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Stable and sustainable supply of Cathode Materials for LIB

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Summary

The LIB industry is facing a turning point in terms of market growth mainly due to the adoption of electrified cars. The need for a stable and sustainable supply chain is hereby one of the most discussed topics in the industry.

Umicore is a leading company in the field of active materials for LIB. Today's cathode materials are using specific metals as raw materials. Each of those metals has its own specific challenges and requirements in terms of sourcing.

Battery recycling as well as appropriate and well controlled standards for primary sourcing are key strategies to answer these challenges.

Keywords: sustainability, battery, materials

1 Introduction

The Lithium ion battery (LIB) is an enabler of a success story. The high energy density of LIBs combined with high safety and durability has promoted the broadening demand of consumer electronics like cellular phones, laptops and tablets.

Although the outward appearance of a LIB cells differs between cylindrical, prismatic and pouch type formats, the general internal structure of these cells are comparable: The cathode (= positive side of the cell) consists of an aluminium foil coated with lithium metal oxides, the so called “cathode material”. The negative side (anode) is a graphite coated cooper foil. To prevent short circuits the “separator” which is an ion permeable inert membrane separates the cathode and anode (figure 1). The electrolyte fills the space in-between and provides the lithium ions for the reaction. The lithium ions are the actual active species in a LIB but do not form the active material themselves.

Figure 1: schematic plot of a lithium ion battery cell

In today’s cells, mainly the cathode and anode material define the cell performance. Starting with material supply to the Li-ion industry in 1990, Umicore is today one of the leading producers of cathode materials and recycler of Li-ion batteries as well as their associated production scrap. For the supply of cathode materials, Umicore is focusing on Lithium cobalt dioxide (LCO) and mixed metal oxides (NMC).

The choice of the right cathode material depends on the application. High-tech consumer electronics for example rely on lithium cobaltite (LCO) as this material provides high capacity together with high power capabilities. However, for automotive applications, the LCO material is not being considered mainly due to high resulting cost. Various cathode materials are today found in automotive applications: lithium nickel aluminium cobalt oxide (NCA), lithium manganese oxide (LMO), lithium iron phosphate (LFP) and nickel manganese cobalt oxide (NMC). As a trend, the NMC material will continue to dominate the market in this sector going forward.

Matching this material roadmap with the expected volume demand per application, allows to give an outlook on the related raw material demand.

2 Market outlook and impact for material makers

Portable electronics has been historically the biggest market for LIB over more than 15 years. With the electrification of the car this picture changes dramatically. Whilst portable electronic is growing in a steady pace, the automotive application is by far the biggest growth driver of the industry today (figure 2). Stationary storage applications add to the overall market, using material technologies that are similar to the automotive application. Nonetheless it is very difficult to predict the related market volume as this is highly dependent on the legislative framework.

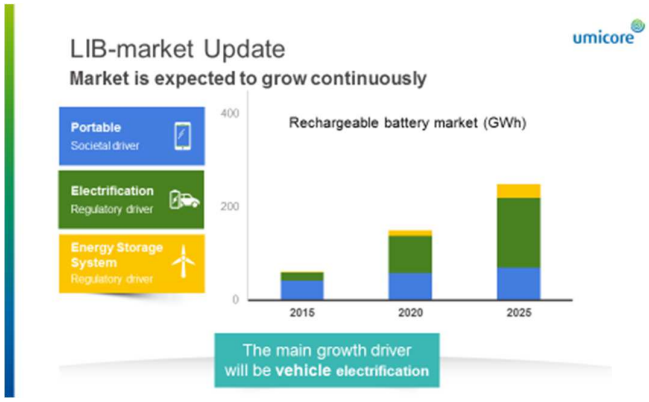

Figure 2: expected energy storage capacity till 2025

Overall we are facing a tipping point in the LIB market in terms of market volume. The entire supply chain needs to adapt itself to never seen volume demand as well as different product life cycles and technical requirements.

For Umicore, as a leading material maker, this means to dramatically increase production capacity. This is even more pronounced as Umicore believes that the competition will further consolidate due to the related financial investments, which might not be acceptable for smaller players. Furthermore it is a necessity to develop new production technologies in order to supply the requested volumes. Umicore is currently heavily investing to further strengthen its position as a preferred cathode material supplier. Details can be found in our latest press releases.

It is not only the own production capacity that is of interest. In order to fill up the production, the right raw materials have to be sourced at the right price, in the right time and in a way that supports the sustainability requirements of the application.

3 Raw material supply

Looking at the material technologies that will be the volume drivers in the coming decade, Umicore sees NMC and LCO as being the most relevant materials. Within the NMC product family there are some competing technologies in terms of exact metal composition but all those technologies have the use of Lithium, Nickel, Cobalt and Manganese as core ingredients in common.

In order to provide the raw materials for a mixed metal cathode material precursor, it is needed to refine various metal and intermediate feeds into a usable format. Those feeds can come from primary mining, but also e.g. from battery recycling. Typically the metals are not available in a pure form, meaning separated from other metals and impurities. The battery application requires most stringent impurity levels and the possibility to mix the single metals in the right composition. As such refining can be seen as a very crucial competence to make high quality cathode materials.

Umicore is deeply integrated, having battery recycling, refining, cathode precursor as well as the final cathode material production in-house. This allows a high speed to market, security of supply as well as responsiveness to customer needs (figure 3).

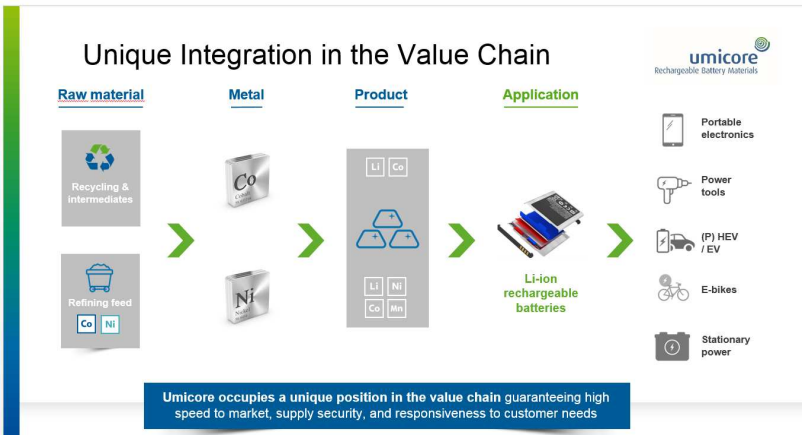

Figure 3: LIB value chain

4 Battery recycling

Looking at the expected market volumes, recycling is seen as a strategic pillar in order to feed the supply of cathode materials, but also to limit the market risk exposure of fluctuating metal prices. Technically relevant aspects hereby are, besides the high yields, also the appropriate recycling and refining techniques to extract the metals units without any technical downgrading effects.

Battery recycling means the recycling of end-of-life batteries as well as their related production scrap. Examples hereof are e.g. slurries, but also coated electrodes. Umicore installed a first recycling unit that perfectly fits into the related refining and as such cathode material production (figure 4). It is able to treat LIB as well as NiMH batteries e.g. from first generation hybrid cars.

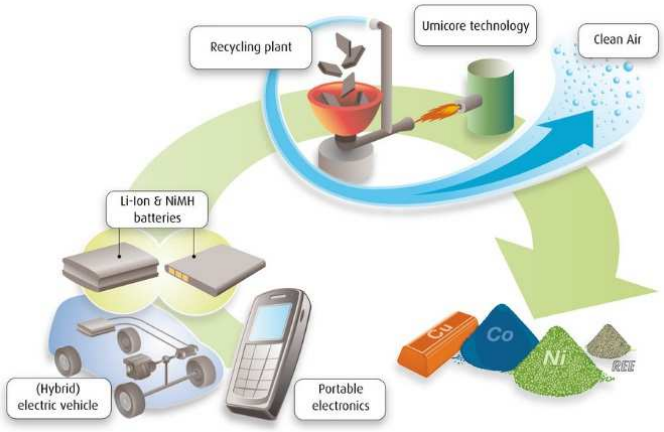

Figure 4: Battery recycling principle

In a rapidly growing automotive market and an expected life time of the final application, being electrified cars, of more than 10 years, it becomes obvious that recycling alone will not be able to provide the required raw material streams in the right mix to satisfy all needs of the industry in the years to come. For portable electronics batteries, there is a well-established market but the collection of end-of-life materials is still a big challenge today.

In conclusion, there is already today recycled metal in the raw material intake of cathode material production, but the returned volumes from the market do by far not allow a sourcing strategy purely based on recycled metals.

Primary souring is de facto today and will be also in the next decade the main source of supply for the LIB industry. Securing the right volumes of raw materials will be a main differentiator in this highly competitive growth environment.

5 Sustainability

Besides the pure need to secure the required raw material volumes at acceptable prices, the industry is increasing its requirements in terms of sustainability and with this also the transparency along the full supply chain. This is valid for raw materials coming from recycling, but in particular for metals coming from the primary mining route.

Especially Cobalt has been in the spotlight in this regard. Umicore introduced a specific approach to sustainable and ethical cobalt sourcing in 2004. This has evolved over time to take into account the specific risks involved in the mining of cobalt in certain countries, such as child labour and poor health and safety

practices. Umicore's framework, which has received third party validation from PwC, is inspired by the OECD's Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. It aims to minimize the risk of any connection between the cobalt in its supply chain – and subsequently that of its customers – and human rights abuses or unethical business practices. Umicore was the first company in the world to have introduced such a framework for cobalt supply and the first to obtain external validation for its ethical procurement approach in this area.

6 Conclusion

The LIB industry is facing a turning point in terms of market growth mainly due to the adoption of electrified cars. Cathode material is a key component in LIB which requires metals such as Cobalt, Nickel, Manganese and Lithium as raw materials.

The metal units are today mostly sourced from primary mining. Recycling is seen as a strategic pillar for the future, in order to reduce exposure to the primary market. Transforming metal-containing raw materials into the right precursor for cathode material is hereby a key competence. Umicore is deeply integrated via recycling, refining, precursor and cathode material production.

The market is increasing its awareness and requirements for the sustainability of the operations along the supply chain as well as the sourcing of raw materials. Appropriate standards and the strict control of those is becoming a key differentiator in the industry. Umicore is the first company in the world to have introduced such a framework for cobalt supply and the first to obtain external validation for its ethical procurement approach in this area.

Authors

Dominic Homberger joined Umicore in the field of rechargeable battery materials in 2009. Today he is responsible for the global product management of Si-based anode materials as well as the sales & marketing of cathode materials with focus on the European market.

Before joining Umicore Belgium, he could gain experience in the German automotive sector.

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