2923	290	0.7700	0.2458	290	0.7423	0.2869