

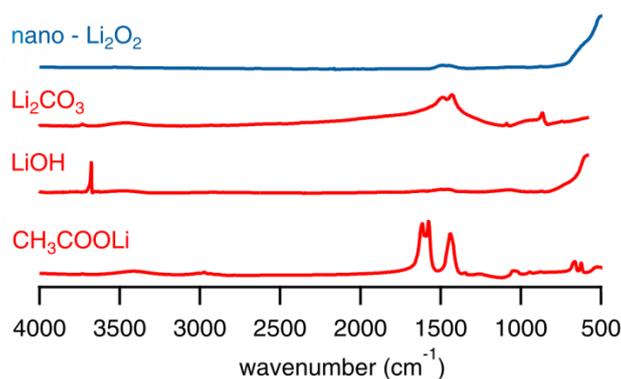
## Supporting Information

### Short-range Li diffusion vs long-range ionic conduction in nanocrystalline lithium peroxide $\text{Li}_2\text{O}_2$ — the discharge product in lithium-air batteries.

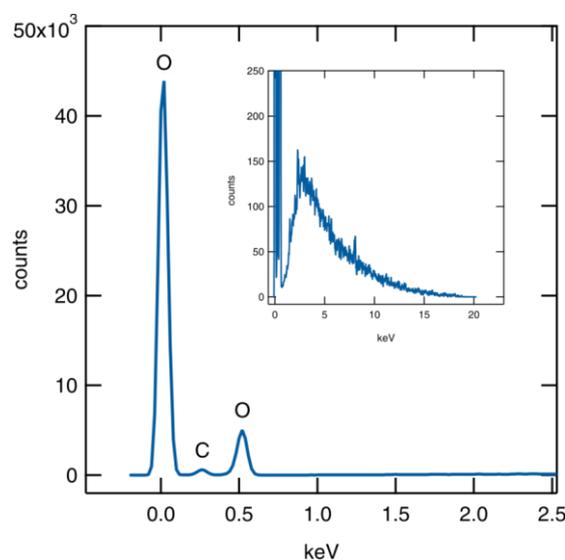
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**Fig. S1.** FTIR spectra of nano -  $\text{Li}_2\text{O}_2$  (blue) and related products of side reactions (red). There are hardly any impurities stemming from preparation within the obtained product nano- $\text{Li}_2\text{O}_2$ . A vanishing small peak of carbonate ( $1488$  and  $1427$   $\text{cm}^{-1}$ ) might be due to a post-contamination with  $\text{CO}_2$  from ambient air. Spectra were recorded on a Bruker ALPHA FT-IR spectrometer housed in an argon filled glove box.



**Fig. S2.** EDX spectrum of nano- $\text{Li}_2\text{O}_2$ . The EDX spectrum shows almost solely oxygen within the investigated sample. The detected carbon could be attributed to a conversion on air during the transfer of the sample to the vacuum chamber of the SEM. Note that minor peaks in the deceleration radiation (see inset) can be assigned to Al and Cu from the specimen holder and internal referencing at a large numbers of counts. The concentrations of these elements were detected via ICP-MS analysis, see below.

Morphology analysis was performed using a Tescan Vega3 scanning electron microscope (SEM) equipped with an energy dispersive X-ray detector (Oxford Instruments INCAx-act) for determination of elemental composition of the sample.

## Trace elements determined by ICP-MS

Element concentrations were determined with an Agilent 7500ce inductively coupled plasma mass spectrometer (ICP-MS) (Agilent, Waldbronn, Germany) equipped with a Micro Mist nebulizer (Glass Expansion, Melbourne, Australia) and a Scott double pass spray chamber. Nano-Li<sub>2</sub>O<sub>2</sub> (30 mg weighted to 0.1 mg) was digested in 10 mL of 10 % HNO<sub>3</sub> and diluted (1 + 9).

**Table S1.** Concentration (mg kg<sup>-1</sup> dry wt) of trace elements in nano-Li<sub>2</sub>O<sub>2</sub>

Li		B	< 1	Mo	< 0.1	Eu	< 0.1	Au	< 0.1
Zr	19	Ti	< 1	Ru	< 0.1	Gd	< 0.1	Hg	< 0.1
Na	14	Ni	< 1	Rh	< 0.1	Tb	< 0.1	Tl	< 0.1
Sn	9.5	Cu	< 1	Pd	< 0.1	Dy	< 0.1	Pb	< 0.1
Mg	4.7	Zn	< 1	Ag	< 0.1	Ho	< 0.1	Bi	< 0.1
Al	3.9	As	< 1	Cd	< 0.1	Er	< 0.1	Th	< 0.1
Fe	3.0	Se	< 1	In	< 0.1	Tm	< 0.1	U	< 0.1
Ba	2.8	Be	< 0.1	Sb	< 0.1	Yb	< 0.1		
Y	0.7	Sc	< 0.1	Te	< 0.1	Lu	< 0.1		
Hf	0.4	Mn	< 0.1	Cs	< 0.1	Ta	< 0.1		
Cr	0.4	Co	< 0.1	La	< 0.1	W	< 0.1		
V	0.2	Ge	< 0.1	Ce	< 0.1	Re	< 0.1		
Ga	0.2	Rb	< 0.1	Pr	< 0.1	Os	< 0.1		
Ca	< 10	Sr	< 0.1	Nd	< 0.1	Ir	< 0.1		
K	< 10	Nb	< 0.1	Sm	< 0.1	Pt	< 0.1		

The impurity level concerning metal ions is very low. There is hardly any abrasion from the vial set used. Of course, the concentration of lithium is out of range of the detection.