Abstracts of technical articles

Résumés des articles techniques

ENGLISH

Lightweight materials for the automotive: environmental impact analysis of the use of composites 541

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The automotive is a sector where energy consumption during the use phase prevails over the production and the end-of-life phase. Therefore, a lot of research and innovations have aimed at replacing classical steel parts by lighter materials like light alloys and polymer composites. While composites are very attractive for the use phase of cars, their introduction suffers from the limited end-of-life options for composite structures. Due to the restrictions imposed by the European ELV directive, the use of non-recyclable composite components in car manufacturing is not obvious.
An extensive life cycle analysis for a reference car design was conducted to study the effects of replacement of conventional steel structures by lightweight carbon fibre composite alternatives. The study also takes second order effects in the design of the car into account, such as the required motor power. The obtained results show the trend towards more intensive use of carbon-fibre composites in car design desires some nuancing, and the opportunities and threats are identified.

Assessing the management of small waste electrical an electronic equipment through substance flow analysis: the example of gold in Germany and the USA 547

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The demand for precious metals by manufacturers of electrical and electronic equipment has increased significantly over the past few years. Although precious metal concentrations in appliances are very low, these metals have a high economic and environmental relevance compared to other substances present in much higher quantity (e.g. iron, copper, plastics). This research project aims at describing and quantifying the flows of small waste electrical and electronic equipment (sWEEE) in Germany and in the USA for the year 2007, based on a combination of expansive experimental investigations carried out at TU Berlin and a review of the relevant literature. The results revealed that, in 2007, only around a third of the gold contained in desktop personal computers was recovered in Germany, and over 60% was lost for the cycling economy. Despite the lack of data, insufficient collection and losses of precious metals due to inadequate treatment were identified as the main weaknesses of the system. The results reveal new findings on precious metal cycles and support the development of strategies for reducing the losses of precious metals related to electronic waste management. The method is not only useful for assessing the recovery of valuable substances, but also for quantifying systematically the amount of hazardous substances that is disposed of in an environmental-sound way versus direct releases to the environment.

How to assess the availability of resources for new technologies? Case study: Lithium a strategic metal for emerging technologies 554

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The development of new technologies is often connected with the use of non-renewable resources. In recent years a qualitative shift in the demand of bulk metals (e.g. Fe, Al, Cu) to more scarce metals (e.g. Te, Ga, Re) is recognisable. Novel technologies and products rely more and more on very specific metals which are indispensable for their function. Although such metals are generally used in low concentrations in products, the demand has raised significantly due to mass production. Some of them are of high importance due to their strategic relevance to emerging innovative technologies.
Lithium so far has gained relatively little attention, although it fulfills the main criteria of a strategically relevant metal. In recent years, however, recognition of lithium increased as a result of the growing market for lithium-based rechargeable batteries in mobile information/communication consumer products and in electric vehicles. Both areas of demand led to a skyrocketed use of lithium in recent years.
Other technologies in the future like fusion power generation will raise lithium consumption at an accelerated rate. It is therefore necessary to determine the availability of lithium in the medium and long term in order to prevent technology failures and to ensure a more sustainable development. The authors will provide a well-founded knowledge base, outline the availability of worldwide reserves and resources, and describe the structure of present and future demands for lithium.

Cadmium flows in Europe 559

R. Lig, M. Held

A Material Flow Analysis (MFA) of cadmium for Europe (EU 27) is described in this paper. In general the purpose of this MFA is to provide a reliable set of time series data on the flows and stocks of cadmium as they pass through the European economy.
For the data on cadmium flows in Europe various sources, statistics and surveys were taken into account. Data on import and export statistics, production and consumption of cadmium use, hidden flows of cadmium, the recovery and recycling of cadmium, especially batteries, as well as disposal and losses were considered.
The study includes the whole life cycle of cadmium, starting from the raw material extraction, which is the basis for the metal production. Cadmium, as it is produced as a by-product of the zinc, lead and copper refinery, is further treated throughout various processes. Within the production and manufacturing, pre-consumer scrap is returned directly to the main production process. Afterwards the cadmium is used within various products, e.g. batteries. After the use phase, having reached the end-of-life within a specific application field, cadmium is recycled. What is not collected for recycling or returned to the recycling system, is lost in the environment. Finally, during the recycling process, cadmium is returned to the cadmium cycle as post-consumer scrap and what could not be recycled is disposed.
One important outcome of the MFA of cadmium was the gained knowledge on available data and data sources within the cadmium industry. In particular, the inconsistency between the data sources became obvious. Nevertheless a comprehensive

system was established which summarizes the cadmium flows in Europe and set up a MFA model as well as the linkages to available data sources of the cadmium industry. In addition to the data management system, the data gaps of relevance were identified to support future activities in this field.

Time consideration in mass flow analysis; a contradiction? 566

G. Rombach

In metals industry Mass Flow Analysis (MFA) has a long tradition. Combined with scenario calculation this method can for example be used to estimate the future development of scrap availability and metal composition. Despite the unknown inaccuracy of such calculations what regional distribution of material, lifetime or growth rates concerns highly valuable information can be generated to support the industrial business strategy.

When particular products or metal applications in functional units become the scope of such calculations besides mass flow often energy consumption and emissions appear on the agenda. And, unfortunately, metals are recycled (of course only from a methodological and not from a resource point of view). At that point MFA crosses the border from being a static snapshot of an existing system towards a time depending life cycle approach. Besides volume, quality, and location time is introduced as a fourth dimension and the dilemma starts. In the past one approach was to develop depreciation models to allocate the expenditures of mining and primary metal production of Copper and Aluminium according to the recycled content. But latter is even more disputable since metal recycling cannot be treated as an alternative production route achieving the original properties and chemical composition. And, as a result of its electrochemical behavior, each metal cycle looks completely different compared to any other. Consequently the general acceptance of the existing allocation methods for recycling in life cycle models is still low.

In case of Aluminium the historic primary metal production cumulates to an amount of almost 900 million tons worldwide. With the aid of recycling 75% of this material could be conserved in the current inventory in use. As this stock significantly contributes to todays and future's raw material supply the following question arises: Can metallic materials have a defined history and therewith an ecological hereditary debt, which will be reduced by further recycling cycles? If the answer would be yes, on a highly aggregated level, another more practical question would be whether such a credit should be based on the historic expenditures of primary production or better considering the future recycling potential of the inventory in use. In these cases recycling credits are either overestimated or underestimated depending on the lifetime and herewith the deviation from current End of Life recycling practices.

Integrated interdisciplinary university: technology, materials, society 572

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RWTH Aachen University has a long history as a research organisation and as an institution of education. It is known as a progressive, modern and forward-looking institution among students, industrial partners and citizens. RWTH Aachen University recognises its responsibility towards society, it has established and demonstrated flexibility and adaptability over the years and it is determined to improve its international visibility.

Within the Excellence Initiative of the German federal and state governments, RWTH Aachen University has been awarded funding for its future concept. This allows a greater concentration on the clear stated goals and principles of the university, one of which is to train a highly-qualified and responsible new generation of academics for the benefit of business and society, research and teaching. RWTH Aachen University has developed a strategic plan which is reflected in the Institutional Strategy and leads to a super ordinate goal: In contrast to a university primarily characterised by the coexistence of individual strengths, especially in engineering, RWTH is developing into an integrated interdisciplinary university of technology that is able to meet global challenges.

Six interdisciplinary forums at RWTH (e.g. Forum Materials Science, Forum Technology and Society) are engaged to provide a better integration and cooperation among all scientific areas. Working groups within the forums and the different departments at the university collaborate in order to make a faster progress in cross-cutting research fields. Interdisciplinary pathfinder project proposals were submitted and doctoral theses, e.g. "Development of materials and technologies in the mirror of literature" and "Material design against the background of technology and society", are begun at our Department of Ferrous Metallurgy, Chair for Metallurgy of Iron and Steel. In cooperation between different departments of Material Sciences and the Humanities we have set up a project relating to „Materials, symbolic meanings of materials and identity construction". The speakers of the Forums support the dialog between academic world, industry, society and politics.

The best researchers are supposed to contribute and collaborate. That is why the social surroundings and environment should be appropriately arranged. Modifications in organization and structure at RWTH Aachen University have been made. With its large number of projects for integration and support for newly-appointed researchers and their families, Dual Career Programme, Parent Service Office, efforts to internationalise all the faculties and to inspire young people to be the future generation of engineers, scientists and leaders in industry and society, demonstrates the strong will to learn and teach.

RWTH Aachen University is looking ahead with a great optimism that it will succeed in Meeting Global Challenges in the next 10 years and that it will bring valuable information, research and development to the SOVAMAT Initiative.

How physical modelling can improve Life Cycle Inventory accuracy and allow predictive LCA: an application to the steel industry 579

O. Mirgaux, D. Ablitzer, A.-M. Iosif

Assessing traditional iron and steelmaking processes from an environmental point of view and developing breakthrough eco-efficient processes for the future are major challenges for the steel industry today. In the framework of the challenging European project ULCOS, which stands for Ultra Low CO_2 Steelmaking, Life Cycle Assessment (LCA) was chosen to assess breakthrough processes that could be part of the future iron and steel making landscape and to compare them to the reference classical integrated steelmill.

To carry out such a study we propose a new methodological concept which combines LCA thinking with physicochemical process modelling.

Physicochemical models were developed for each processes of the classical integrated steelmaking route in order to generate the data required to draw the Life Cycle Inventory of the route. Such a method bypasses the traditional data collection and brings accuracy to the inventory by introducing rigorous mass and energy balances into the methodology.

In addition it was shown that such an approach allows testing and assessing different operational practices of the processes in order to optimise the use of energy and the CO_2 emissions, which showed that it can be used as a powerful tool for eco-conception of processes.

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