AEROXIDE® Fumed Metal Oxides as performance additives in Li-ion batteries

AEROXIDE®

EVONIK
Leading Beyond Chemistry

AEROXIDE® Fumed Metal Oxides

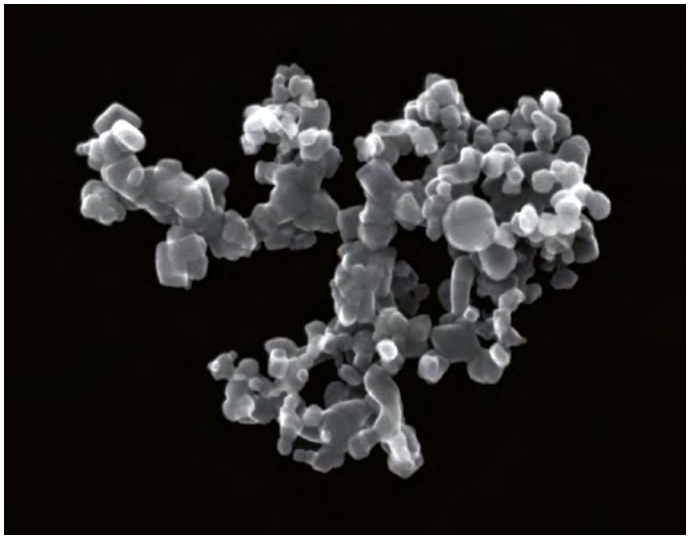
Evonik is a global leader in specialty chemicals. As a worldwide manufacturer of high-quality silica and metal oxides, Evonik offers innovative solutions in the design of ultra-fine nanostructured particles as performance additives in Li-ion batteries.

AEROXIDE® fumed metal oxides from Evonik are used as additives in Li-ion batteries to increase the performance, life-time and safety of the battery.

APPLICATIONS

- Protective dry coating for cathode materials
- High performance LIB separator coating
- Nanostructured ceramic fillers inside separators
- Additive for electrolyte immobilization (gel polymer type)

Properties of
AEROXIDE® Fumed Metal Oxides

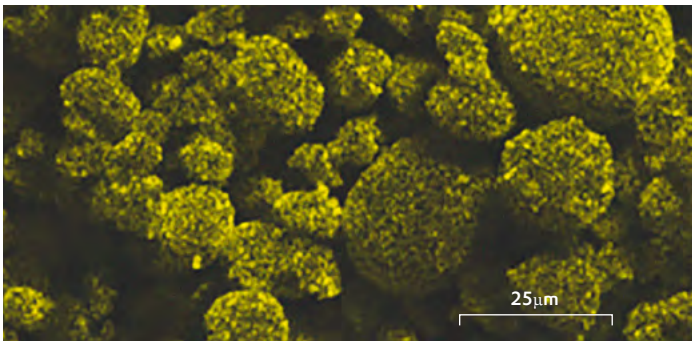


The SEM image shows a single AEROXIDE® TiO_2 P 25 aggregate

Property	Unit	VP Alu 45	AEROXIDE® Alu C	AEROXIDE® Alu 130	AEROXIDE® Alu C 805	AEROXIDE® TiO_2 P 25
BET surface area	m^2/g	30–60	85–115	110–150	75–105	35–65
pH (4 % eq. Dispersion)		4.5–6.0	4.5–5.5	4.4–5.4	3.0–4.5	3.5–4.5
Loss on drying (2h at 105 °C)	%	≤ 2.0	≤ 5.0	≤ 5.0	≤ 2.0	≤ 2.0
Tamped density	g/l	approx. 80	approx. 50	approx. 50	approx. 50	approx. 140

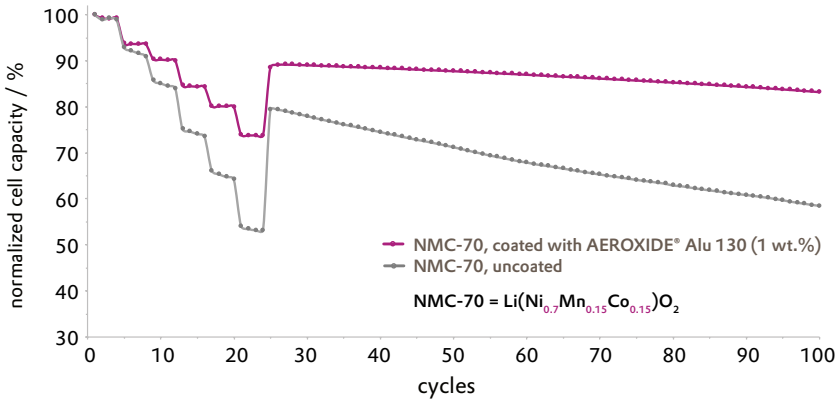
Physico-chemical data of fumed aluminum and titanium oxides.
The data represent typical values, no product specification.

AEROXIDE® Fumed Metal Oxides as dry coating for cathode materials



The **AEROXIDE®** fumed metal oxide layer acts as defined SEI (solid electrolyte interface). It protects the cathode material from undesired reactions with electrolyte, especially at increased cut-off voltage.

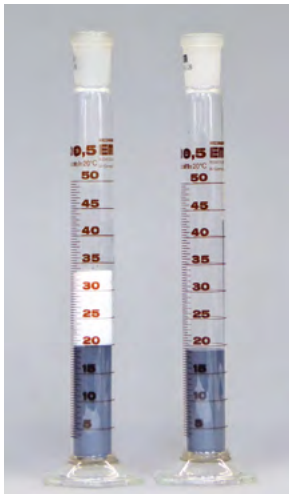
SEM: Al mapping of AEROXIDE® coated NMC particles



AEROXIDE® fumed metal oxides (Al_2O_3 and/or TiO_2) as dry coating on cathode particles leads to a significant increase in capacity retention and improved rate capability of LIB cells!

Example for stabilization of NMC-70 with AEROXIDE® Alu 130. Similar effect for other types of NMC (e.g. 811-NMC)

Left
Powder mixture before dry coating process:
Uncoated cathode powder
+1 wt.-% AEROXIDE® Alu 130



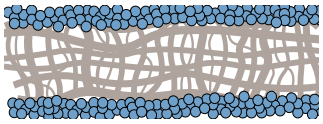
A successful dry coating of the cathode particles with nano-structured AEROXIDE® is visible in the increase of powder density after coating process.

Right
Final product after dry coating process:
1 wt.-% AEROXIDE® Alu 130 coated on cathode powder

High performance LIB separator coating with **AEROXIDE®** Fumed Alumina

Two concepts for ceramic particle modification

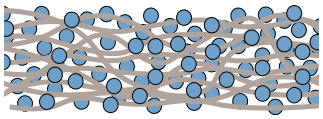
Particle coated



Ceramic particles on top of the micro porous membrane

AEROXIDE® AERODISP®

Particle incorporated



Ceramic particles throughout the whole interior of a polymer matrix

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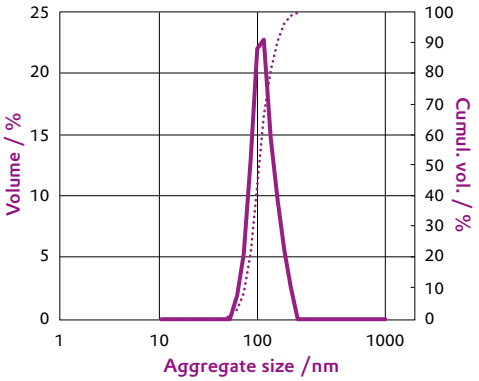
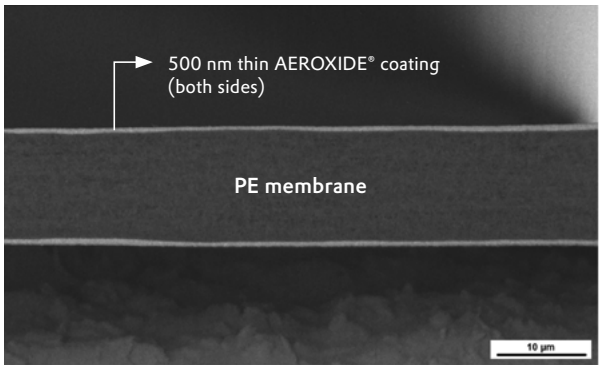
AEROXIDE® fumed alumina enables the preparation of ultra-thin (≤ 1µm), homogenous ceramic coatings which is not possible by the use of conventional coarser inorganic particles.

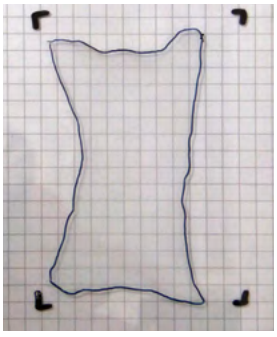


Particle size distribution of dispersed AEROXIDE® in water



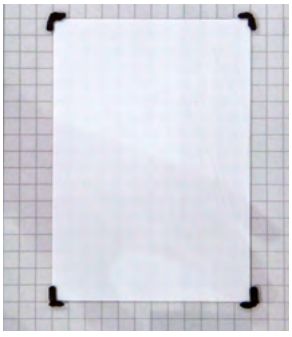
Cross section SEM imaging of an AEROXIDE® coated separator

150 °C:
uncoated separator

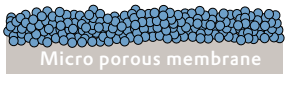


Thermal shrinkage of membrane
→ risk of short-circuit!

150 °C:
AEROXIDE® coated separator



AEROXIDE®



Micro porous membrane

A thin ceramic coating made of AEROXIDE® fumed alumina strongly reduces the thermal separator shrinkage and thus leads to an increased cell safety.

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