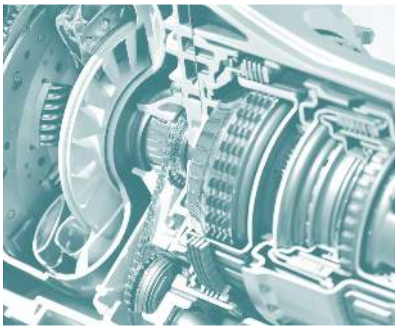
Minor Metals

Sustainable Road Transport



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Some Minor Metals Found in Vehicles

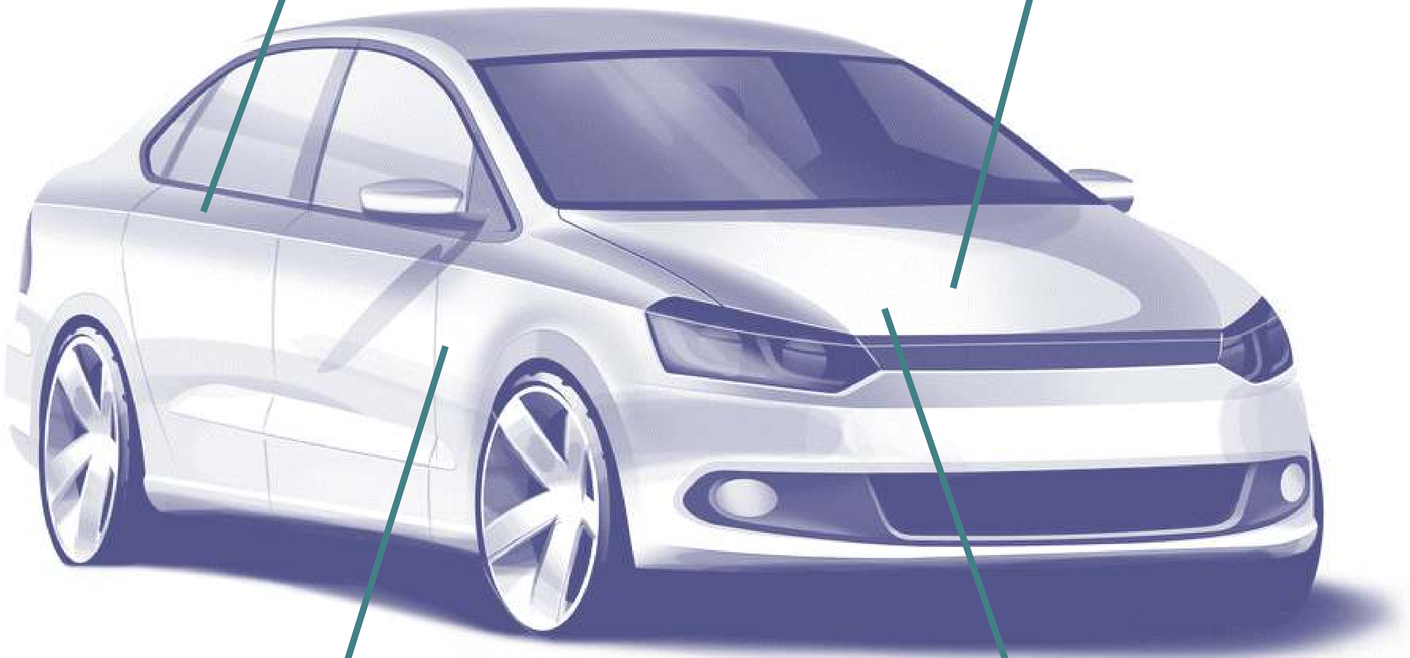
Silicon, Tungsten, Molybdenum in alloys

Titanium in paint

Vanadium in gears and batteries

Magnesium in transmission casings, seat and door frames, intake manifold and engine components

REEs **neodymium** and **dysprosium** in the permanent magnets of electric vehicles



Beryllium in batteries and gears

Chromium in decorative parts and alloys

Indium in bearings

Lead in batteries

Manganese in batteries and alloys

Rhodium in catalysts

Cobalt in measurement devices and rechargeable batteries

Gallium in mirrors, transistors and semiconductors

Antimony in flame retardants and lead storage batteries

Strontium in dials

Key Facts

- Road transport contributes significantly to man-made greenhouse gas emissions
- Legislation has been introduced in many jurisdictions to reduce emissions from vehicles
- End-of-life vehicle legislation helps to sort materials for recycling and re-use, minimising waste
- By making vehicles lighter with high-strength alloys, they require less power, so produce fewer emissions
- Electric vehicle technology is improving rapidly with infrastructure, such as charging stations, growing fast

Overview

Road transport contributes significantly to man-made greenhouse gases; this has presented an opportunity for the industry to develop sustainable practices. Safeguarding the planet for the future depends on the reduction of emissions now.

Under continuous scrutiny from governments and NGOs, the road transport sector must adapt to requirements that vary by jurisdiction, focusing primarily on lowering emissions and increasing end-of-life recycling. Already from this year (2015), car manufactures can be fined for exceeding emission limits on vehicles sold* in the EU.

*Legislation applies to all cars sold in the EU no matter where they were manufactured

Two options to achieve lower emissions include:

- Reducing vehicle weight, thereby reducing the resources needed to power the vehicle
- Leveraging electric and hybrid technologies

Minor metals* are essential for both approaches as they are important raw materials in the production of vehicles. From the steel and aluminium alloys in the structure, to batteries and electronics, minor metals play a key role.

Described by governments as ‘strategic’ or ‘critical’ because of their exceptional characteristics, minor metals are part of the innovative solutions which will ensure a sustainable future.

European Legislation

The fleet average to be achieved by all new cars is 130 grams of CO_2 per kilometre (g/km) by 2015- with the target phased in from 2012 - and 95g/km by 2021, phased in from 2020.

If the average CO_2 emissions of a manufacturer's fleet exceed its limit value in any year from 2012, the manufacturer has to pay an excess emissions premium for each car registered. This premium amounts to €5 for the first g/km of exceedance, €15 for the second g/km, €25 for the third g/km, and €95 for each subsequent g/km. From 2019, the cost will be €95 from the first gram of exceedance onwards.

European regulation first set binding targets to reduce the CO_2 emissions of new cars in 2009 (EC Regulation No. 443/2009).

European Commission

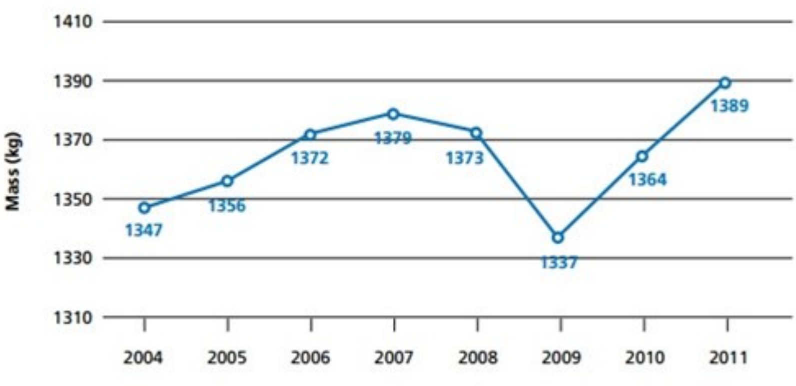
*The term 'minor metals' encompasses a vast array of metals, including tungsten, titanium, cobalt and molybdenum, to name just a few. Traditionally, minor metals were those metals not traded on formal exchanges, although cobalt and molybdenum are now traded on the London Metal Exchange along with base metals. Minor metals have a relatively low annual production volume in comparison to base metals, and very specialist, and often high technology, applications.

The Challenge

Over the last 20 years, both safety and luxury features in vehicles have increased, while at the same time legislation has been introduced to reduce emissions. Over time, heavier vehicles, combined with changes in user behaviour, have become a priority concern for vehicle manufactures.

In 2012, greenhouse gas emissions from transportation accounted for about 28% of total U.S. greenhouse gas emissions, making it the second largest contributor of U.S. greenhouse gas emissions after the electricity sector.

EPA



Evolution of the average mass of new cars registered in Europe

Source: European Environment Agency

In California more than 100,000 rechargeable cars have been sold in the last four years, representing about 40 percent of the U.S. plug-in market. The U.S. government has an ambitious target of 1 million plug-in car sales by the end of 2015.

The weight spiral

The average mass of a European vehicle has been increasing, with a small drop in 2009 when 'scrapping schemes' favoured small vehicles. Technology, safety and luxury features are proliferating with examples including; windscreen sensors, digital speedometers, parking sensors, wing mirror sensors, Bluetooth, Satellite Navigation, and headlight sensors. These, together with customer demand for bigger cars, are increasing the weight of the engine, transmission and breaks. This weight spiral, in conjunction with emissions legislation, is a big challenge for the automotive industry.

Global macro trends over the last 10-15 years such as economic growth, population increase and urban sprawl have led to increased demand for travel.

Where minor metals help

Some minor metals used - chromium, magnesium, manganese, silicon, niobium, molybdenum, tungsten

The solution

Lightweight - Lighter car structures using stronger, thinner and, therefore, lighter alloys. The use of minor metals in alloys improves their mechanical properties. For example, molybdenum added to high strength steel makes not only a high strength product, but also one with good formability and weldability, which are important qualities for automotive manufacturing processes.

Electric Vehicles - Increased adoption of electric vehicles, with benefits as follows:

- Energy security
- Fuel economy
- Infrastructure development with more charging stations installed
- Emissions reduction - with the exact figure depending on the source of electricity used to charge the vehicle

Minor metals are essential for both reducing the weight of vehicles and in electric vehicles.

The importance of weight saving was recognised early on in the automotive industry. Henry Ford's Model T was made of steel containing vanadium for strength. With its aluminium bonnet, the vehicle weighted less than 2,000 pounds (approx. 900kg) so it could meet ambitious performance targets with its 20 horsepower engine.

A more recent weight saving example is the Ford F-150 using aluminium alloys containing small amounts of chromium, copper, iron, magnesium, manganese, and silicon. This alloy has good mechanical properties, a high strength to weight ratio and corrosion resistance.

What about using more magnesium?

Used sensibly, magnesium could lighten a medium sized car by 18 to 50 kilograms depending on whether iron/steel or aluminium was replaced, if magnesium was also used in the car body and interior then the gains could be more. These figures indicate a reduced fuel consumption of around 0.1-0.25 litres/100km. [European Commission]

What happens at the vehicle end-of-life ?

For many precious and minor metals there is an economic incentive to retrieve the material at end-of-life, with strong markets for recycled metals. Designers need to consider the end-of-life of vehicles, making it easier to retrieve valuable metallic elements so they can be recycled into similar components, rather than downgrading their usage, which happens when the components cannot be fully separated.

Every year, end-of-life vehicles (ELV) generate between 7 and 8 million tonnes of waste in the EU which needs to be managed correctly. The directive on end-of-life vehicles (ELV) aims at making dismantling and recycling of ELVs more environmentally friendly. It sets clear quantified targets for reuse, recycling and recovery of the ELVs and their components. It also pushes producers to manufacture new vehicles without hazardous substances, thus promoting the reuse, recyclability and recovery of waste from vehicles.

About 75% of end-of-life vehicles, mainly metals, are recyclable in the European Union. The rest (25%) is considered waste and generally goes to landfills. Environmental legislation of the European Union requires the reduction of this waste to a maximum of 5% by 2015.

End-of-Life legislation - Global Differences

There is no U.S. federal law governing extended producer responsibility (EPR). Also known as 'product stewardship', this calls upon all parties involved in a product's life cycle (i.e., producers, manufacturers, retailers, users and disposers) to share responsibility for reducing the product's impact on the environment. The focus of most product stewardship programmes related to vehicles at the national level in the U.S. has been on voluntary measures to address contaminants of particular concern or to further specific recycling goals. [EPA]

There is also specific legislation by country in the EU, as well as similar laws in Asia. In Japan, the 2002 recycling law is based on the idea of shared responsibility with the consumers paying a fee when they buy the car. An electronic manifest helps to ensure the end-of-life vehicles are properly recycled.

South Korea, with its law of 2007, holds producers and importers responsible for their use of resources, and looks at the use of hazardous substances, recyclability of materials, collection of ELVs, recycling rates, and information exchange through an on-line database.

Looking forward

Recent news has focused on driverless vehicles as a potential 'game changer' for the automotive industry, with the current project by Google a prominent example, however it seems likely that we will have to wait a while before driverless technology means a stress-free commute.

Electric vehicles, however, are already making an impact on the market. The materials used need to be considered throughout their life cycle and the opportunity is there to recover and reuse metals and components.

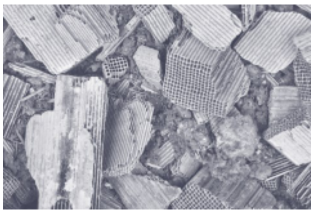
At the same time, lightweighting will continue to be a priority even with a move towards electric or hybrid vehicles. The lighter the vehicle the further it can travel on the same size battery.

Recovering battery materials

There are predictions that the lithium-ion battery recycling market will be worth £1.3bn by 2022 and Umicore has developed a low-energy smelting technology that separates the valuable elements from batteries and removes harmful toxins. The extracted cobalt, nickel and copper can then be converted into active cathode materials in the next generation of rechargeable batteries. Tesla and Toyota will use this technology to recycle lithium-ion batteries in their European all-electric and hybrid vehicles.

Numerous other minor metals are used throughout vehicles, but recycling systems still need to be developed further. Not only are lithium and cobalt used in electric car batteries, but germanium may also be used more frequently in the future. Tantalum can be found throughout a vehicle, as it is used in capacitors because of its resistance to corrosion and chemical inertness. And LED devices include alloys that incorporate gallium. These are just a few examples of the minor metals that can be found in a variety of vehicle components. (See p. 2 for other minor metal usage in an average car)

Catalytic Converters



More than ever, highly variable compositions and volatile prices of platinum (Pt), palladium (Pd), and rhodium (Rh) are important factors in the purchase and recycling of spent catalytic converters. In 2010, the global sales of Pt, Pd, and Rh totalled, respectively, 245, 299, and 27.2 tons. About 46% of the total Pt, 57% of the total Pd, and 77% of the total Rh were consumed by the automotive catalyst industry. That same year, 33.7 tons of Pt, 41.2 tons of Pd, and 7.3 tons of Rh were recovered from the recycling of spent catalytic converters, representing a total value of $3 billion at the 2010 cumulative average price of fine metals.

Promising Recycling Projects

Some recent projects to identify the economic viability of recycling minor metals in ELVs included the involvement of organizations such as EMPA (the Swiss Federal Laboratories for Materials Science and Technology), FOEN (Switzerland's Federal Office of the Environment), SARS (the Foundation Auto Recycling Switzerland), and VASSO (the Association of the Official Car Collection Proprietors). Efforts are focusing on how to process ELVs with current technologies, so that materials can be better sorted and recovered. Needless to say, some of the sought after materials are very hard to recover in comparison to others and the technology to recover these materials may not yet available.

One model that may show promise in this field is the Advance Recycling Fee (ARF). Already implemented with great success in the U.S. state of California, consumers pay a fee for electronics at the point of purchase. The fee is then placed into a state-wide fund which is then distributed to recyclers handling the electronic items at their end-of-life. This strategy is also currently implemented in Switzerland, Belgium and parts of Canada, and could possibly be applied to vehicles, especially those that are electric, to make recycling of electric ELVs more economically viable.

It should be noted that there are not many facilities that are capable of processing a wide variance in input materials containing minor metals (by-product and post-consumer). Most are in Europe and Japan, and include companies such as Boliden, Umicore and DOWA. Therefore, a massive investment in technology must be made over the proceeding decades to ensure that the processing capacity and recycling of materials found in ELVs is even possible. The U.S. may have an opportunity to lead future initiatives since it currently has zero treatment capacity for e-wastes, such as those found in ELVs, and development of new technologies would need to adhere to strict environmental regulations.

Will the recycling rates of minor metals approach those of other metals?

According to the **American Iron and Steel Institute (AISI)**, in 2004 over 14.5 million tons of steel was recycled and reused from end-of-life vehicles.

From World Aluminium - Aluminium can be recycled again and again, saving about 95% of the energy required for primary production. Over 70% of the aluminium ever produced worldwide is still in use today.

Further Reading

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