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## Supporting Information

**Section S1.** Experimental and simulated powder X-Ray diffraction patterns.
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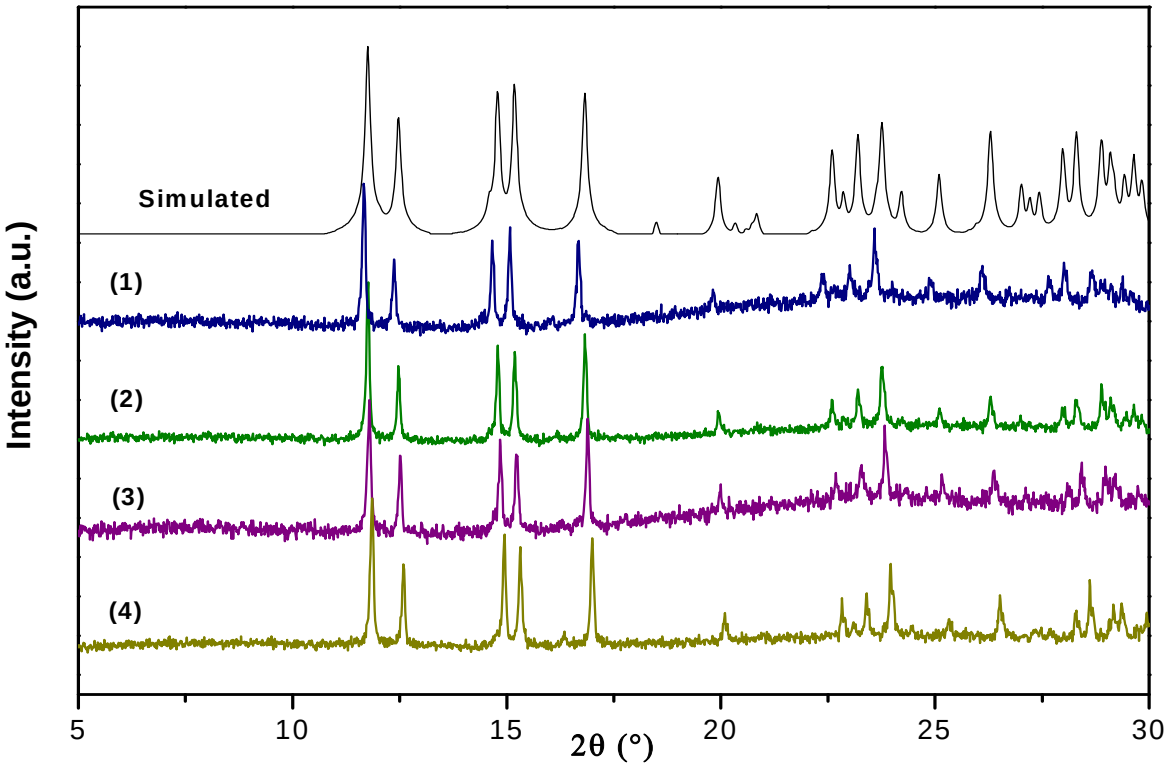
**Section S1.** Experimental and simulated powder X-Ray diffraction patterns.

Powder X-ray diffraction (PXRD) measurements were performed with a Bruker D8 diffractometer in the θ-θ mode using nickel-filtered Cu Kα1 (λ =0.15406 nm) radiation. All samples were ground to ensure a sufficient dispersion in the bulk, and then mounted onto a glass slide fixed on a sample holder by dropping powders and then leveling the sample surface. The best counting statistics were achieved by using a scanning steps of 0.02° that were taken between 5 and 30° Bragg angles with an exposure time of 0.5 s per step. Comparison was made of the experimental PXRD patterns for synthesized compounds $[Ln_2(C_2H_4C_2O_4)_2(SO_4)(H_2O)_2]$ [Ln= La (1), Pr (2), Nd(3) and Sm(4)] with the simulated patterns from single crystals X-Ray data.



**Section S2.** Table Selected bond lengths [Å] and angles [º] for the compounds **RPF-16**

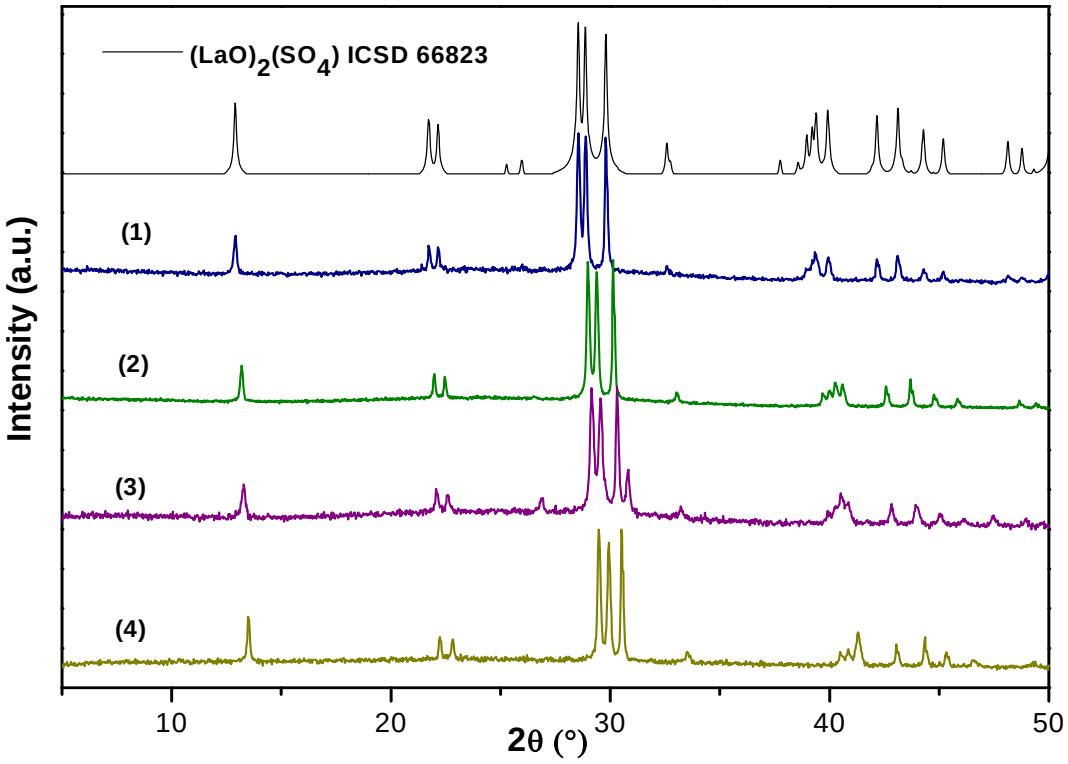
| | **1** | | **2** | | **3** | | **4** |
|---|---|---|---|---|---|---|---|
| La1-O2 | 2.563(5) | Pr1-O2 | 2.537(6) | Nd1-O2 | 2.538(14) | Sm1-O2 | 2.520(7) |
| La1-O3 | 2.515(5) | Pr1-O3 | 2.459(6) | Nd1-O3 | 2.440(15) | Sm1-O3 | 2.417(7) |
| La1-O4 | 2.471(5) | Pr1-O4 | 2.648(6) | Nd1-O4 | 2.621(14) | Sm1-O4 | 2.621(7) |
| La1-O5 | 2.636(5) | Pr1-O5 | 2.589(6) | Nd1-O5 | 2.577(15) | Sm1-O5 | 2.544(7) |
| La1-O6 | 2.604(5) | Pr1-O6 | 2.562(6) | Nd1-O6 | 2.541(15) | Sm1-O6 | 2.521(7) |
| La1-O12 | 2.484(5) | Pr1-O12 | 2.452(6) | Nd1-O12 | 2.437(14) | Sm1-O12 | 2.415(7) |
| La1-O13 | 2.555(5) | Pr1-O13 | 2.498(6) | Nd1-O13 | 2.491(16) | Sm1-O13 | 2.453(8) |
| La1-O14 | 2.558(5) | Pr1-O14 | 2.521(6) | Nd1-O14 | 2.502(15) | Sm1-O14 | 2.482(7) |
| La2-O1 | 2.562(5) | Pr2-O1 | 2.512(6) | Nd2-O1 | 2.502(15) | Sm2-O1 | 2.464(7) |
| La2-O2 | 2.652(5) | Pr2-O2 | 2.609(6) | Nd2-O2 | 2.592(15) | Sm2-O2 | 2.564(7) |
| La2-O6 | 2.520(5) | Pr2-O6 | 2.490(6) | Nd2-O6 | 2.479(16) | Sm2-O6 | 2.460(7) |
| La2-O7 | 2.560(5) | Pr2-O7 | 2.508(6) | Nd2-O7 | 2.495(16) | Sm2-O7 | 2.467(7) |
| La2-O8 | 2.495(5) | Pr2-O8 | 2.462(6) | Nd2-O8 | 2.445(14) | Sm2-O8 | 2.427(7) |
| La2-O9 | 2.484(5) | Pr2-O9 | 2.446(6) | Nd2-O9 | 2.421(16) | Sm2-O9 | 2.406(7) |
| La2-O10 | 2.524(5) | Pr2-O10 | 2.476(7) | Nd2-O10 | 2.462(16) | Sm2-O10 | 2.426(7) |
| La2-O11 | 2.597(5) | Pr2-O11 | 2.555(6) | Nd2-O11 | 2.545(15) | Sm2-O11 | 2.523(7) |
| La1-La1 | 4.1800(7) | Pr1-Pr1 | 4.1360(7) | Nd1-Nd1 | 4.1236(15) | Sm1-Sm1 | 4.0995(7) |
| La2-La2 | 4.1340(7) | Pr2-Pr2 | 4.0872(6) | Nd2-Nd2 | 4.0723(15) | Sm2-Sm2 | 4.0463(7) |
| S1-O9 | 1.472(5) | | 1.474(6) | | 1.495(16) | | 1.478(7) |
| S1-O11 | 1.480(5) | | 1.488(6) | | 1.493(15) | | 1.490(7) |
| S1-O12 | 1.474(5) | | 1.468(6) | | 1.475(15) | | 1.472(7) |
| S1-O14 | 1.474(5) | | 1.482(6) | | 1.489(15) | | 1.487(7) |
| | | | | | | | |
| La1-O2-La2 | 114.33(18) | Pr1-O2-Pr2 | 114.7(2) | Nd1-O2-Nd2 | 114.9(6) | Sm1-O2-Sm2 | 115.4(3) |
| La2-O6-La1 | 117.54(18) | Pr2-O6-Pr1 | 118.1(2) | Nd2-O6-Nd1 | 119.0(6) | Sm2-O6-Sm1 | 119.3(3) |
| La1-O4-La1 | 108.19(17) | Pr1-O4-Pr1 | 109.2(2) | Nd1-O4-Nd1 | 109.8(5) | Sm1-O4-Sm1 | 110.0(2) |
| La2-O8-La2 | 108.25(17) | Pr2-O8-Pr2 | 109.2(2) | Nd2-O8-Nd2 | 109.7(5) | Sm-O8-Sm2 | 110.2(2) |
| O9-S1-O11 | 109.8(3) | | 109.5(4) | | 110.1(9) | | 109.7(4) |
| O9-S1-O14 | 108.3(3) | | 108.3(4) | | 108.0(9) | | 108.5(4) |
| O12-S1-O11 | 109.0(3) | | 108.9(4) | | 109.4(9) | | 109.4(4) |
| O12-S1-O14 | 110.6(3) | | 110.9(4) | | 110.8(9) | | 110.9(4) |

**Section S3.** Table intramolecular hydrogen bonds for the compounds **RPF-16.**

| Compound | D-H···A | *d*(D-H) [Å] | *d*(D···A) [Å] | *d*(H···A) [Å] | *d*(D-H···A) [º] |
|---|---|---|---|---|---|
| **1** | **O13 -H13A···O5** | 0.793(6) | 2.673(8) | 1.967(6) | 148.09( 45) |
| | **O13 -H13B···O11** | 1.007(6) | 2.877(8) | 1.958(6) | 150.34( 34) |
| | **O10 -H10B···O14** | 1.064(5) | 2.913(9) | 2.233(6) | 119.91( 33) |
| | **O10 -H10A···O1** | 1.019(6) | 2.663(9) | 1.656(6) | 168.91( 39) |
| **2** | **O13 -H13A···O5** | 0.995(8) | 2.691(11) | 1.777(8) | 150.80( 52) |
| | **O13 -H13B···O11** | 0.998(8) | 2.859(11) | 1.895(8) | 161.34( 47) |
| | **O10 -H10B···O14** | 0.997(8) | 2.907(12) | 1.927(8) | 167.05( 49) |
| | **O10 -H10A···O1** | 0.995(9) | 2.653(12) | 1.670(8) | 168.57( 54) |
| **3** | **O13 -H13A···O5** | 1.003(20) | 2.680(26) | 2.082(17) | 116.18( 1.12) |
| | **O13 -H13B···O11** | 0.998(19) | 2.867(25) | 1.898(17) | 163.10( 1.08) |
| | **O10 -H10B···O14** | 1.027(17) | 2.891(25) | 1.987(17) | 145.35( 1.03) |
| | **O10 -H10A···O1** | 0.999(20) | 2.653(26) | 1.685(18) | 161.85( 1.19) |
| **4** | **O13 -H13A···O5** | 0.676(149) | 2.694(12) | 2.104(132) | 146.60(14.76) |
| | **O13 -H13B···O11** | 0.878(161) | 2.848(13) | 1.977(166) | 171.80(13.78) |
| | **O10 -H10B···O14** | 0.808(17) | 2.900(12) | 2.098(121) | 172.11(10.40) |
| | **O10 -H10A···O1** | 0.907(180) | 2.655(12) | 1.763(172) | 167.29(16.08) |

**Section S4.** X-ray powder patters for all compounds after TG analysis.

Comparison was made of the experimental PXRD patterns for the residue of the compounds $[Ln_2(C_2H_4C_2O_4)_2(SO_4)(H_2O)_2]$ [Ln= La (1), Pr (2), Nd(3) and Sm(4)] after TG analysis the pattern of the compound $[(LaO)_2(SO_4)]$ from the ICSD.



**Section S5.** X-ray powder patters for the compounds **1-4** after catalysis studies

Comparison between experimental PXRD patterns of the compounds $[Ln_2(C_2H_4C_2O_4)_2(SO_4)(H_2O)_2]$ [Ln= La (1), Pr (2), Nd(3) and Sm(4)] after the catalysis with the pattern of the compound **1** before catalysis.