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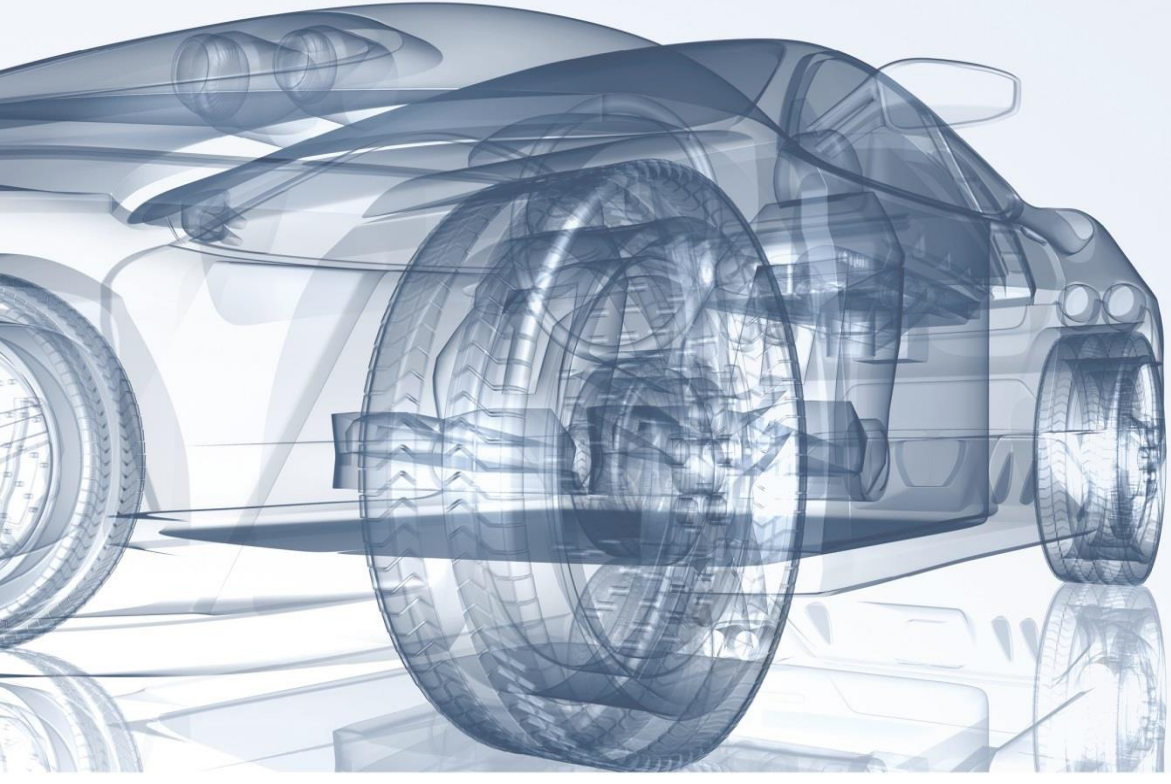

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Stable and sustainable supply of Cathode Materials for LIB

09/10/2017

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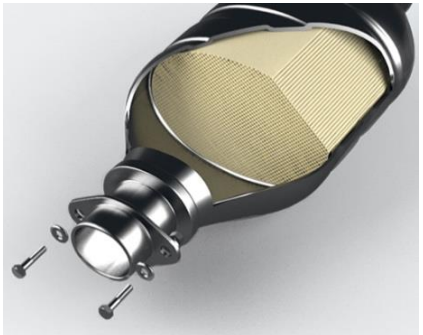
Product & Sales Manager RBM

Introduction

Umicore - A global materials technology and recycling group



One of three global leaders in emission control catalysts for light-duty and heavy-duty vehicles and for all fuel types

A leading supplier of key materials for rechargeable batteries used in portable electronics and hybrid & electric cars

The world's leading recycler of complex waste streams containing precious and other valuable metals

Introduction

Umicore RBM has already produced enough cathode materials to…

….provide a smartphone to every person on this planet

…power more then 1Million EV´s

1 out of 5 batteries ever made contains Umicore technology

Over 15 years in the market

6 production sites

Introduction

Li-ion value chain

Raw material

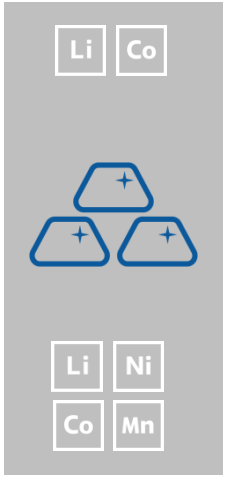
Recycling & intermediates

Refining feed

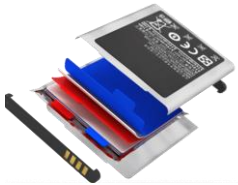
Co Ni

Metal

Product



Application



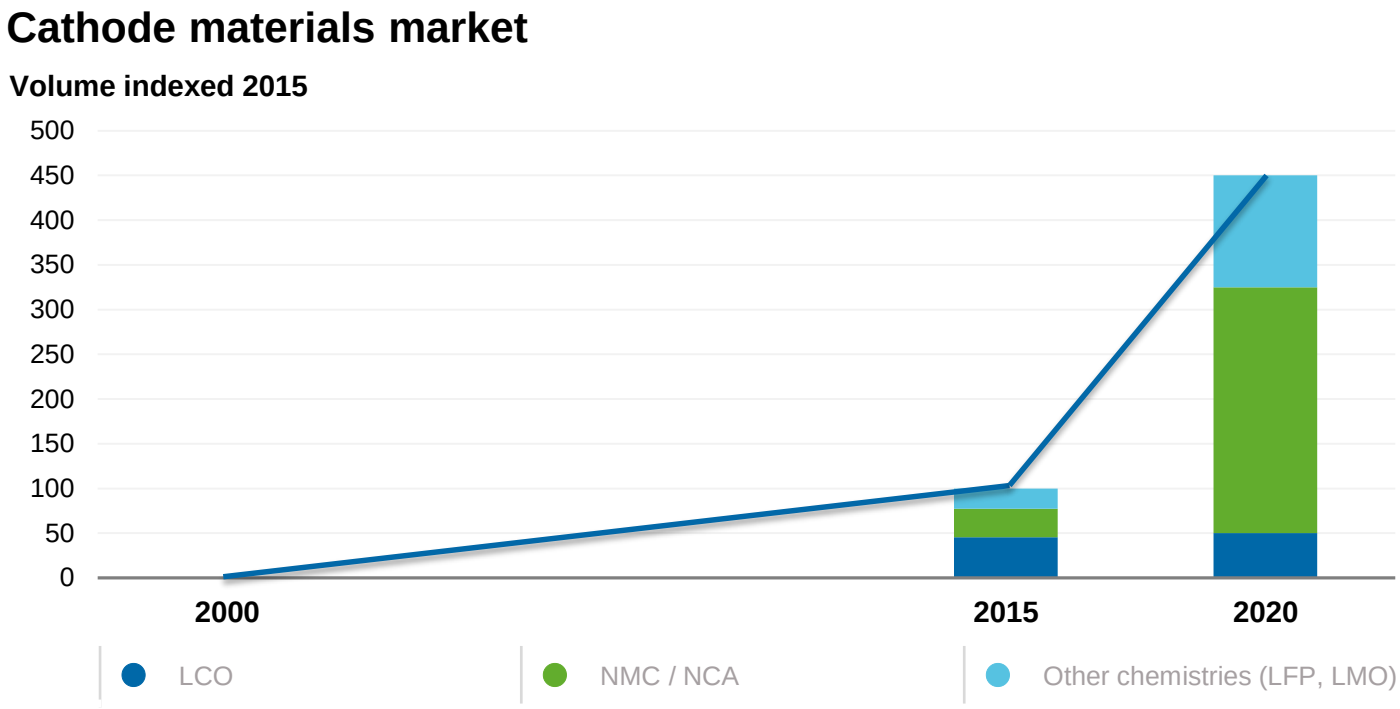
Li-ion rechargeable batteries

- Portable electronics
- Power tools
- (P) HEV / EV
- E-bikes
- Stationary power

Umicore occupies a unique position in the value chain guaranteeing high speed to market, supply security, and responsiveness to customer needs

Growth drivers in cathode material

Automotive and ESS type materials are the biggest contributors



Stable and sustainable supply

of Cathode Materials for LIB

Key challenges for cathode material producers in the decade(s) to come

- Production capacity ramp-up
- Raw materials
- Sustainability

Stable and sustainable supply

of Cathode Materials for LIB

Key challenges for cathode material producers in the decade(s) to come

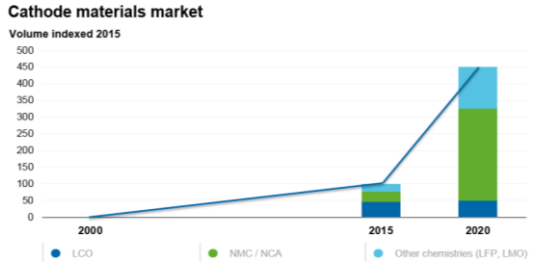
- **Production capacity ramp-up**
  whilst meeting automotive cost and quality targets
- Raw materials
- Sustainability

Production capacity ramp-up

Automotive and ESS are driving the overall cathode material market growth

- Automotive tenders reached critical volume requirements
  - Smaller players don't have sufficient installed capacity
  - Break-through production processes required
  - Leading producers expected to increase market share due to market consolidation

→ Above market growth investments required



→ **Umicore increases total production capacity more than six fold between 2015 and 2020**

Production capacity ramp-up

It’s more than building factories

- Is the supply chain doing the same?
- Can your equipment suppliers keep up?
- Can the local community support your staffing requirements?
- And so much more…
  - Logistics
  - Utilities
  - …

Stable and sustainable supply

of Cathode Materials for LIB

Key challenges for cathode material producers in the decade(s) to come

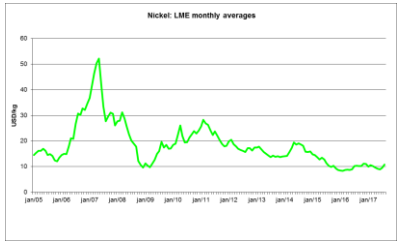
- Production capacity ramp-up
- **Raw materials**
  sourced in right quantity and price range
- Sustainability

Raw material sourcing for NMC

Nickel, Cobalt and Lithium have each their own risk profile

- Driven by stainless steal and less by LIB
- Prices are historically low
- New projects lead-time >5 years from decision to implementation

→ **Investment environment not favorable today**



- Only ~20% of the Nickel market usable for LIB
- In May 2017, the salt premium for NiSO4 on top of LME nickel was >50%

→ **Grade risk further intensifies the situation**

→ **Chemistry decision should not be based on 2017 pricing**

Raw material sourcing for NMC

Nickel, **Cobalt** and Lithium have each their own risk profile

- Majority of Cobalt is sourced as a by-product of Nickel and Copper mining

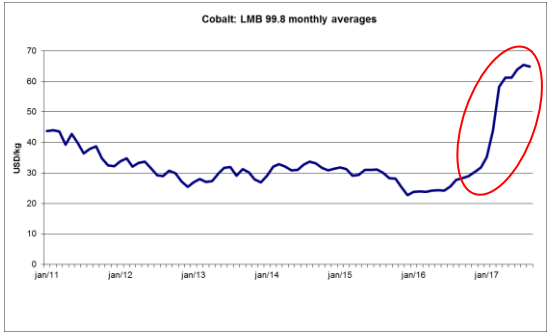
→ **High dependency on Nickel and Copper investment plans**

- >65% of today's Cobalt production is based in DRC
- Behavior of current Kabila government and opposition difficult to predict

→ **Geo-political risk is present**

- Cobalt market size relatively limited

→ **Speculation can influence Cobalt pricing in a tangible way**



Raw material sourcing for NMC

Nickel, Cobalt and **Lithium** have each their own risk profile

- Supply / Demand balance remains uncertain in 2018

→ **Numerous new projects both brine-based and spodumene-based coming mid-term**

- World's supply still very much dependent on 2 regions: Australia & Chile/Argentina

→ **Local events e.g. rain in Atacama can have a global impact**

- Right now, Chinese LiOH is cheaper than Li2CO3

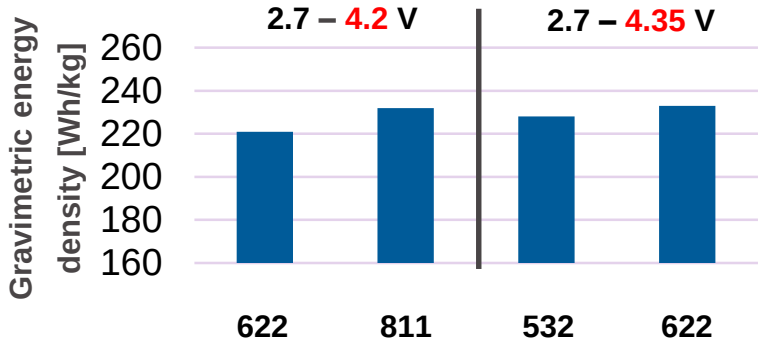
→ **High-Ni cathodes (NCA) is very much focused towards one specific supply chain. Overall demand is still lower than many market observers expected**

Raw material sourcing for NMC

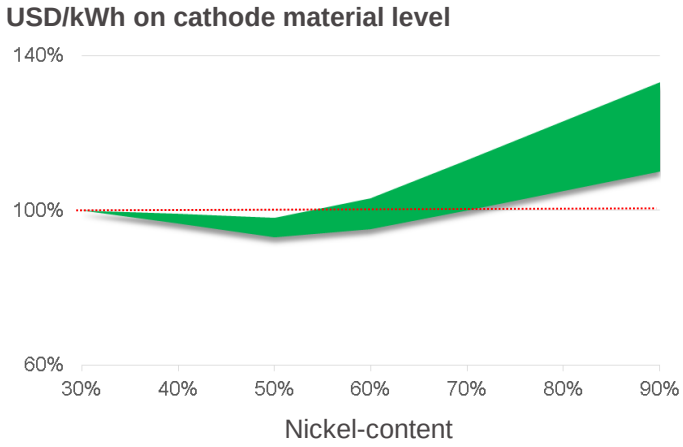
Mitigation strategies

Product development

- Higher Nickel materials operated at conventional voltage compete with medium Nickel materials operated at increase voltage also due to financial risk profiles



Simulation results: 120Ah prismatic hard case cell, C/5 discharge rate



Raw material sourcing for NMC

Mitigation strategies

Primary sourcing

- Long-term strategy, keeping the changing market in mind, is necessary

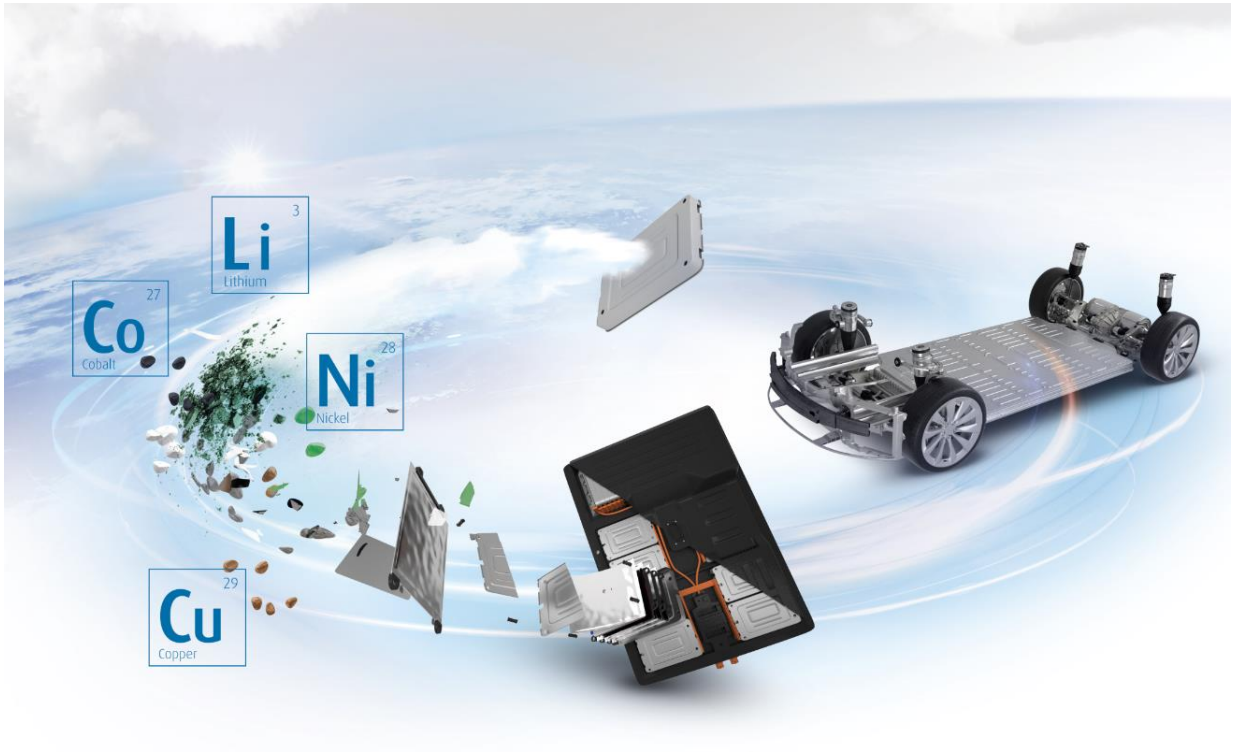
Secondary sourcing

- Battery and production scrap recycling are a strategic pillar
- Umicore invested in a 7000mT p.a. pilot installation to proof its unique recycling technology
  - Best in class environmental impact
  - Scalable to industrial size
  - Future proof in regard to changes in chemistry intake
  - Recovery of key metals like Co, Ni, Li,…
  - Separation down to refined metals allows flexibility and re-use in latest cathode materials

Raw material sourcing for NMC

Mitigation strategies

Umicore battery recycling approach

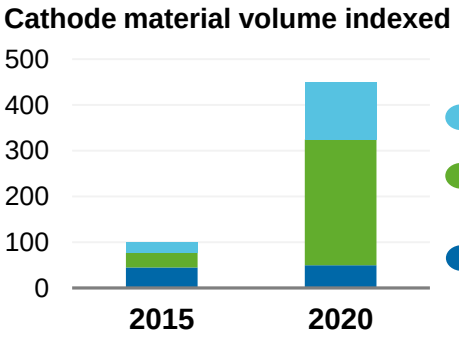


Raw material sourcing for NMC

Battery recycling in perspective of timing

- Similar to lead-acid, Li-ion battery recycling will be a must for the automotive and industrial applications in the longer term
  → **Battery recycling will be a strategic pillar in the supply chain**

- Today there is not enough recycling feed collected to support the LIB market growth in a tangible way
  → **Current LIB growth will be mostly fed by primary raw materials**



Chemistry	Valuable metals	Application	Time to recycling	Collection
LFP, LMO	Li	Automotive, ESS,…	10-15 years	Potentially high
NMC, NCA	Li, Co, Ni	Automotive, ESS, portable electronics	10-15 years 2-5 years	Potentially high Low
LCO	Li, Co	Portable electronics	2-5 years	Low

Stable and sustainable supply

of Cathode Materials for LIB

Key challenges for cathode material producers in the decade(s) to come

- Production capacity ramp-up
- Raw materials
- **Sustainability**
  implement proper policies and control mechanisms along the entire supply chain

Sustainability

is becoming a requirement in order to supply LIB

- Cobalt has been on the radar screen due to unsafe / unethical practices in a limited part of the supply chain

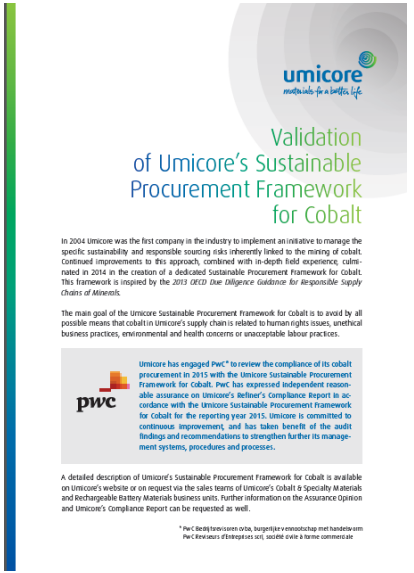
- More than 65% of annual Cobalt production happens in Congo, of which 20% happens via artisanal small-scale mining
  - High risk of child labor and insufficient health and safety conditions
  - → **Proper due diligence system (including on-site visits) is required**
  - → **Umicore does not support a general ban of Congolese material and is committed to engage with trustworthy Congolese companies**

- Material flows from the mine to the application are complex and interlinked
  - → **Risk of mixing**
  - → **Profound investigation of upstream supply chain is key**

Sustainability

Minimize the risk of connection between the cobalt in the supply chain and human rights abuses or unethical business practices

- Start program for sustainable cobalt sourcing in 2004
- In 2012, as first company worldwide, Umicore introduced its due diligence framework aligned with the OECD's Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas
- PwC audit on reporting years 2015 and 2016
- For the reporting year 2016, Umicore publicly shared the compliance report of the PwC audit via its annual report



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materials for a better life

Validation of Umicore's Sustainable Procurement Framework for Cobalt

In 2004 Umicore was the first company in the industry to implement an initiative to manage the specific sustainability and responsible sourcing risks inherently linked to the mining of cobalt. Continued improvements to this approach, combined with in-depth field experience, culminated in 2014 in the creation of a dedicated Sustainable Procurement Framework for Cobalt. This framework is inspired by the *2013 OECD Due Diligence Guidance for Responsible Supply Chains of Minerals.*

The main goal of the Umicore Sustainable Procurement Framework for Cobalt is to avoid by all possible means that cobalt in Umicore's supply chain is related to human rights issues, unethical business practices, environmental and health concerns or unacceptable labour practices.

pwc

Umicore has engaged PwC* to review the compliance of its cobalt procurement in 2015 with the Umicore Sustainable Procurement Framework for Cobalt. PwC has expressed independent reasonable assurance on Umicore's Refiner's Compliance Report in accordance with the Umicore Sustainable Procurement Framework for Cobalt for the reporting year 2015. Umicore is committed to continuous improvement, and has taken benefit of the audit findings and recommendations to strengthen further its management systems, procedures and processes.

A detailed description of Umicore's Sustainable Procurement Framework for Cobalt is available on Umicore's website or on request via the sales teams of Umicore's Cobalt & Specialty Materials and Rechargeable Battery Materials business units. Further information on the Assurance Opinion and Umicore's Compliance Report can be requested as well.

* PwC Bedrijfsrevisoren cvba, burgerlijke vennootschap met handelsvorm PwC Réviseurs d'Entreprises scrl, société civile à forme commerciale

→ Umicore shows a high level of transparency to its customers and stakeholders

Sustainability

Next Steps

Several industry initiatives have emerged

- RCI
- CDI initiative
- WEF / The Battery Alliance

Umicore is exploring how to contribute and share its expertise

→ **Sustainability is more than child labor only**

→ **Occupational health and safety, as well as environmental topics need to be addressed**

Summary

Stable and sustainable supply of cathode material for LIB

- The overall market conditions are changing dramatically and put stress on all components of the supply chain
- Significant investments in production but also new processes and technologies, staffing and others are needed to follow the growth
- The raw materials market is turning into a sellers market
- Sustainability efforts and recycling are key strategic pillars within the LIB supply chain

Umicore Value Proposition

Ultimate peace of mind ensured through 5 pillars:

Thank you

Contact:
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