Possible topics

Oveview

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Lighting

Criticism:

LED

phosphor Ce:YAG

Semiconductor In, Ga

CFL (compact fluorescent light)

Phosphor Tb, Eu.

Display and Panels

Liquid crystal displays (LCD), light-emitting diode displays (LED-D), electronic papers and plasma display panels (PDP).

Criticism:

LED-D

LCD REE

OLED

Transparent conductive panel

Indium (in ITO)

The flat panel display industries use up to 80% of all indium available!!

Optical fibers

Optical glass fibres doped with rare earths:
Dysprosium (Dy), erbium (Er), Neodymium (Nd), praseodymium (Pr), thulium (Tm) and ytterbium (Yb)

The main raw material is germanium, accounting for around 30% of the overall consumption of germanium worldwide.

The world's total production of germanium was around 100 – 120 tons in 2011, approximately 30% of that was recycled from electronic devices and coal fly ash. Over 60% of the germanium used during the manufacturing of most optical devices is routinely recycled as new scrap. The pre-consumer recovery of germanium mostly comes from photovoltaic panels and fibre optics, while post-consumer recovery is very limited.

China is the leading producer of germanium metal and products in the world. In 2011, most of the around 100 tons of germanium metal and compounds produced in China comes from 6 companies. China used around 35 tons of the amounts produced and exported the rest.

China and India are the major suppliers of basic optical fibre cables, and in the field of more complex specialist fibres, North America is a strong producer.

France was the leading producer of optical fibers in Europe

Alternative materials (optical fiber)

Germanium-free photonic hollow fibres, fibres with tellurium layers (OM2)
Phosphorous based doping (P_2O_5) is one possible option to avoid the use of germanium.

Although possibilities for substitution of germanium in fibre optics exist, they suffer from performance losses and does not fulfil the product requirements or industrialization capability is unclear.

Magnetic resonance imaging apparatus (MRI)

Magnetic resonance imaging (MRI) is a medical imaging technique used for visualising the internal morphology of the body.

Critical raw materials in an MRI system are found in the magnet unit, spring contacts, cold heat, pole-piece computer display and printed circuit boards.

Critical materials

- NbTi
- Nb_3Sn
- NbN

The majority of superconductive materials produced in the world are destined for use in MRI systems. About 60% of all superconducting wire and about 40% of niobium-tin alloy produced are consumed by MRI magnet.

Other Critical Materials in MRI systems:

- Berillium (Be) in spring contacts (in a form of beryllium-copper), for shielding the magnet and to obtain a durable, solid resolution (other materials would break).
- Holmium (Ho) is used in high field MRI systems; it is an important component of the cold head and operates as a helium-liquefier to prevent evaporation of He and enables helium reuse.

Around 20% of the total rare earth consumption, corresponding to more than 24,000 tons of rare earth metals was used for producing permanent magnets

Alternative materials (MRI)

YBCO (Yttrium barium copper oxide) is the most studied high-temperature superconductor, and expected to be a promising technology for a broad range of commercialization.

Another substitution option for Nb-based superconductive magnets is offered by high temperature superconductors , such as bismuth strontium calcium copper oxide **BSCCO** and especially the second generation conductor YBCO.

Magnesium-diboride (**MgB_2**) has potential characteristics, such as the low cost of its chemical components, for replacing niobium-based superconducting magnets.

Large household appliances

Refrigeration equipment	Compressor	Nd, Dy
Washing equipment	Electric motor, Electronics (PCB)	Nd, Dy, Pd, Ta, Ru, Ga, Ge, In, Sb
Dishwashers Electric motor		
Air conditioners Compressor	Compressor, Electric motor, Electronics (PCB)	

These motors include permanent magnets of which some are neodymium magnets.

Each washing machine contains between 100 and 200 grams of permanent magnets with Nd and Dy concentrations of 28% and 3% respectively.

The total amount of permanent magnets in Large is about 1,200 tons. In addition, Nd and Dy amounts are estimated to be between 300 and 35 tons respectively.

Criticism

NdFeB magnets are used in small motors to reduce the size of the motor and noise. In washing machine motors. Often doped with Heavy rare earths (Tb, Dy).

Alternatives

Hot pressed nanocrystalline NdFeB magnets, avoids the use of other rare earths

Ferrite can substitute NdFeB magnets
$SmCo_5$ **Sm_2Co_{17}** However, the hardness and brittleness of SmCo limits its processability.

Assembled printed circuit boards

Every electronic product contains at least one printed circuit board (microprocessors, resistors, capacitors, sensors and magnets).

Antimony (Sb): dopant in n-type silicon
Beryllium (Be): High performance connectors. PC contains approximately 2 g. of Be.
Gallium (Ga): Ga containing III-V semiconductors GaAs, AlGaAs, InGaAs etc. are used in high frequency transistors, LED and solar panels, wireless product. In 2010, 106 tons of gallium was used in PCBs.
Germanium (Ge): substrate material for III-V semiconductors for solar cells and light emitting diodes.
Indium (In): InSb, InP and InN are used in infrared light detection, magnetic field sensors, fast transistors, LED and solar cells. Around 6 tons of In was used in minor alloys in 2010. Niobium (Nb): Niobium is used in ceramic capacitors.
Palladium (Pd): It is a key material of multi-layer ceramic capacitors. Annual demand for palladium is over 15.5 tons.
Ruthenium (Ru): Thick film chip resistors. The amount used is around 12.2 tons annually representing around 61% of the total supply of Ru.
Tantalum (Ta): anode metal in tantalum electrolyte capacitors.

Research & Innovation:

NMP-23-2015
Topic: Novel materials by design for substituting critical materials

ERA-NET (COFUND):

NMP-14-2015
ERA-NET on Materials (including Materials for Energy)

Coordination and support:

WASTE-4d-2015
Topic: Raw materials partnerships
Contribution to the implementation of the EIP on Raw Materials.

SC5-13d-2015
Topic: Raw materials research and innovation coordination
Contribution to achieving the objectives of the EIP on Raw Materials.

Deadline March 2015