Approach on material management and substitution – Case studies on certain phase-outs

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Materials & Substance management at Microsoft Mobile

Materials management for mobile devices – Microsoft mobile approach

Changes to materials management are initiated from

- Regulatory restrictions and requirements – EU RoHS, EU REACH, California proposition 65, China RoHS, others
- Precautionary principle initiated voluntary restrictions and requirements

Microsoft Mobile controls materials and substances in the Nokia Substance List (NSL)

- Updated at least on yearly basis
- Part of Standard Product Requirements and Purchase agreements

NSL initiates product level compliance verification

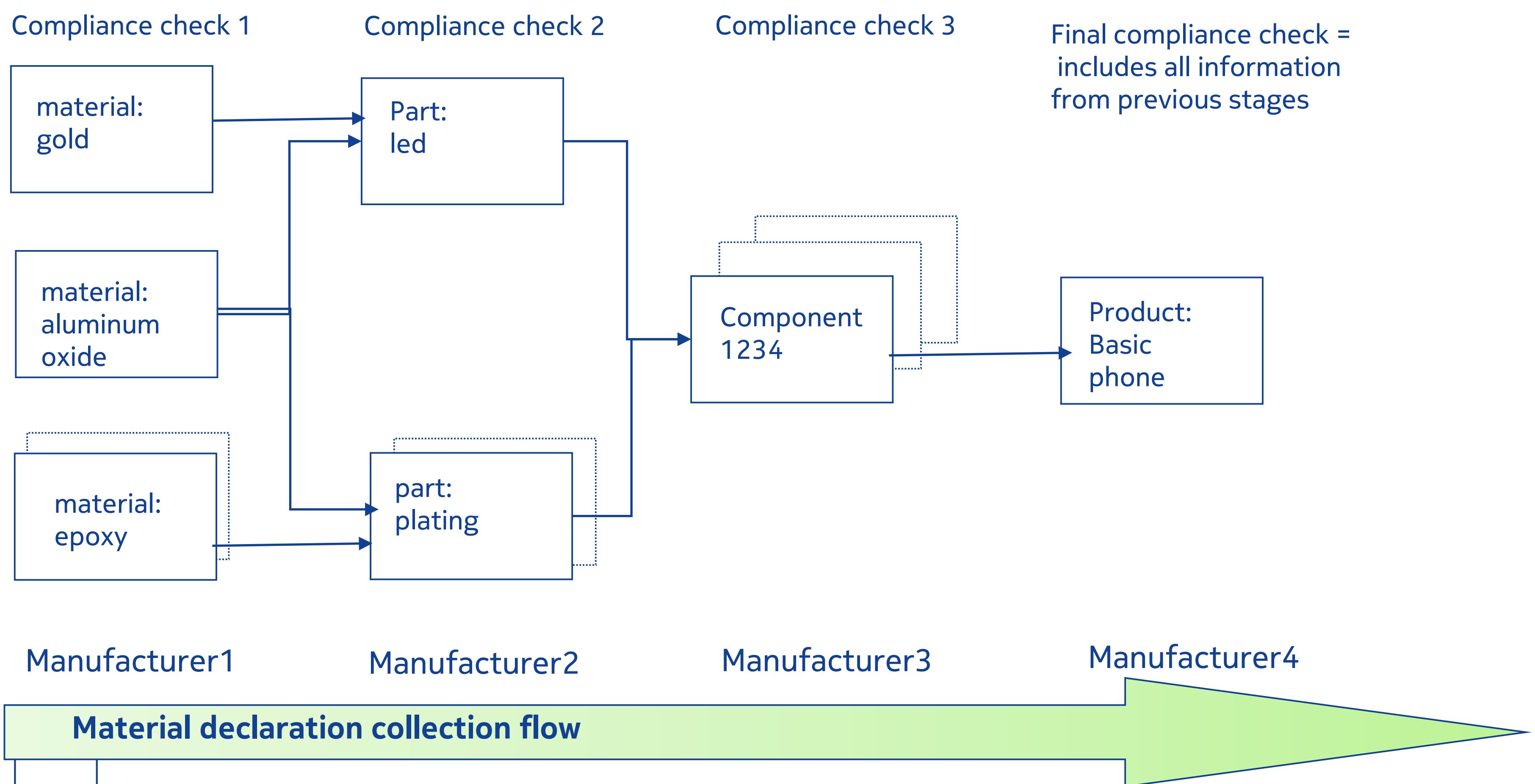
- Compliance verification is done for each product on full material declaration basis

More information found from

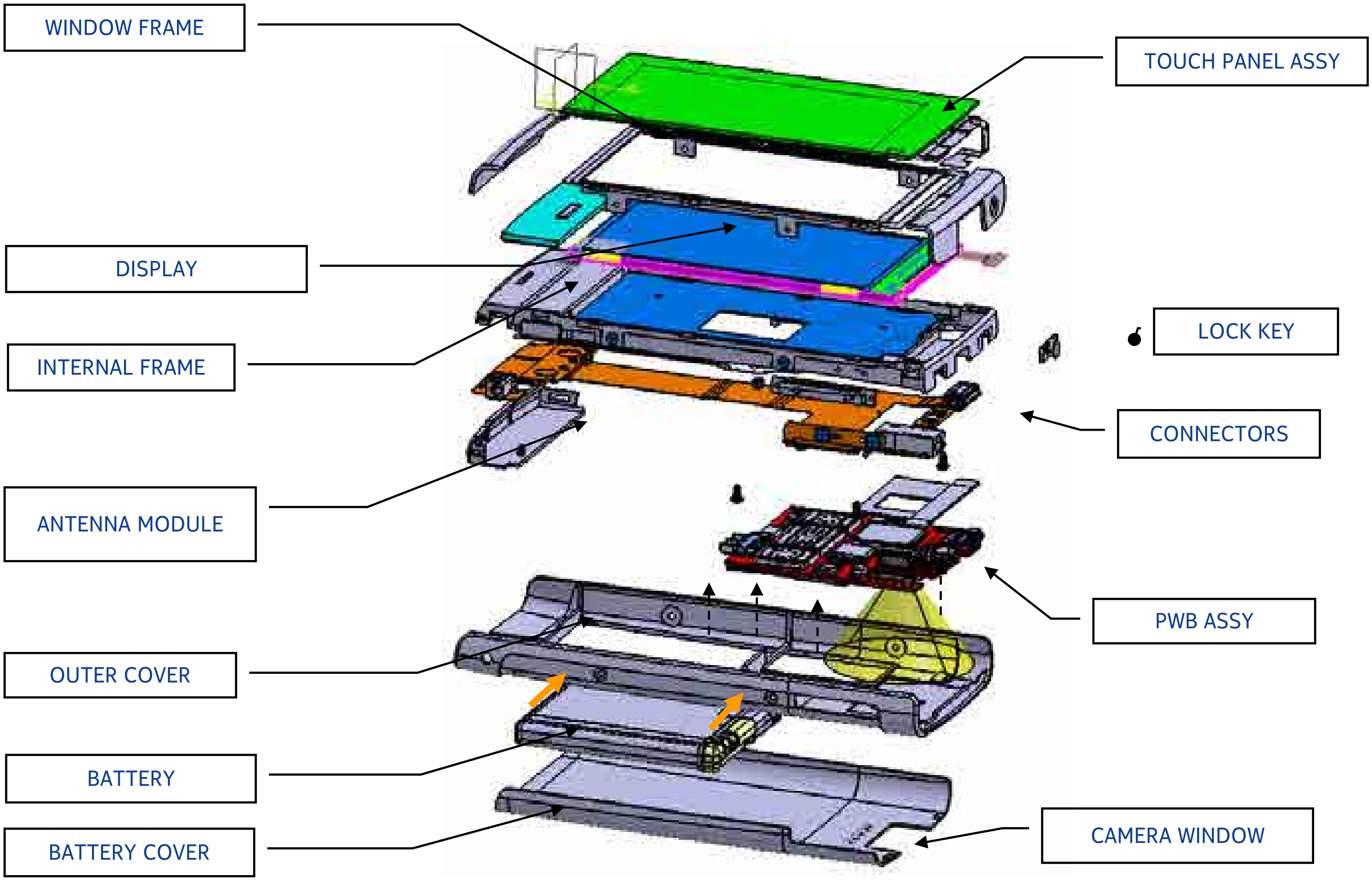
- http://www.nokia.com/global/about-us/people-and-planet/sustainable-devices/materials/materials/

Full material declaration approach

- All the materials used in the components and, cumulatively, in mobile phones are declared by using the full material declarations (FMD) through whole supply chain.
- Material declaration (on homogeneous material (=substance) level)) is required from every supplier through the entire supply chain and data is stored in the Material Data Management System.



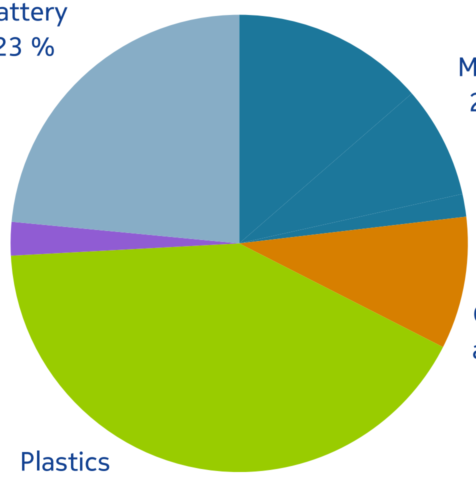
Material declaration on part level



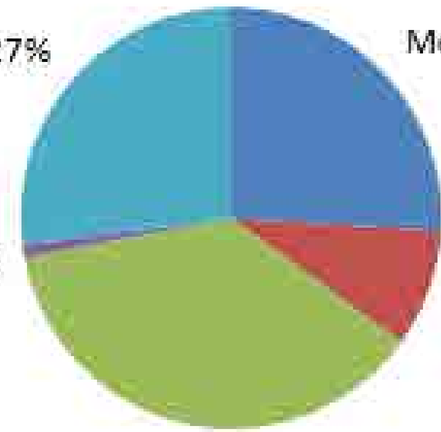
- Similar pictures available e.g. from iSuppli corporation

Material content of a mobile phone

Nokia 2600 Classic

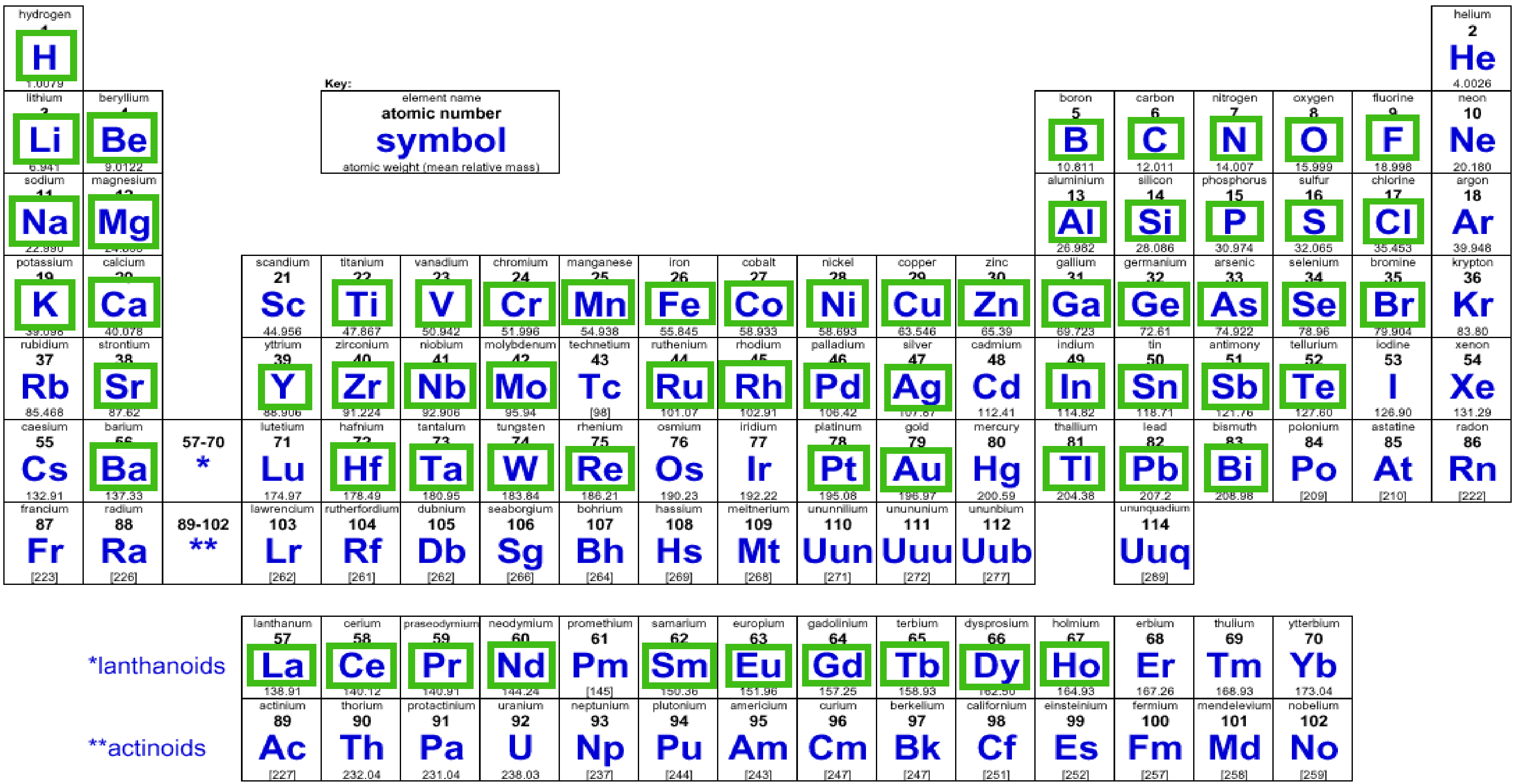


Asha 300



Other (1% - 2%) contains :
- precious metals,
- rare earth metals,
- tungsten, tin, nickel, chromium, titanium and zinc alloys
- (and other metal alloys with amounts less than 0.01g)

Elements typically used in a mobile devices

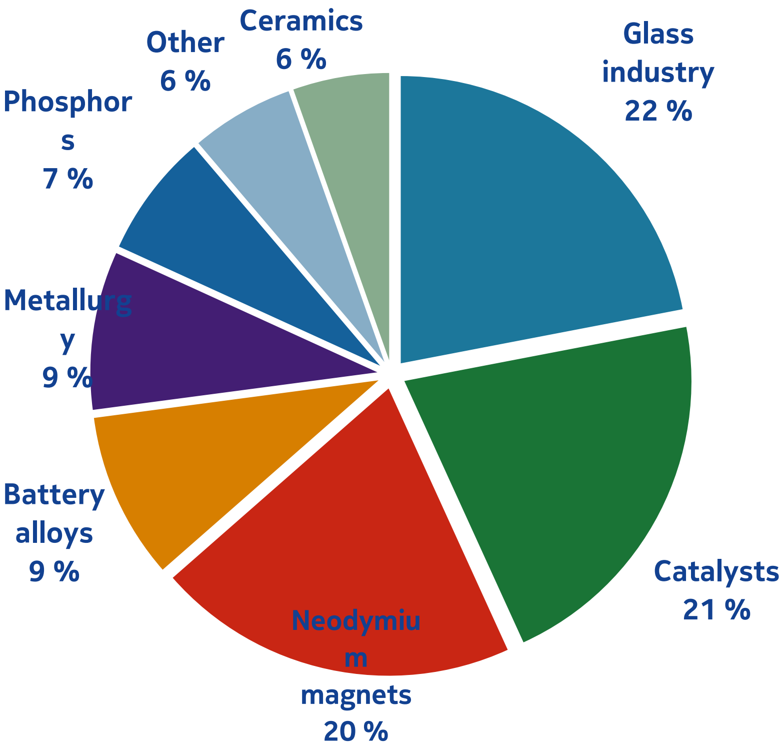


This periodic table does not take into account in what quantities and concentrations the elements have been used (only the smallest impurities are excluded). Neither does it take into account the form the element in question has been used in.

Identification of Rare Earth Metals

- The FMD methodology gives also visibility on the use of the Rare Earth Metals (REM) on homogeneous material level in the products.
  - FMD is useful when discussing on the availability of REM and whether better recycling of REM could help solve the issues of availability.
  - If substitution requirement is initialized by legislation a phase-out can be initialized on certain applications through FMD

Rare earth elements: general information



Use of rare earth metals by market sector in 2008

Source: USGS - Rare Earth Elements - End Use and Recyclability (2011)

- High-technology applications of the rare earth metals (REM) have grown dramatically in diversity and importance over the past four decades
- As many of these applications are highly specific, rare earth metals have acquired a high level of technological significance.
- Global production for REMs in 2009 was 124 000 t (source: USGS)
- Nokia's volumes in 2009 (2012): 440 (335) million pieces
- Yearly REM use (rough estimate) around 106 t, which constitutes for 0.09% of global production
- If REM use per phone of all mobile phone is appr. the same, mobile phone sector's REM use would have been 290 tons (corresponding 0.25% of yearly REM production).

Rare earth metals in typical mobile devices

- Mobile phones contain numerous metals, including many new technology metals
  - Mostly in very small absolute quantities and rarely as pure metals but more commonly as countless different compounds.
  - They provide the user with many additional applications, and all this with a comparatively low weight and volume.

- For example of the new technology metals, neodymium and dysprosium can be linked to the powerful loudspeaker magnets and passive components, cobalt and lithium to the battery, indium to the LEDs and displays and gallium to the processor.
  - The most used rare earth in mobile phone products is **neodymium** (80-90% of all rare earths)

- Below is shown masses of rare earth metal (REM) use in Nokia products (in all forms, not only in metallic forms)

Phone	Mass of the phone	Mass of REMs
Nokia 2600 Classic	73.2 g	0.11 g
Nokia 5530 XpressMusic	107 g	0.24 g
Nokia Lumia 900	160 g	0.29g

Examples of substance restrictions in NSL

- Microsoft Mobile fulfills all legal requirements, follow also precautionary principle
  - We aspire to go beyond legislation and compliance, and also restrict use of other materials and substances that have negative effects for human health or for the environment.

- No phase outs or restrictions have been previously made at Microsoft Mobile because of a metal being classified as critical, but some of the critical metals defined by EU are restricted on NSL for other reasons.
  - **Antimony:** antimony trioxide is banned in polymeric materials (max. concentration of Sb_2O_3 in polymeric materials shall be ≤ 0.09% by weight of a homogeneous material.
  - **Beryllium:** Banned as intentionally introduced in all applications.
  - **Cobalt:** completely banned on product surfaces.

- All new material/substance restrictions are studied thoroughly beforehand with the impacted technology areas
  - Thorough studies are done to make sure that we are not substituting a material/substance with a worse alternative.

Substitution / phase-out ground rules

- ”Time is of the essence”
- Substitution has to happen ”case by case” – ”application by application”
- The proposals for substitution of CRMs should involve latest developments and allow innovation
    - Substitution can happen naturally, as part of product development, legislation is not necessarily required.
    - Good example of this is how the use of graphene can replace indium tin oxide (ITO)
- It needs to be carefully assessed whether substitution or better recovery of a raw material is the more suitable alternative.
- It should be understood that being listed as critical does not necessarily mean that a substance poses a risk or that it should be substituted in every use case.
- In Microsoft Mobile a Business Impact Analysis (BIA) is utilized as a methodology for material substitution from EHS / OHS point of view.

Business Impact Analysis as a Substitution methodology

- As new material/substance is substitution need is identified, there are two methods in which are proceeded:
  1. If initiated by the legislation, controlled substitution/phase-out is organized
  2. If initiated by the voluntary substitution/phase-out decision a Business Impact Analysis is performed

- Business impact analysis contains following issues:
  - Reason for proposed substitution: technical properties, EHS properties
  - Current usage status analysis
  - Life cycle impacts: impacts for material mfg, component mfg, product assembly processes, (EOL) recycling
  - Socio-economic impact
  - Identification of alternative materials / substances
  - Effects on business: short term business effects: reliability, cost, yield etc. Long term business effects.
  - Market overview: raw material manufacturers, other business areas
  - Time required for the substitution in controlled method

Case examples: antimony trioxide substitution / phase-out

- Antimony
  - 2001 antimony trioxide Sb_2O_3 was introduced in NSL on 2001 v.2.0 as monitored substance
    - *“Expected to be reduced or gradually phased out from Nokia applications, subject to the availability of technically, environmentally and economically sound alternatives”*
  - 2004 Sb_2O_3 raised to Restricted category on
    - *“Actions ongoing to reduce or gradually phase out Sb2O3 as a flame retardant in Nokia mobile terminal applications. For maximum allowable concentration value, the level of up to 0.1% by weight in resin shall be tolerated.”*
  - 2005 Sb_2O_3 was introduced more strict restriction for
    - *” All Nokia mobile terminal equipment (excluding car equipment): Banned as a flame retardant in components, parts and modules approved for production after 01.01.2007 and to be phased out from standard components by 30.6.2007.*
      For maximum allowable concentration value, the level of up to 0.1% by weight in plastic (resin) shall be tolerated.”
  - 2010 Sb_2O_3 restriction defined for all parts and components
    - *” For all new Nokia products: Sb2O3 is banned in polymeric materials in all parts and components. The concentration of Sb2O3 in polymeric materials shall be ≤ 0.09% by weight of a homogeneous material”*
- Substitution /phase-out project was initiated by thorough Business Impact Analysis and phase-out of antimony trioxide was initiated on 2007.

Case examples: beryllium substitution

- Beryllium and compounds
  - 2001 beryllium introduced in NSL as monitored substance
    - *“Expected to be reduced or gradually phased out from Nokia applications, subject to the availability of technically, environmentally and economically sound alternatives”*
  - 2004 beryllium oxide was restricted, while beryllium compounds remained monitored
    - *” Banned as intentionally introduced in all applications.”*
  - 2009 beryllium and compounds were restricted
    - *”Banned in new parts and components, whose development starts form 1.1.2009 onwards. MCV shall be ≤0.1% of homogeneous material”*

- Substitution /phase-out was initiated by thorough Business Impact Analysis and beryllium substitution with alternative material was started on 2009.
- Based on the substitution planning and alternative material implementation
  - *“All new products are free of beryllium compounds as defined in NSL.”*

Conclusion

- The uses of Rare Earth Metals / Critical Raw Materials in mobile devices are continuously assessed.

- As new alternative materials and technologies become available, material specific substitution /phase-out analysis shall be performed (Business Impact analysis)
  - Analysis should focus on specific applications of certain critical raw materials, take into account existing research initiatives and innovations. Life cycle impact needs also to be part of the analysis.

- Recycling of REM and some of the CRM of mobile phones are still difficult
  - The figures (Page 8) show clearly that the amounts of rare earths required to fulfill the needs of the industry cannot be met by simply focusing on recycling of mobile phones.
  - In recycling processes it is important to recycle all material or use material as energy for the processes. Recycling processes for complex products requires optimization of processes for specific critical materials.
    - More international research is required for the efficient recycling of specific CRMs.

- Substitution may be seen as more beneficial way to reduce dependency on CRM.
  - Decision to substitute materials into less harmful materials need to be carefully analysed in order to control the life cycle impact of specific CRMs.
  - Substitutes for at least three applications of critical raw materials (CRMs) are amongst the concrete targets of the European Innovation Partnership (EIP) on raw materials to be achieved by 2020

Questions ?