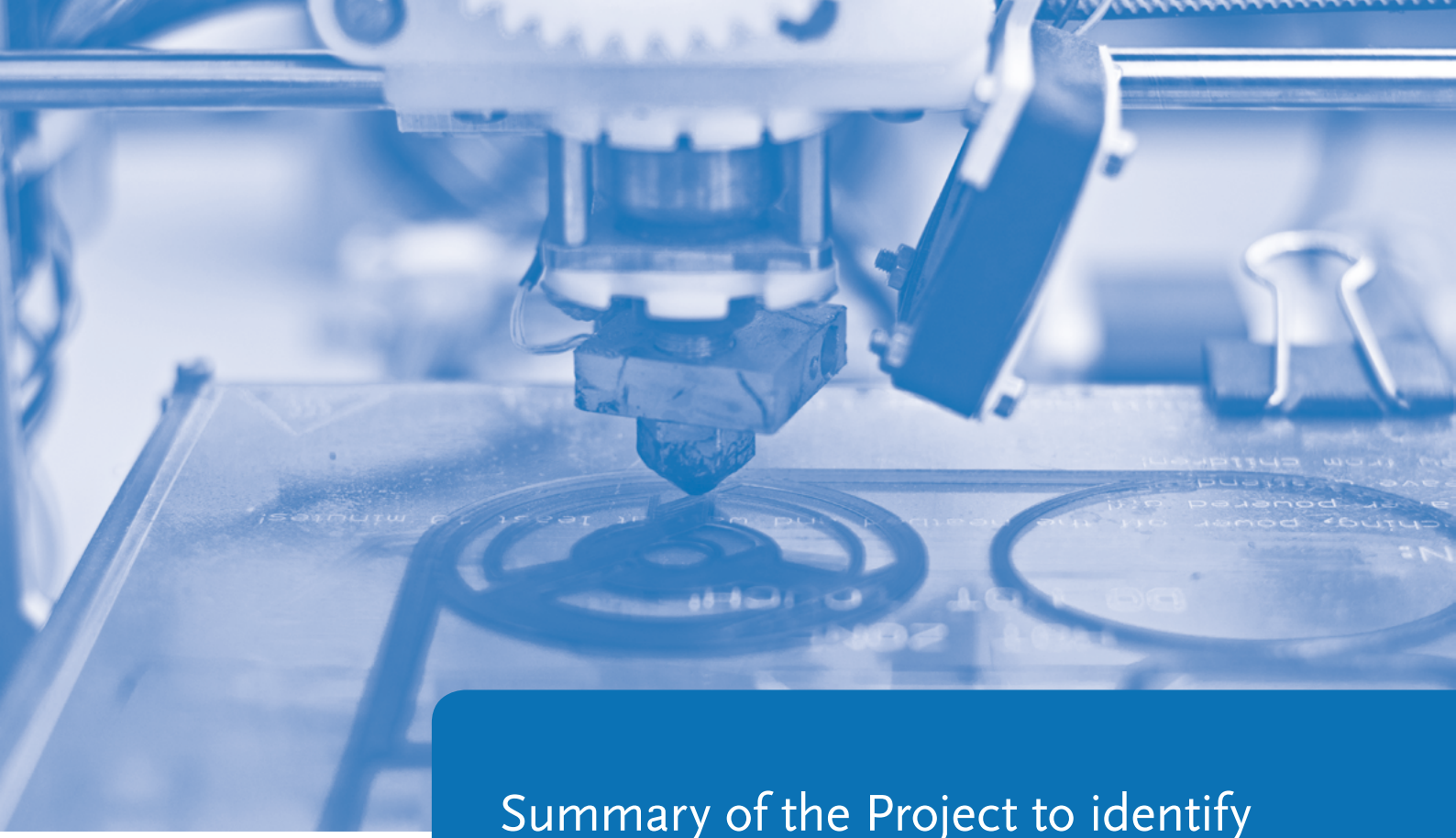

Summary of the Project to identify Substances that are used in innovative Techniques and Materials

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This publication is the executive summary of the project ‘Identification of substances that are used in innovative techniques and materials’ carried out for the Assessment Unit OSH on behalf of the Federal Institute for Occupational Safety and Health. This publication is identical with the pre-published Report entitled: “Summary of the Research Project to identify Substances that are used in innovative Techniques and Materials”.
The responsibility for the contents of this publication lies with the authors.

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Abstract

In order to carefully weigh the most appropriate risk management measures for a substance under REACH, all available information has to be considered. Especially substances that are used in innovative techniques and materials which will gain market maturity in foreseeable time it is of importance to consider potentially arising risks at an early stage. The research project generated a list of substances that matter amongst others in techniques such as 3D printing, organic semiconductors or photovoltaic and in materials like functional polymers.

Key words:

Innovative techniques and materials, REACH

Zusammenfassung des Rechercheprojektes zur Identifizierung von Stoffen, die für innovative Techniken und Materialien verwendet werden

Kurzreferat

Um Risiken, die von einem Stoff ausgehen, unter REACH reduzieren zu können, bedarf es einer umfassenden Betrachtung aller verfügbaren Informationen über diese Substanz.
Insbesondere Stoffe, die bei innovativen Techniken und Materialien zum Einsatz kommen und in absehbarer Zeit Marktreife erlangen werden, ist es wichtig bereits frühzeitig eventuell von diesen ausgehende Risiken zu identifizieren. Durch das Rechercheprojekt wurde eine Liste von Stoffen generiert, die unter anderem bei Techniken wie dem 3D-Druck, organischen Halbleitern oder Photovoltaik oder Materialien wie funktionellen Polymeren eine Rolle spielen.

Schlagwörter:

Innovative Techniken und Materialien, REACH

Desktop Search: „Identification of substances that are used in innovative techniques and materials“

According to current estimates around 70 % of all product innovations in modern industrial societies are based on new materials. The basis for these developments are on the one hand new materials and substances classes such as organic semiconductors, and on the other hand material modifications that can be achieved for example by nanostructuring, surface functionalization or coatings. Some material developments are directly coupled with innovative production technologies such as 3D printing or printed electronics.

New material developments can be a challenge from the point of view of chemical safety and occupational health. Generally the REACH legislation constitutes the framework for the European market to ensure that chemicals are safe for humans and the environment. However, especially in emerging technologies the production volume of new substances often falls below the threshold quantities for REACH. Therefore, there is usually little transparency with new technologies and new materials which substances are used in what quantities and in what applications. This can be problematic because dynamic market developments may cause a rapid increase in production and quantities of substances. Against this background, it was the goal of the desktop search to provide an overview of innovative techniques and materials for which a significant increase of market significance can be expected in the next years. To obtain a list of priorities that focuses and facilitates the selection of materials to be viewed, a substance list was generated, where relevant substances used in innovative materials or techniques are listed. The generated list of substances may provide clues to specifically identify those substances that are relevant with regard to occupational health and safety aspects in the production or use.

Methodologically, this study was based mainly on desktop searches. The sources of information comprised monitoring studies as well as technology and market analyses, which describe technological developments and trends in recent years with comprehensive outlook in the near future. This information was supplemented by searches in relevant literature and patent databases. The selection of the examined technology fields was carried out from a larger pool of technological topics by evaluating the criteria of market dynamics and the relevance of new material developments. As a result, the selection phase delivered a pool of about 50 topics that have been evaluated most significant in terms of market potential and material relevance. Out of this pool of topics 20 technological fields were selected for further investigations. Due to limited resources a focus on a limited number of technology fields was necessary in order to achieve a sufficient depth for substance identification and description of the relevant production processes.

Each of the 20 selected technological fields were analysed according to the following criteria:

- Short description of the technology field
- Applications and markets (products, market readiness and market potential)
- Methods and processes (chemical synthesis, production, processing)
- Applied materials (chemicals, additives, solvents, material mixtures)
- Selection of relevant companies and institutions in Germany

The selected topics cover a representative sample of the broad spectrum of technologies and industrial applications fields of new materials. The study investigated examples of new production technologies and processes, new materials applications in the fields of electronics and information technology, construction and lightweight technology, energy and environmental engineering as well as textile engineering. In addition cross-cutting technologies, such as surface modifications and new functional materials were analyzed.

The topics included on one side technologies where established substances and materials are used in a new application and product context as a consequence of new kind of production processes such as 3D printing, or find an increased industrial use due to social or market-driven developments (e.g. the increased demand for fiber-reinforced plastics as a consequence of increasing energy costs and measures of energy-saving policies). On the other hand, new material developments are addressed, that find an increasing spread in industrial mass markets due to advanced technological maturity. In this category, for example, organic semiconductors can be mentioned which are on the edge of a broad commercialization for applications like organic light-emitting diodes or organic photovoltaics as well as functional polymers in the application field of medical technology. An overview on the selected technology fields can be found in table 1. The topic micro reaction technology constitutes a special case, because it is not directly connected to the use of new materials but represents an alternative process technology for the production of specialty chemicals. Because the different process routes of micro reaction techniques may have implications on issues of worker protection, the topic has been included in the selection list.

Table 1 Overview on selected technologies

New production technology and processes
• **3D printing:** Generative production method (also called additive manufacturing), in which real three-dimensional objects of polymers, metals or ceramics can directly produced from digital data (3D CAD).
Electronics/ information technology
• **OLEDs** ("organic light emitting diode") are surface-emitting light sources based on semiconducting organic molecules or polymers e.g. for displays, monitors and lighting.
• **Printable electronics:** Electronic components or circuits manufactured by printing processes of inorganic and especially organic conducting and semiconducting materials.
• **Power electronics:** Electronics based on compound semiconductors for optoelectronic and sensor applications as well as high temperature and high voltage applications.
• **Glass fiber materials** as light wave guides for optical data transmission, fiber optical sensors, lighting or energy transmission (e. g. laser beams).
Construction/ lightweight engineering
• **New adhesives:** Adhesives with additional functions such as switchability and reverseability, electrical conductivity or biological functionalities.
• **Metallic matrix composites:** Materials with a metal matrix and a discontinous ceramic or organic reinforcement phase (fibers, whiskers, particles) e.g. for automotive, aerospace and engineering applications.
• **Glass and carbon fiber reinforced polymers** as lightweight material for construction and engineering.
Energy and environmental engineering
• **Organic photovoltaics:** Photovoltaics based on organic substances (e.g. polymer semiconductor, organic dyes) as light and flexible foils for mobile applications such as smartphones, laptops, tablets, new design concepts in architecture or in the automotive sector.
• **Chemical heat storage:** Thermochemical and latent heat storage by using e.g. phase change materials or adsorption materials (zeolites, silica gels, salts).
• **Membranes/ filters** for air and water cleaning (ceramic and polymer membrane filter, surface functionalized fabric filters).
• **Chemical hydrogen storage** based e. g. on metal hydrides or metal organic compounds for applications in automotive and energy sector.
Textile technologies
• **Technical textiles:** Textile fibers and fabrics for industrial applications (e.g. building substructures, membranes for light structures, isolation materials, filters, etc.)
• **Functional textiles/intelligent textiles:** Functionalized textile fibers and fabrics for personal use (e.g. body armor textiles, integrated sensors and electronics for health-monitoring of workers, medical or sports applications).
Surface functionalization and functional materials
• **Switchable shading systems** based on substances that change their optical properties depending on physicochemical parameters (e.g. electrical current or temperature).

• **Polymeric foils** for car wrapping and other applications (e.g. foils for façade elements).
• **Wear protection coatings** for tools and machines (e.g. diamond like carbon, hard metal and ceramic coatings).
• **New lacquers** (e.g. high-solid-lacquers, UV curing lacquers, solvent free coatings).
• **Functional polymers** for medical technology e.g. materials and disposables for diagnostics, wound management or regenerative medicine.
Other topics
• **Micro reaction techniques** as alternative route to synthesize chemicals (e. g. for modular chemical plants)

Many of the technologies presented are based on the use of materials that can contribute to improved resource efficiency. A number of lightweight materials are composed of organic or polymeric compounds such as fiber composite materials, textiles and functional polymers that increase the energy efficiency in many industrial applications such as aerospace and automotive engineering or wind turbines. Some technologies such as 3D printing, micro reaction technology, organic light emitting diodes, printable electronics, organic photovoltaics and wear-resistant coatings for tools and machines require less amounts of material (material savings) or energy (energy saving) compared to conventional technologies. Also new materials for paints, adhesives, polymer films and functional textiles have been analyzed that can be made from sustainable, non-fossil fuels (renewable resources). In addition, these materials are often more environment-friendly due to their biodegradability and low solvent load. Furthermore, energy technologies such as thermal energy storage and hydrogen storage are described, which play a central role in sustainable and renewable energy.

For the analysis some 400 references such as scientific publications, market studies and manufacturer information have been evaluated and cited. The individual substances and materials were each assigned to categories with regard to the material class or the respective functions of the material/substance in the observed field of technology. For the substances identified data for registration and classification under the REACH and CLP regulation were extracted from the ECHA databases and compiled in an Excel list. As a result of the analyses, around 470 different substances/materials were compiled that are manufactured or processed within the value chain of the various technological fields described. For two-thirds of the entries, a material assignment on the basis of the CAS number could be made. The remaining materials were substance combinations or complex mixtures, such as composite coatings or alloys for which no CAS number could be assigned. About 130 of the identified substances were registered under REACH and about 80 substances classified under the CLP regulation.

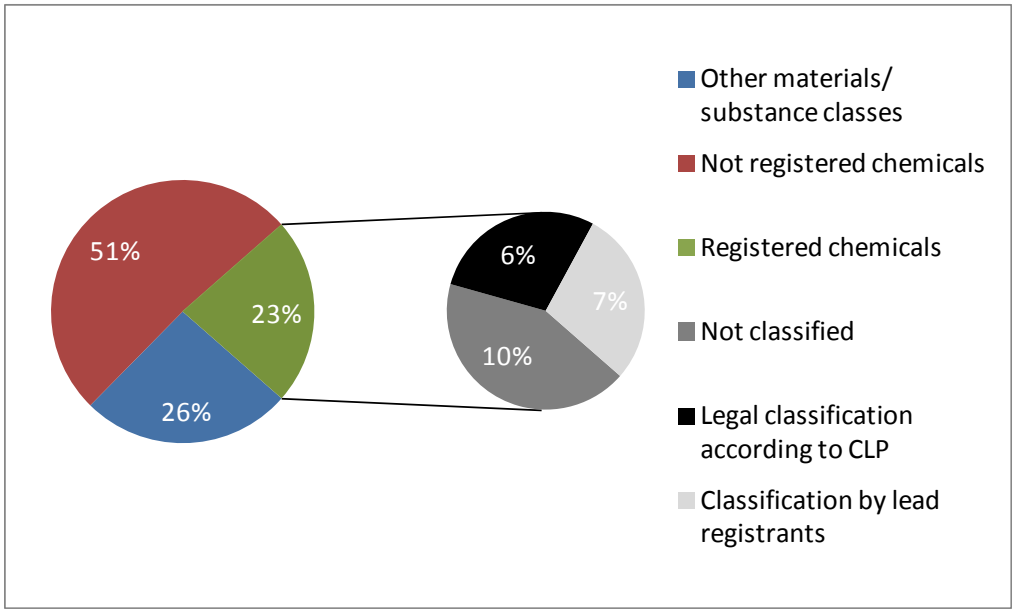

Figure 1 Overview on identified substances and materials (total number 470)

Because of the broad scope of the search and the variety and complexity of material developments only an overview of the most important and typical substances and materials could be given within the limited resources. The identification of substances was predominantly carried out by the analysis of the technological state of the art described in scientific publications and market studies. Concrete product formulations of commercial products have been taken into account when available. Because material developments in new technology areas have a high dynamics in terms of material and process optimization and competitive process solutions, the search results can be seen as a snapshot. However, the results give a good overview on relevant trends in the use of new materials and technologies.

In summary, the desktop search contributes to improved transparency in the use of new materials and substances in innovative technology fields. Furthermore, the descriptions of the technology fields in terms of applications and markets, procedures and processes, materials applied, as well as a selection of relevant companies and institutions, allow for a prioritization and selection of topics which might be further evaluated with regard of worker protection aspects. The use of new materials in innovative technology fields offers both opportunities and challenges for occupational safety. New developments in materials, for example, help to minimize the use of hazardous materials in the work process (e.g. solvent-free paints) or to substitute material (e. g. replacement of heavy metals in coatings). On the other hand, new production techniques can also lead to changes in work processes and production patterns in the use of chemicals that may need to be reevaluated in terms of worker safety. An example to mention here is the decentralization of industrial production through 3D printing where processes usually take place under less defined conditions as in big industrial plants. Also changed joining and processing procedures due to the replacement of metallic materials by fiber-reinforced plastic composites may have to be further evaluated. To examine the impact of these new technologies and materials to health and safety, however, was not within the scope of the desktop search.