

## Supplementary information

**Table S1.** Lanthanum species characterization by MS/MS.

La species	<i>m/z</i> (% <sup>a</sup> )	<i>m/z</i> daughter ion (% <sup>a</sup> )	<i>E</i> <sub>collision</sub> (V)	Loss <sup>b</sup>
[LaOH(H <sub>2</sub> O) <sub>7</sub> ] <sup>2+</sup>	141 (3)	173 (11)	10	[H(H <sub>2</sub> O) <sub>6</sub> ] <sup>+</sup>
		155 (4)		[H(H <sub>2</sub> O) <sub>7</sub> ] <sup>+</sup>
		132 (6)		H <sub>2</sub> O
		123 (29)		2 H <sub>2</sub> O
		114 (100)		3 H <sub>2</sub> O
		105 (76)		4 H <sub>2</sub> O
		96 (71)		5 H <sub>2</sub> O
		87 (9)		6 H <sub>2</sub> O
		81 (4)		n.a.
		73 (17)		[LaO(H <sub>2</sub> O) <sub>3</sub> ] <sup>+</sup>
		71 (4)		n.a.
		57 (11)		n.a.
		43 (4)		n.a.
		[LaO(H <sub>2</sub> O)] <sup>+</sup>		173 (100)
[La(NO <sub>3</sub> ) <sub>2</sub> (H <sub>2</sub> O)] <sup>+</sup>	281 (10)	263 (100)	10	H <sub>2</sub> O
		233 (13)		n.a.
		218 (11)		HNO <sub>3</sub>
[La(SO <sub>4</sub> )(H <sub>2</sub> O) <sub>2</sub> ] <sup>+</sup>	271 (10)	253 (100)	10	H <sub>2</sub> O
		173 (21)		H <sub>2</sub> SO <sub>4</sub>
[La(SO <sub>4</sub> )(H <sub>2</sub> O) <sub>2</sub> (HNO <sub>3</sub> )] <sup>+</sup>	334 (8)	316 (75)	10	H <sub>2</sub> O
		298 (100)		2 H <sub>2</sub> O
		253 (21)		H <sub>2</sub> O+HNO <sub>3</sub>
		218 (5)		H <sub>2</sub> SO <sub>4</sub>
		137 (5)		n.a.
[La(SO <sub>4</sub> )(H <sub>2</sub> O) <sub>2</sub> (H <sub>2</sub> SO <sub>4</sub> )] <sup>+</sup>	369 (5)	351 (36)	15	H <sub>2</sub> O
		333 (100)		2 H <sub>2</sub> O
		253 (28)		H <sub>2</sub> O+H <sub>2</sub> SO <sub>4</sub>
[La(SO <sub>4</sub> )(H <sub>2</sub> O)(H <sub>2</sub> SO <sub>4</sub> ) <sub>2</sub> ] <sup>+</sup>	449 (14)	431 (41)	10	H <sub>2</sub> O
		413 (18)		H <sub>2</sub> O
		387 (4)		SO <sub>3</sub> – H <sub>2</sub> O
		369 (51)		SO <sub>3</sub>
		351 (100)		H <sub>2</sub> SO <sub>4</sub>
		333 (14)		H <sub>2</sub> O+H <sub>2</sub> SO <sub>4</sub>
		90 (69)		n.a.

<sup>a</sup> Peak height relative to the highest peak.

<sup>b</sup> n.a. means not assigned.

**Table S2.** Species detected by nanoESI-MS of a  $10^{-3}$  M  $\text{La}(\text{NO}_3)_3$  and 0.1 M  $\text{H}_2\text{SO}_4$  solution, using the negative detection mode.

Species	$m/z$
$[\text{HSO}_4(\text{H}_2\text{SO}_4)_n]^-$ , $n=0-7$	97, 195, 293, 391, 489, 587, 685, 783
$[\text{La}(\text{SO}_4)_2(\text{H}_2\text{SO}_4)_n]^-$ , $n=0-4$	331, 429, 527, 625, 723

**Figure S1.** NanoESI-MS spectra of a  $10^{-3}$  M  $\text{La}(\text{NO}_3)_3$  and 0.1 M  $\text{H}_2\text{SO}_4$  solution, using the negative detection mode at a cone-voltage of 30 V, total ionic current  $1.06 \times 10^8$ . (a) 50-800  $m/z$  range (b) 2-fold magnified spectrum in the 300-800  $m/z$  range.

