ENTWICKLUNGSFONDS SELTENE METALLE

ESM Workshop at WRF Davos

October 13, 2016

Handling critical materials – resource strategies, value chains and their impact

Defining and determining criticality

Prof. Tom Graedel, University of Yale

Topics:
Determining criticality has been a complex and sometimes contentious challenge ever since the topic was introduced early in this century. Criticality evaluations have been produced for the world, for countries, for regions, and for corporations. They tend to show a divergence of the elements designated as critical or not. Why is this the case, and can the situation be improved?
To explore criticality determination from and enhanced perspective of rigor and breadth, a comprehensive methodology has been developed by Yale University and applied to 62 elements of the periodic table. Factors that have been considered include aspects of geology, geopolitics, regulatory structures, environmental implications, substitutability, import dependence, and others. All of the results have been published in the peer-reviewed literature, and important ones are presented in this talk.

Discussion:

- Should the term "essentiality" be used, instead or supplementary to "criticality"?
- Combination of the recycling potential by Yale and the technical possibilities defined by UNEP will be included into a new document according in spring 2016.
- The extraction efficiency of single materials is hard to determine as companies do not reveal this.
- In by-products, the uncertainty of data is much higher.

Conclusions:

1) Yale has defined three axes of criticality: vulnerability and supply risk (together creating five "clusters" of critical materials" as well as ecological impact). The different factors are rated as an equal mix of different criticality indices.
2) Properties leading to relatively high criticality are identified, but it is demonstrated that no single list of "critical metals" can be derived.
3) 3Criticality is a dynamic property – mines open and close, material demand evolves, recycling becomes more efficient, etc. As a consequence, periodic reassessment of criticality will always be needed.

Critical elements and their impact on a circular flow economy

Dr. Hans-Jörg Althaus, Lifecycle Consulting Althaus

Topics:
The energy demand for closing material cycles depends on product design and use and on recycling technologies. But in any case, energy demand will rise with rising recovery rate. What is the solution for deciding on an optimal recovery rate of raw materials and a sustainable use of natural resources in general?

Discussion:

- Also considering a 100% recycling rate, the demand on raw materials will rise.
- Total material requirement does not take into account of scarcity, environmental impact, etc.
- There are different kinds of "use": e.g. precious metals like platinum are "pooled" in jewellery with hardly any dissipation, but also in medication, dissipating completely when used.
- The use of natural resources should be included in the assessment of supply risk.

Conclusions:

1) Circular Flow Economy is just a matter of how much energy one is willing to invest, but a 100% Circular Flow Economy is not a sustainable option. The optimal recovery rate depends on how the energy is provided and therefore on the geographic region and, if we are looking into a future with changing energy systems, on the time.
2) Material criticality can be solved by existing market mechanisms. This is not the case for natural resources other than raw materials. GHG emissions, land and water use and biodiversity loss kept rising at increasing rates despite growing awareness of and global initiatives to mitigate the criticality of those natural resources.
3) Material criticality cannot be addressed properly without internalization of external costs.

Critical, conflict and strategic materials risks

Dr. James Goddin, Granta Design

Topics:
Granta Design is the world-wide leader in material database solutions. Granta's approach to integrate the identification of product specific supply chain risks from critical/conflict materials and restricted substances into an overall solution for material selection provides companies with a tool for better designing and forcasting the design of components and products.

Discussion:
The data on critical materials is updated on a yearly basis. But not all of Granta's data is publically available and can therefore not be used for comparison with other approaches.
How does the substitution potential by using other technologies influence the criticality?

Conclusions:

1) For many companies understanding and responding to the environmental impacts of their products and operations is rising up the business agenda. Business drivers include legislation on energy consumption, hazardous substances and conflict minerals, volatile material and energy prices, product marketing, brand value and Corporate Social Responsibility and stimulus for product innovation and a transition to a circular economy.
2) Approaches such as Life Cycle Assessment (LCA) generally require significant knowledge and expertise, both to perform the analysis and to understand the results. Furthermore, the LCA approach is substantially divorced from product development activities as it is generally applied at the end of the product

development process. This results in poor engagement of designers and engineers with environmental issues and a general lack of support (or capability) to address these issues within the organization. Similar challenges exist for critical materials where lists of critical elements that have been produced in order to advise broad economic and trade policies continue to be inappropriately applied in an attempt to guide the more specific technical, commercial and supply chain requirements of individual businesses seeking to identify and mitigate these potentially very significant supply chain risks for their products.

3) Several industry-based projects Granta Design is active in are attempting to overcome implementation barriers by adopting a product specific, risk-based approach to the management of product sustainability issues, the identification of product specific supply chain risks from critical/conflict materials and restricted substances, the substitution of materials and the design of products incorporating Circular Economy principles.

Product design for the efficient use of critical materials: the case of mobile information technology devices

Karsten Schischke, Fraunhofer IZM

Topics:

The content of critical and valuable material is manifold in todays' electronics devices. The recycling industry can do a lot to achieve high recovery rates of some of these materials, but product design has to play at least a similarly important role. Different approaches are discussed in this talk.

Discussion:

- Electronic industry is diversified in their production – not many standards – , and depending on Asian suppliers which makes it difficult to introduce "green design" although it would be necessary
- Electronic consumables are strongly dependent on a "fashion" design demanded by end-users and which leads to short lifetimes. New design approaches that introduce modularity and with that longer lifetimes and less change of overall design must either be accepted by the end-user or introduced by national or European/international laws

Conclusions:

1) Although laptops, tablets and smartphones are difficult to recycle, there are also some promising design options found among individual brands, including MicroPro's iameco D4R laptop, imasD's Click ARM tablet, Google's project ARA, the Puzzlephone by Circular Devices and the second generation Fairphone.
2) Modularity first of all means inevitably more material consumption, as additional sub-housing and universal connectors are required, partly also a larger total product volume to allow for incorporation of the maximum potential configuration and anticipated future technologies. This has to pay off through a significantly longer use of individual devices and modules.

Critical elements – strategies and advanced technologies for closed material loops

Prof. Gerhard Sextl, Fraunhofer IWKS and University of Würzburg

Topics:

The resource strategy described in this presentation is based on a comprehensive approach. Main elements are investigations into sourcing processes of critical elements that are applied in various products, recycling technologies for an efficient and energy saving recovery of materials after use of products, for example in the field of electronic systems and batteries, and the potential to substitute critical elements in high-tech applications like magnets in electric engines and wind turbines, energy materials and luminescent systems.

Discussion:

- Criticality discussion is not only related to avoid certain elements and how to substitute them, but also to recycling opportunities that focus on “whole materials” re-use of e.g. same alloy or mixtures.
- Functional materials should be retained by using suitable processes instead of recycling elements
- Also old technologies can be applied beneficially for new applications

Conclusions:

1) To satisfy the growing demand on functional materials in the future also secondary resources out of re-manufacturing, re-using and re-cycling procedures will become more important for the continuous and stable supply of critical metals and materials.
2) A computer-based material data model for critical elements describes for each element the scarcity of materials, state-of-the-art sourcing processes with regard to energy consumption and provides an overview on related technical applications.
3) Recycling concepts should be tailored to end-users needs, cost/benefit ratio and optimal energy and carbon footprint balance.

Mobilising industry to act on material criticality – how other domains can inspire concrete actions

Willem Bulthuis, Business Angel and Digitization Advisor

Topics:

Reducing the use of and dependency on critical materials and improving the circulation of such materials within the value chain requires concrete actions by industrial companies. How can we motivate and support the management of individual companies to take action?

Discussion:

- How to encourage companies, especially SME’s to discuss risks on critical materials in their normal risk strategy
- Importance of opening the discussion on criticality also on the management level and to be aware of problems also in “low risk” times (low prices, availability of critical material)

Conclusions:

1) Industry will only pay attention to the topic of materials criticality if it is perceived as a risk with major impact.
2) Industrial management should be motivated to consider materials criticality in established business concepts and risk management structures.

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Expert debate on "What is materials criticality and how can it be assessed?"

Introductory talk:

Prof. Jo Dewulf (JRC): "EU methodology for criticality assessment"

Moderation:

Alessandra Hool (ESM)

Participants:

Prof. Jo Dewulf (JRC); Prof. Armin Reller, University of Augsburg; Dr. Luis Tercero Espinoza, Fraunhofer ISI; Prof. Tom Graedel, University of Yale; Dr. Hans-Jörg Althaus, Lifecycle Consulting Althaus; Dr. James Goddin, Granta Design; Dr. Patrick Wäger, Empa; Dr. Christian Hagelüken, Director EU Government Affairs Umicore; Willlem Bulthuis, Business Angel and Digitization Advisor

Topics:

The "criticality" of raw materials is a well-known term, but its exact definition differs widely dependent on the respective approach. In the expert debate, a variety of criticality concepts was highlighted by experts from a wide range of backgrounds who discussed the advantages of different approaches, their applicability and limitations. The following topics were discussed in detail:

- EU methodology
- Definitional issues
- Criticality and risk
- Inclusion of ecological impact
- Substitution and recycling
- Criticality and the industry
- General discussion on methodology development and its value

Conclusions:

1) "Criticality" is used for a variety of concepts depending on the context.
2) The concept of materials criticality based on supply vulnerability, economic impact and additional life cycle parameters is recommended to be adapted to the field of application (stakeholder interest, sector).
3) The topic is a very complex and volatile one; the different variables change also in view of their relevance for "criticality". It is therefore necessary to monitor and re-evaluate the topic on a regular basis. The discussion with such a variety of valuable experts as at the ESM Session at WRF should continue, and this network should be further fostered, opened and enlarged by stakeholders from additional areas.