Advanced battery materials by spray pyrolysis

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Nordbatt
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Introduction to CerPoTech
About CerPoTech

What? High-quality complex oxide powders
Why? Superior quality, tailor-made materials
Where? Tiller, Norway
How? Spray-pyrolysis based on aqueous solutions

History of CerPoTech

2003 Spray pyrolysis unit installed at NTNU
2007 CerPoTech founded in Trondheim, Norway
2013 Pilot production facility established
Production Process

• Spray pyrolysis is CerPoTech’s core technology.
• The precursor chemistry, the pyrolysis equipment and know-how make it unique.
• The spray pyrolysis technology allows for a seamless up-scale of the from pilot scale production to industrial size.
Production Process

Droplet of precursor solution → Shell of metal salts → Mix of metal oxides → Shell structure of complex oxide primary particles → Homogeneous ceramic oxide powder

Evaporation → Decomposition → Calcination → Milling

Spray pyrolysis → Post pyrolysis treatment

As-produced

Particles

Crystallites

5-50 µm

0.1-2 µm

10-500 nm

Specific surface area in the range 1-100 m²/g

Exact specification depending on material and post treatments

Not to be published without consent
Complete process chain from raw chemicals to finished powder
Current capacity approx. 5.000 kg per year, typical lead time 4-6 weeks
Wide range of compositions can be synthesized
High batch to batch consistency

Powder specifications:
- High phase purity
- Very homogeneous powders
- Exact stoichiometry
- Very low level of contaminants
- Excellent sinterability -> reduced processing temperature
The Periodic Table of CerPoTech

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** Ac | Th | Pa | U  | Np | Pu | Am | Cm | Bk | Cf | Es | Fm | Md | No | Lr |
Applications

Energy

SOFC / SOEC Batteries Supercapacitors Superconductors

Environmental

Membranes Catalysts Photocatalysts

Electronics

Lead-free electro ceramics Lead-free piezo ceramics Others

“Toolbox”

Custom-made materials for R&D and novel applications

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Current R&D projects

• **EVOLVE**
  – **EVOLVED** materials and innovative design for high-performance, durable and reliable SOFC cell and stack.

• **AMSCOPPER**
  – Anti-microbial photocatalytic coatings for e.g. hospitals.

• **COATELY**
  – High performance coatings for PEM electrolyser metallic bipolar plates.

• **ZAS**
  – **Zinc-Air** Secondary batteries based on innovative nanotechnology for efficient energy storage
CerPoTech's battery materials
Battery oxide materials

Advanced ceramic oxide materials

Zn-air batteries
  -> Oxygen Reduction/Evolution Catalysts

Li-ion batteries
  -> Li-based oxides
Battery oxide materials

Advanced ceramic oxide materials

Zn-air batteries
- Oxygen Reduction Evolution Catalysts
  Very good expertise

Li-ion batteries
- Li-based oxides
  No experience yet, but we have the potential
Case study: $\text{La}_{0.6}\text{Ca}_{0.4}\text{CoO}_3$
Tuning the material – Organic additives

Precursor solutions + Organic additives

- Particle size
- Particle morphology
- Pore structure
- Phase purity
- Specific surface area

Electrochemical properties
Tuning the material – Organic additives

Precursor solutions + Organic additives

- Particle size
- Particle morphology
- Pore structure
- Phase purity
- Specific surface area

Electrochemical properties

5 additives
2 levels
= 11 batches
Particle morphology

Without

A₁

B₁

Cₙ

C₁

D₁

Without

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Specific Surface Area

![Bar chart showing specific surface area (m²g⁻¹)]

- **Without**: 12
- **B**: High: 16 | Low: 15
- **C**: High: 13 | Low: 12
- **A**: High: 14 | Low: 11
- **E**: High: 15 | Low: 13
- **D**: High: 16 | Low: 15

**Legend**:
- Blue: High
- Green: Low

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Conclusion

- Spray pyrolysis is an effective method of producing a large variety of compositions.
- We can tailor powder properties through careful choice of organic additives.
- Calcination and milling can be optimised to meet quite narrow specifications.
- Cerpotech is more than willing to assist you in developing the optimum powders for your needs.
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