DANISH MINISTRY
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Survey of nanotechnological consumer products

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Preface

These years, the industrialized countries invest heavily in nanotechnology and consequently the area is progressing with great speed. Almost every day new industrial prospects are presented in this area. However, as the nanotechnological products are increasingly developed for the consumer market, the Danish Environmental Protection Agency (DEPA) tendered a "Survey of products which contain nanoparticles or which are based on nanotechnology". The survey is performed by DHI – Institute for Water and Environment (DHI) in cooperation with Institute for Environment and Resources of DTU.

The consumer product market is very dynamic and the turnover is quick. Already when this project was finalized in early2007, some of the products mentioned in this report had disappeared from the market and new products appeared that are not covered by this survey. Due to this, the conclusions of the project concentrate more on product groups and development tendencies rather than individual products.

In Denmark there are no full-scale production of nanoparticles for use in consumer products and nanotechnologically based articles are imported primarily directly as final products or for the production of own products.

Participants:
Anja Kamper (product survey)
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Frank Stuer-Lauridsen (Project Mangement)
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The work has been supervised by a steering committee consisting of:
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Representatives of the DEPA occupational groups:
Anne-Mette Jørgensen, Poul Bo Larsen, Flemming Ingerslev and representatives of the Project Group. The Steering Committee meetings are held in March, July, September and November.

The actors of the market, among these both individual companies and trade associations have contributed very constructively to the project. The innovative environment, research institutions and authorities have shown great interest in the project and we thank them all for their positive engagement.

The report was closed for contributions in January 2007.

Conclusions

These years, the industrialized countries invest heavily in nanotechnology and consequently the area is progressing with great speed. Almost every day new industrial prospects are presented in this area. However, as the nanotechnological products are increasingly developed for the consumer market, the Danish Environmental Protection Agency (DEPA) tendered a "Survey of products which contain nanoparticles or which are based on nanotechnology". The present survey was performed by DHI – Institute for Water and Environment (DHI) in cooperation with Institute for Environment and Resources of DTU.

Survey of actors and consumer products

The primary source of information was interviews and questionnaires to the actors in Denmark, internet searches and follow-up on search results of consumer products in an American database ('A Nanotechnology Consumer Products Inventory' called the Woodrow Wilson database). Focus were only to consumer products where the user is exposed to nanotechnology by general use, e.g. are electronic products with nanotechnologically produced memory chips deep inside the product not included, whereas tennis rackets and golf balls with nanotechnologically treated surfaces are.

Typically, the consulted trade associations in Denmark do not have information on their member's nanoproducts and they report that until now the activity with respect to production, formulation or import of consumer products containing nanomaterials seem to be limited. An exception is the Association of Danish Cosmetics, Toiletries, Soap and Detergent Industries (SPT), which has already treated nanotechnology on their meetings and mini conferences. On these meetings the foucs was on assessment of possible health effects. However, the associations report an increasing number of inquiries about possibilities and regulations of nanotechnology.

The primary Danish actors are a number of Danish companies with net shops, specializing in products for surface treatment for industry and consumers and a number of producers and suppliers of cosmetics whose brands are found in the retail trade. Generally, distributors of branded goods, for example sports clothes and electronics may also market articles containing nanotechnology.

The survey is based on direct contact to the supply chain and publicly available information such as advertisments, web pages, brochures etc. There is no legal requirement to producers or importers of products to declare the content of nanomaterials. Therefore, it is not possbile to be certain that a producer or importer who uses the prefix 'nano' in association with a product are referring to a content of nanoparticles, a nanometer thin surface layer of materials or whether it is the technology behind the product that is 'nano'. The likelihood that 'nano' is used in advertisement without a background in real nanotechnology is assessed as minimal.

The survey found 243 products based on a nanomaterial on the Danish consumer market. The searches for Danish importers and distributors of

products in the Woodrow Wilson database and Danish web shops selling these articles showed that generally two out of three products registered in the U.S.A. are for sale in Denmark.

There are products on the market containing nanomaterials, especially within surface treatment, cosmetics and sport equipment. Within the areas of surface treatment for cars and houses the Danish market is very dynamic and considerably more products are registered in Denmark than in the U.S.A.

More than two thirds of the products on the Danish market – 154 pcs. - are variuos liquid products partly for surface treatment of a great number of materials such as glass, concrete, metal (especially car maintenance) glass fibres and textiles and partly skin protection products, especially sun lotions. The remaining products are especially sporting goods- and clothing, which account for 60 out of the 99 remaining products. Here the nanomaterial is structurally encapsulated in the product, e.g. in golf balls or tennis rackets.

More than half of the consumer products on the Danish market are products from Europe. Out of the 135 European products on the Danish market, almost 100 come from Germany. The remaining originates in United Kingdom, Finland and France. Three products are sun lotions formulated in Denmark.

In 202 out of 243 products it was not possible to identify the nanomaterial in the product. Of the 41 known nanomaterials, half of them were found in cosmetics products (six products with zinc oxide and 13 with titanium dioxide), 10 with antibacterial silver in textiles and home appliances, and 12 with carbon tubes or balls (seven with carbon tubes in sporting goods and five with fullerenes in cosmetics).

Titanium dioxide was assessed by the European Commission's Scientific Committee on Consumer Products (SCCP) to be safe for consumers when used in sunscreens in concentrations up to 25% regardless of the particle size. Zinc oxide is accepted for use as a colouring agent, but it is not allowed for use as a UV filter in cosmetic products. Silver as a biocide is under risk assessment in the EU. It is assumed that fullerenes are imported with products formulated outside the EU.

A considerable part of the consumer products are sold in web shops in Denmark and abroad, especially products for surface treatment within the product types `Car accessories', 'Home and gardening' and 'Personal care and sports equipment', but a smaller increasing part are found in street shops.

Paints are particular products in relation to nanomaterials. In certain black paints 'carbon black' (20-100 nm) is applied as colouring agent, and in some paints the thickening agent silica is used in nano size (down to approx. 10 nm). Both these materials have been used for a number of years, but are only now recognized as nanomaterials. In the Danish Product Register a great number of individual products are registered with carbon black (approx. 9,500) or silicium dioxide (approx. 15,500). It cannot be established how many of the products actually contain nanomaterials since it is not registered whether the substances occur as larger particle, nanosized particles, in liquid or solid form. The registered amounts used in paints are 483 tons carbon black and 622 tons silicium dioxide. The individual products containing these materials have not been further analysed.

Consumer exposure to products containing nanomaterials

A risk assessment of nanomaterials in consumer products would normally be based on a hazard assessment of the relevant nano-sized chemical substances in the products, and the first challenge here would be to identify the chemical substances found in the products and their concentration. This information is available from the producer, but the information of the chemical substance and the characteristics of it are confidential. Therefore, information of the composition of the specific surveyed products could not be obtained.

If the identity of the nano-sized chemical substances was known, the next challenge would be to identify toxicological effects of the substances. There are very few available data on nanomaterials, and the toxicity of nanoparticles may depend on e.g. the surface area of the substance rather than on the dose.

Due to this and to prioritize the efforts made with certain types of products, an assessment of the exposure potential for the surveyed products has been developed.

Since the exposure scenarios are based on the available information they are somewhat theoretical. It is not possible to estimate a risk associated with the use of the products since it may not be known whether nanosized substances are in fact absorbed in humans. Regarding sunscreens titanium dioxide has been used for a number of years. The European Commission's Scientific Committee on Consumer Products has assessed the use to be safe for consumers.

The nanomaterial in most products on the Danish market is found in the category 'Nanoparticles suspended in liquids' that comprises the many products for surface treatment. The remaining products are categorized as 'Nanoparticles encapsulated in solid materials', 'Film in nanometre thickness', 'Surface-bound nanoparticles' and 'Nanostructured film', where the nanomaterial is often encapsulated in or bound to the surface. No consumer products containing nanomaterials in free form have been found.

An assessment shows that the risk of exposure to the consumers is greatest from products of the category 'Nanoparticles suspended in liquids', because it is a liquid product for e.g. surface treatment or cosmetic application to the skin. Products in spray form must be expected to cause exposure both by inhalation and by dermal contact – however, only a few spray products were found (with pumps, not with gas propellants).

According to the actors of the market, nanomaterials do no appear in the products in concentrations demanding labelling or classification. Thus, there is no available information on the active nano material in the products. Safety data sheets on the remaining ingredients of the products can often be provided as well as a producer declaration about the general characteristics of the nanomaterial.

1 Introduction to survey of nanotechnological consumer products

1.1 What is nanotechnology?

It takes 1 million nanometre (nm) to equal 1 millimetre, and nanotechnology is based on controlled processes effective from approx. 0.1 nm to 100 m. The new technology is a so called 'enabling technology' and will form the foundation of many other new technologies and products within the areas of materials science, environment and health. Almost all industrialized countries including India, China are making huge investments in nanotechnological research (COM, 2004). Also in Denmark research and development within nanotechnology is expanding rapidly. Publications and electronic media often report fantastic possibilities of revolutionary treatment of diseases with nano knives, nano measuring instruments in the bloodstream or fixed in the packaging of foodstuffs, surface treated materials that never require cleaning, windows with built-in invisible Venetian blinds, etc. etc.

Many of these 'nano visions' will only perhaps come true, but it is certain that the technical possibilities do exist. With this new technology we can develop materials, in which the placing of each individual atom and molecule is controlled. Generally, it means that a product based on the reactions of chemical substances is working much more precisely and effectively in a nano-shape than in a product based on traditional chemistry (Davis 2005). This means that it is much easier controlled to design the properties of a chemical substance, and for instance the developers are far ahead with nanoparticles that are a temperature sensitive chemical indicator or that show a colour code by contact with Salmonella in foodstuffs.

Styregruppen for Teknologisk Fremsyn (The Steering Group of Technological Foresight in Denmark) defined in 2004 nanotechnology as: "The ability to work on the atomar, molecular and supramolecular level on a scale from 0.1 to 100 nm to design, produce, manipulate and apply materials, components and systems with new physical chemicals and biological functional properties. These new properties appear due to the small scale of the structure, and cannot be acquired in any other way".

Nanoparticles as a product of nanotechnology were defined by Oberdörster et al. (2005) as "a particle constructed or produced by humans in nanoscale with specific physiochemical composition and structure to make use of properties and functions related to these dimensions".

As nanoparticles intuitively are considered as a terminated more or less spatial entity, it is difficult to relate the expression to surface treatments, tubes and fibres. Consequently, we have in this report chosen to use the expression nanomaterials about nanotechnologically produced products generally. The expression nanotechnology is used about the processes behind. The

designation ‘Nanoparticles’ is used about nanomaterials with particle character.

1.2 The consumer market for nanotechnological products

The path from development to product or from research to invoice may be short when speaking about nanotechnology. Every year, the web magazine, Nanotech Briefs, nominates the 50 most interesting nanotechnologies-products, -and developers (NASA 2006) of the year. Even if these leading edge products have only been known for some months, surface treatments and sports equipment are found in the consumer market. The great bustle is the USA (Woodrow Willson Centre 2006) and Asia (Nano Frum 2006), but also in the EU the market for consumer products based on a nanotechnological platform is prosperous.

For several years, the magazine Forbes has nominated the product with the greatest potential among the consumer products based on nanotechnology. The below table shows the latest nominated, and it is clear that the commentator Josh Wolfe, who prepares the list often chooses correct – both iPod, cosmetics, sporting goods, textiles, paint and windshield treatment are marketed and sold because of their nanotechnological properties.

Table 1: Top 10 consumer products based on nanotechnology from Forbes (2006)

2004	2005
Foot warmers (nanogel)	i-Pod Nano
Top mattress with surface treatment	Health oil with nano encapsulated vitamins.
Golf ball and club	Chocolate chewing gum
Skin lotion (anti-aging)	Skin lotion
Wound cleaning plaster	Baseball bat
Lotion for muscle pains	Surface treated jackets
Disinfectant	Anti-respiratory socks
Waterrepellant paint	Non-cleaning paint
Glue for tooth enamel	Self-cleaning glass
Nanofilm for windshields	Air cleaner

Nanotechnology is not attached to particular productions or types of products and it is often emphasized that the technology can be applied in almost all possible trades and products as an enabling technology. However, the main part of the consumer products seems to be cosmetics, a number of products for different surface treatments and sporting goods.

For many years, companies within cosmetics and “health care” have come very far with their product development and it is assumed that this type of consumer products will be marketed considerably during the coming 5-10 year. In addition, it is expected that areas in line with the consumer products, such as medical devices and implants, veterinary and human pharmaceuticals as well as biocides/pesticides will be deeply affected by the nanotechnology during the same period. (Luther 2004). They are fields of application that also influence humans direct or indirectly. Some of the products will also find their way to the market as consumer products as is the case with band aid containing nano-crystalline silver.

1.3 Legislation in brief

The chemicals legislation specifies a number of demands for classification and labelling of existing chemical substances based on the effects to man and the environment. Generally, the triviality limit for classification is 0.1%, indicated as the content of the chemical substance in the product. Under this limit there is no demand for classification and labelling of chemical substances regardless of toxicity (with few exceptions). Existing nano-sized substances will be classified and labelled as the corresponding substance in bulk form, despite of its different characteristics.

Introduction of a new chemical to the European market requires specific documentation depending on the application and quantity of the produced/imported chemical. If a nano-sized chemical is a new chemical substance, the existing notification procedure for new chemical substances[1] will apply.

In the REACH legislation, the lowest tonnage limit for registration is 1 tonne per producer or importer per year both for existing substances and new chemical substances.

The cosmetic products are covered by a specific legislation, where an assessment of the substances is carried out by the European Commission's Scientific Committee on Consumer Products (SCCP) before a regulation is decided. SCCP has compiled and used information on particles in the nanosize range in the assessment of titanium dioxide and zinc oxide as UV-filters in sun lotion[2].

Basically, it is the producer or the importer of a cosmetic product who has the responsibility only to market products safe for consumer's health. Their assessment must be documented by a dossier available to the authorities (DEPA). For cosmetic products the regulation also stipulates that ingredients must be declared on the product.

The product safety legislation is a consumer protection legislation to ensure only products that are not dangerous are marketed. When marketing a product the origin and name and address of the previous link in the product chain must be documented. If producers and distributors know that a product marketed by them is risk-bearing to the consumer they must at once advise the control authorities with information about the measures taken to prevent the risks to the consumers. In principle, the legislation for product safety should comprise all safety aspects connected to possible nanoproducts that are not comprised by other special legislation.

1.4 Categorization

The survey collected information on the products sold by the individual companies and on the quantity sold in the Danish market. In addition and if possible also information on the product composition as well as the percentage share of the ingredients in the product will be collected. To obtain

[1] Statury Order no. 928 of 19/11/2002

[2] Titanium dioxide was assessed by the European Commission's Scientific Committee on Consumer Products (SCCP) to be safe for consumers when used in sunscreens in concentrations up to 25% regardless of the particle size. Zinc oxide is accepted for use as a colouring agent, but it is not allowed for use as a UV filter in cosmetic products.

a systematized survey, various products containing nanoparticles and nanotechnology will be divided and categorized in the following product types concurrently with identification of them.

I a.	Solid substance with nanostructure in one phase
I b.	Solid substance with nanostructure in several phases
II a.	Materials with nanostructure surfaces
II b.	Film of nanometer thickness
II c.	Nanostructured films
III a.	Surface-bound nanoparticles
III b.	Nanoparticles suspended in liquids
III c.	Nanoparticles suspended in solids
III d.	Airborne nanoparticles

This categorization of nanomaterials is based on developmental work made by DTU (Hansen et al., 2007). The basic method in the survey is to describe human exposure to nanomaterials in products by: 1) nanomaterials are characterized by means of a categorization developed by DTU, 2) The categorization is linked to the use of the product and 3) typical exposure by normal use.

When categorizing the products in the American edition of the Woodrow Wilson database they are divided as follows: 2, 10 and 75 % in the categories bulk (I), surface (II) and particle (III). A categorization of the remaining products is not possible.

Consumer products may very well fall under to different categories during its cycle of life. As an example, a product for surface treatment of bathroom tiles will typically be sold as a liquid in a bottle, e.g. III b. ‘Nanoparticles suspended in liquids’, but when used on the tiles and forming a new surface, it is categorized in III a. ‘Surface-bound nanoparticles’.

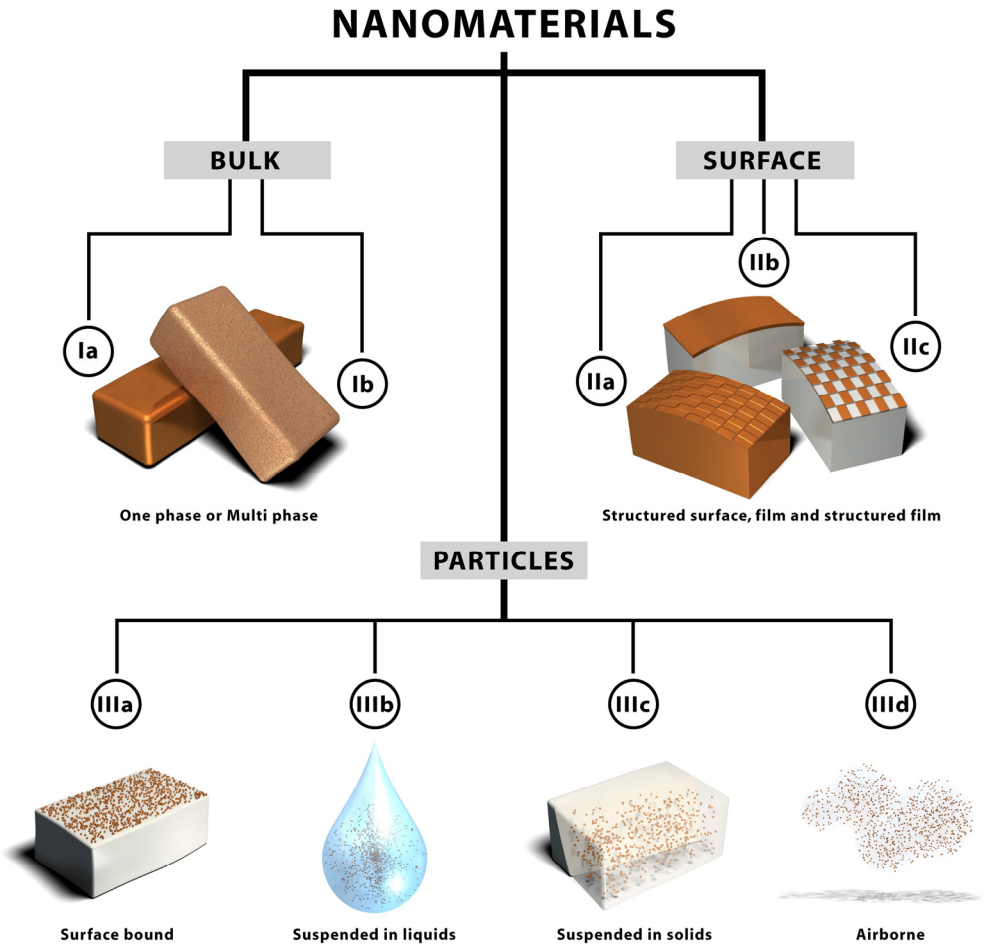


Figure 1 Categorization of nanomaterials based on DTU's developmental work (Hansen et al., 2007)

Main category I is divided into the sub categories Ia and Ib. The nano-systems of category Ia consist of a single type of material, and the systems of category Ib of two or more ingredients/materials. Examples of systems categorized in Ia is nanocrystalline copper, and the materials in category Ib include ceramic zeolites which are used as support material in industrial catalysts nanoporous materials, i.e. one on the components in the nanostructure is air.

In category II, the nanostructure is placed on the surface (See Figure 1). Category II can be divided into three subcategories: IIa (structured surface on nanoscale level and surface and solid of the same material); IIb (unstructured nano-thick film on a substrate of another material, e.g. coatings on windows); and IIc (structured film on a substrate with the film being either nano-scale in thickness or the surface structure has nanoscale dimensions.) Many of the reading/writing heads applied on hard disks and lab-on-a-chip systems are categorized under IIc.

Category III contains nanoparticles in free structures, the size of which is nanoscale level in at least two dimensions, which are quantum dots, fullerenes, nanotubes and nanofibres. The subcategories of III have been established in accordance with the carrier vehicle of the nanoparticles. Category IIIa contains nanoparticles bound to the surface of another solid structure, e.g. heterogenous catalysts. Category IIIb comprise systems, in which the nanoparticles have been suspended in a liquid such as titanium dioxide in

cosmetics. IIIc is nanoparticles suspended in a solid substance, e.g. carbon tubes in tennis rackets. The last and fourth category, IIId consists of airborne nanoparticles – e.g. free carbon nanotubes or fullerenes, which will probably not appear in consumer products.

1.5 Objective and reading instructions

With reference to the tender of the DEPA, the objective of this project is to prepare a survey of consumer products on the Danish market that contain nanoparticles or are based on nanotechnology and the possible health problems caused by the use of nanoparticles or nanotechnology.

The report contains a survey of the actors on the consumer market followed by a list of the product on the Danish market. In chapter 4 is given a first attempt to calculate the exposure to nanomaterials from different products.

The attachments comprise the methods of the survey, the exposure estimtes and the database on the consumer products.

Consumer products may contain a great number of components, of which some may be produced in a nanotechnological process, e.g. chips in electronics. It has been decided only to focus on products that may cause exposure to the consumer directly via exposure to the nanomaterial in the product.

Attention should be drawn to the fact that the consumer products of the Danish Environmental Protection Agency do not include pesticides or biocides, pharmaceuticals and medical devices, foodstuffs and devices for the manufacture, preparation and storage of foodstuffs.

2 Survey of actors on the Danish market

2.1 Producers and the innovative environment

Consumer products – innovation and nanotechnology in Denmark

In "Teknologisk Fremsyn om Nanoteknologi"(Technological Vision on Nanotechnology) (VTU, 2004), Danish "nano companies" were identified (see also Andersen and Rasmussen, 2006). However, several of these companies are not believed to be active within nanotechnology but can be regarded as interested in the potentials of the nanotechnology. Andersen (2006) mentions that the prevailing focus of nanotechnology in Denmark today is mainly research and development. The interaction between the nano research institutions and the companies is considered weak except in specific focus areas such as the nanocatalyst area with Haldor Topsøe A/S as the industrial partner. Andersen (2006) estimates that less than 10 of the important Danish companies are involved in nanoscience/-technology.

In connection with the "Technological Vision" (VTU, 2004), a total of 58 Danish development companies were identified by Danish nano researchers. These companies do not produce consumer products and the Danish companies within nanotechnological products in development are aiming more at business to business products than regular consumer products.

Table 2: Number of Danish companies categorized according to general nanotechnological areas (Andersen, 2006)

Technological areas	Number of Danish companies
Polymer electronics/fotonics	10
Monitoring & diagnosis	25
Nanostructured surfaces	15
Nanocomposite materials	6
Nanoporous materials	3
Nanoparticles/-fibres	2
Energy production	2
Catalytic production of chemicals	1
Catalytic air cleaning	4
Other separation- /cleaning processes	7

A number of established Danish production plants do research in nanotechnology and will be able to develop products that in a couple of years may be on the consumer market either directly or as suppliers to other producers. Judged by the product profile of the companies, their participation in the Nano-networking Group of Danish Standards and their applications and projects to "Højteknologifonden", Velux, Hempel, Dyrup, Coloplast, Aalborg Portland and Fibertex are examples of such companies.

2.2 Industry and trade organisations

The survey project has made direct contact with different trade associations in order to identify important actors within the different trades and if possible also the marketed nanoproducts. The results of these contacts are reported in the following. Information on products is included in the database and is reported in chapter 3. The selected trade associations are considered to represent the trades that are at the front within nanotechnology in consumer products.

The Association of Danish Cosmetics, Toiletries, Soap and Detergent Industries (SPT)

Already today SPT's members apply nanoparticles, typically titanium dioxide in their products and the substance is applied primarily in sun lotions. Also, liposomes/nanosomes (encapsulated active substance) and nanoemulsions (water-oil detergent) are applied.

During the project, SPT has inquired their members directly about which products the individual members produce and/or distribute. According to SPT, the development of the products containing nanomaterials is discussed on the meetings of the trade association, but a specific strategy or common development platform does not exist.

The Federation of Danish Textile and Clothing (DTB)

DTB works closely together with "Videncenter for Intelligente tekstiler" (Center of Intelligent textiles) in this area and has no independent activities or knowledge of member activities. The Center offers consultancy to Danish companies about newly developed textiles and future products within the area.

Intelligent textiles are a very fast developing area in the U.S.A., United Kingdom and Germany, and the potentials are considered very large. The intelligent clothing and textiles of the future will be based on electronic textiles, 'nano'–treated textiles and new functional materials. For example can be mentioned: baby clothes with alarm, if the baby is not breathing. Bags checking if you have remembered your keys and cigarettes. Sport clothing with sensors that measure puls and liquid condition. Clothing with bacteria-restraining substances that kill infections, for instance in working clothes. According to the Centre, particularly nano-treated working clothes will be launched on the Danish market within very few years.

The Association for Glue and Filler, the Danish Paintmakers' Association (FDLF)

Apart from pigments such as carbon black and the thickener silica that have been used for decades, the trade association does not yet expect its members to use the nanotechnology. However, the association is familiar with members that have started ordering raw material samples containing nanoparticles or nanotechnology for individual Danish companies.

Danish Association for Trade and Distribution of Chemicals

The association does not collect information about the possible nanotechnologically based products of the members.

2.3 Suppliers of finished goods for consumers

A number of Danish actors are Danish companies with web shops especially supplying product for surface treatment, for example NanoCover, Nanosalg TCnano, Nano-tec and NanoRen.

A number of Danish producers of cosmetics are marketing own brands and ´private labels' which are found in the retail trade (e.g. Persano, Blumøller) Also suppliers of internationally branded goods may have products containing nanomaterials in their collections (for example from Lancôme or L'Oreal).

Generally distributors of branded goods, for example of sports clothing and sporting goods or electronics may also easily shelve articles containing nanotechnology (See also Attachment C)

3 Survey of products

3.1 Product areas

The survey of consumer products is based on direct contact with suppliers or use of information sources, e.g. the internet, advertising etc. There is no legal requirement to producers or importers of products to declare the content of nanomaterials. Therefore, it is not possbile to be certain that a producer or importer who uses the prefix 'nano' in association with a product are referring to a content of nanoparticles, a nanometer thin surface layer that is formed upon use, a nanotechnological function expressed when used or whether it is the technolgy behind the product that is 'nano'. The likelihood that 'nano' is used in advertisement without a background in real nanotechnology is assessed as minimal.

Among other things, identification of products was based on the database "A Nanotechnology Consumer Products Inventory[3]", which is a cooperation between the Woodrow Wilson International Center for Scholars and Pew Charitable Trusts. The products in this database (356 in November 2006), which is updated regularly fulfills mainly the following conditions: The products can be purchased directly by the consumers or identified by the producer or another source as based on nanotechnology and the information about nanomaterials in the product seems probable.

The database categorizes the products as follows:

- Appliances (heating, cooling and air; large kitchen appliances, air cleaners and air condition devices, domestic appliances, bio-up and textile protection products)
- Automotive(exterior) maintenance and accessories)
- Goods for children (basics; toys and games)
- Electronics and computers (audio; cameras and film, computer hardware; display; mobile devices and communications, television; video)
- Foodstuffs (cooking, foodstuffs, storage, dietary supplement)
- Health and fitness (clothing, cosmetics, filtration, personal care, sporting goods, sun screen)
- Home and garden (cleaning, construction materials, home furnishings; luxury products; paint)
- Surface treatment (overlapping several groups)

The survey investigates if the products registered in the database are also marketed in Denmark or may be available through a web shop. We have registered if products, which are not sold in Denmark at present, are sold in our neighbouring countries and may be imported to Denmark through cross-frontier shopping, or if they may be introduced into the Danish market later on.

[3] The Woodrow Wilson database (http://.nanotechproject.org/44/consumer-nanotechnology) compiled in "The Project on Emerging Nanotechnologies"

3.2 Status in Denmark at the start of 2006

In the start of the survey in 2006, the American market showed approx. 80 consumer products (Bullis, 2005). Soon after the establishment of the American Woodrow Wilson database, a considerable number of consumer products were registered: 8 March 2006: 212, in the middle of May 2006: 276 and by the end of the project in the beginning of November 2006 356 products were registered.

Already in 2005 the first Danish specialized web shops with nanoproducts for surface treatment and care products for the regular consumer appeared. In the beginning of 2006, the most well-known products socks treated with nano-silver particles and sun lotions with nanofilters were intensivly advertised. Also, for a number of yeards certain black paints has contained 'carbon black' (20-100 nm) applied as colouring agent, and in some paints the thickening agent silica is used in nano size (down to approx. 10 nm).

3.3 Identification of consumer products through the Woodrow Wilson database

In 2006 SPT has asked its 83 member companies within the washing- and cleaning detergent and cosmetics trade, if they market nanotechnological products, and 31 companies corresponding to approx. 37.5% replied. None of the companies in the washing- and cleaning detergent trade informed that they apply nanotechnology in their products on the Danish market. Four companies producing cosmetic products reported that they apply the technology in specific products, primarily sun lotions, on the Danish market.

This survey does not count individual products containing 'carbon black' or silicium dioxide nanomaterials. Hempel A/S informs that the percentage used in paints is below 0.01%.

Besides the inquiry to the above companies the survey also identifies if the products registered in the Woodrow Wilson database are also present on the Danish market, or may be available in a web shops. A number of products was found by searching on the internet for Danish companies selling nanoproducts. The identified companies are primarily selling their product via the internet.

The proposed survey method was based on contacting Danish producers and suppliers of products containing nanoparticles or products based on nanotechnology, but this method turned out unsatisfactory. Therefore, the survey of consumer products is primarily based on the Woodrow Wilson database. At the time of writing the number of products registered in this database was 356. However, all these products do no fulfill the definition of consumer products included in the survey project. For instance foodstuffs, dietary supplement and equipment for production, preparation and storage of foodstuffs are registered in the Woodrow Wilsom database but are not included in the survey of The DEPA. All the surveyed products can be purchased directly by the consumers. A local database has been established to register products that can be purchased or provided through web shops. The products in this database are categorized as follows:

- Child products (care products, games and plays)
- Applicances (heating, air cleaning and cooling, refrigerators, washing machines)
- Cross cutting(comprises products for surface treatment widely applied)
- Electronics and computers (audio, camera and films, computer hardware, display, mobile units and communication, television, video)
- Car accessories (Exterior and interior care and accessories
- Home and garden (cleaning aids, building materials, home furnishings, luxury, paint
- Personal care and sports equipment (clothes, cosmetics, sun screen, filtration, personal care, sporting goods.

The product categories used in the present Danish database are the same as in the Woodrow Wilson-databasen, and also here sunscreens are registered as its own group. Normally sunscreens are a part of the cosmetics group, but since there are a comparably large number of sunscreen products with nanomaterials they are grouped separately.

It is registered, if products not sold in Denmark at present, are sold in our neighbouring countries and may be imported to Denmark through cross-frontier shopping, or if they may be introduced into the Danish market later on. Besides the Woodrow Wilson database, a large number of products have been identified by direct contact with Danish producers and importers of nanotechnological consumer products.

In the following, the number of products of the above product categories has been calculated. The figures show a comparison to the products registered in the Woodrow Wilson database. This comparison gives an overview of the number of products found in Denmark within the category in question.

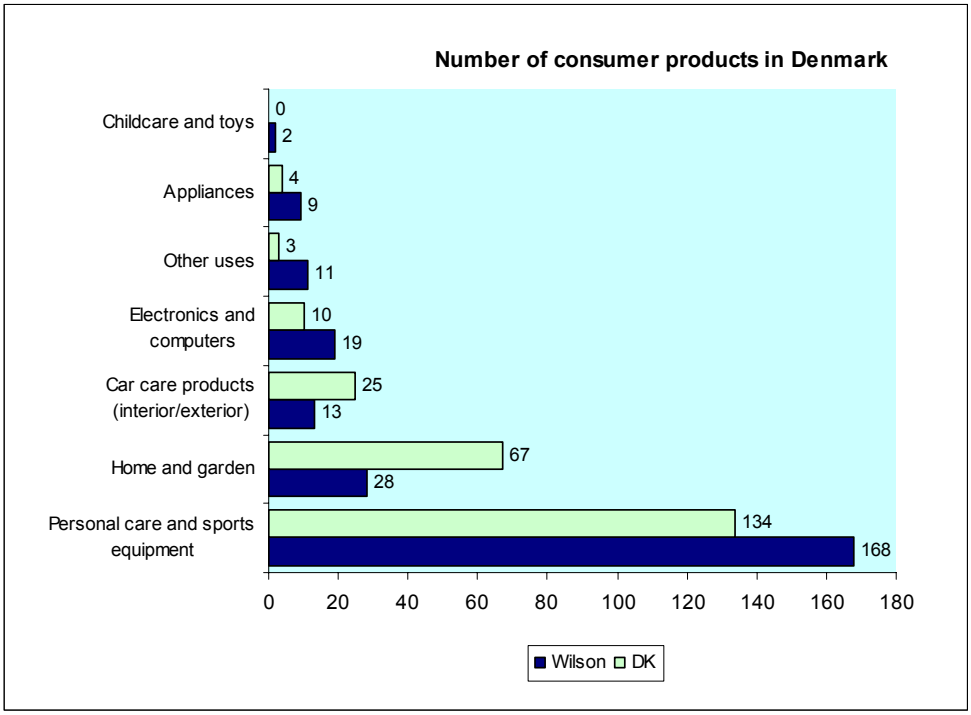


Figure 2: Survey of number of products in the individual product categories in Denmark and in the Woodrow Wilson database.

As previously mentioned, the category 'Foodstuffs and storage'of the Woodrow Wilson database is not included in this survey. However, refrigerators are included because they can also be classified as appliances. As shown in the figure, there are fewer products in the individual categories in Denmark than registered in the Woodrow Wilson database, however except the categories 'Home and garden' and 'Car accessories'. The reason why there are many products in the two categories is that many products are based on surface treatments and have been found through direct contact with importers and internet searches. Generally spoken, the survey shows that the main part of the products in Denmark fall under the categories 'Personal care and sports euipment' and 'Home and garden'. The individual categories are further examined below with focus on Danish findings.

In the Woodrow Wilson database only two products for children are found, of which one is a toy and the other is wet tissues containing silver nanoparticles. In the Woodrow Wilson database, this category also includes sun lotions for children, but these products would appear in the present survey under the category 'Personal care and sports euipment (cosmetics). Thus, no products in the category 'Child products' have been found in Denmark.

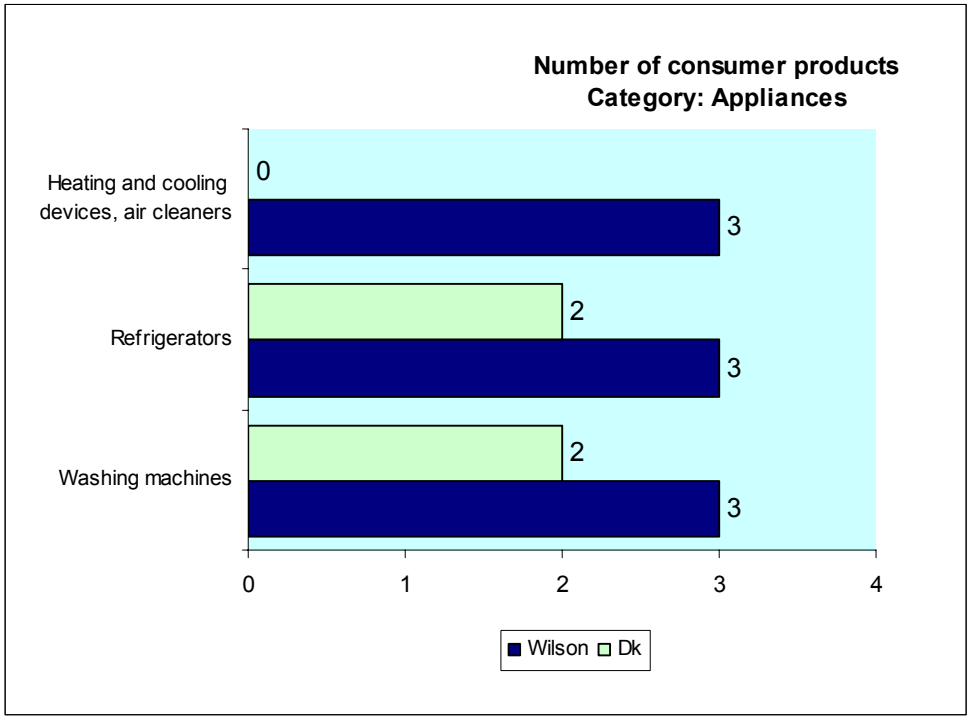


Figure 3: Electric devices (heating, air cleaning and cooling, refrigerators, washing machines)

Two out of three products have been found within the category refrigerators and washing machines. The refrigerators are coated with nano silverparticles with anti-bacterial effect preventing bacteria coatings and obnoxious smells, whereas the washing machines have either antibacterial coatings or rinsing water to which is added silver ions from electrodes. The latter is in fact not nanotechnology, since silver ions are not designed, but the technology is often reported as nanotechnology. Samsung, the producer of the washing machines, has been registered with one product but in reality the company is marketing six models with the Silver Wash system. No products were found within heating, cooling, and air-cleaning.

The category ‘Cross cutting’ comprises in Denmark three surface treatment products with different applications, which is not already included in the category ‘Home and garden’ or ‘Car accessories’. There are 11 corresponding products in the Woodrow Wilson database.

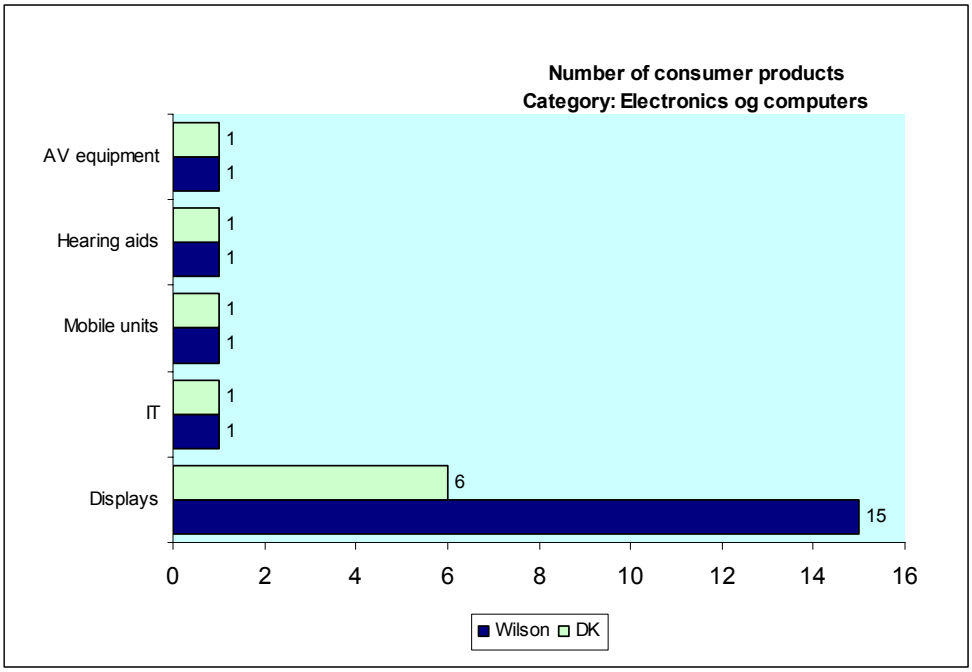
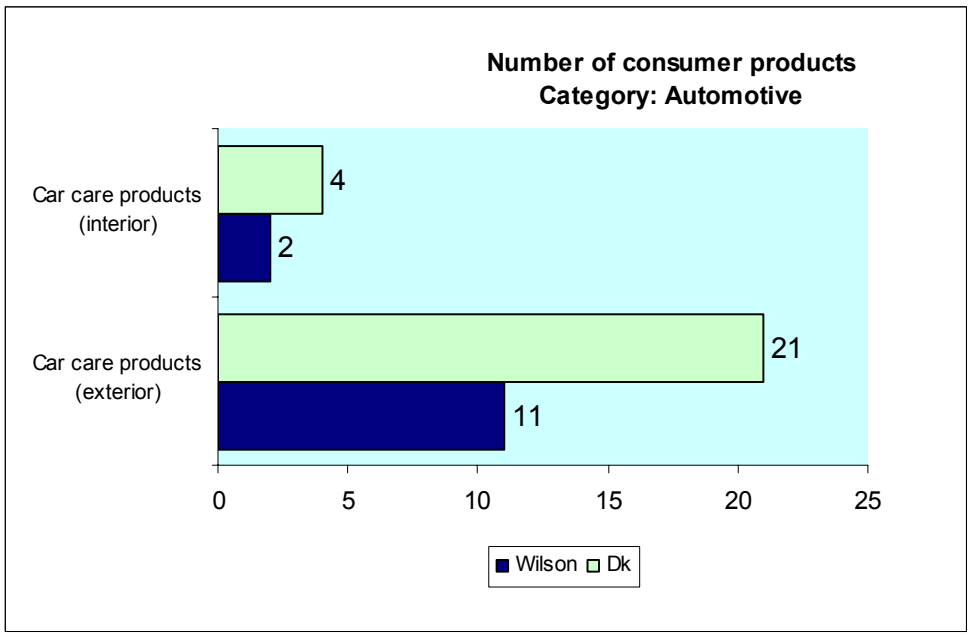


Figure 4: Electronics and computers (audio, camera and films, computer hardware, display, mobile units and communication, television, video

The category ’Electronics and computers’ comprises only products containing nanomaterials which may be exposed to the consumer or nanomaterial produced by means of nanotechnology similarly to the entry criteria in the Woodrow Wilson database. Computers that only contain nanotechnology in memory chips etc. are not included. Most products are categorized in ‘Displays’. They are found in both videos, mobile telephones and televisions. The consumer is not intentionally in contact with the display by ordinary use but is typically exposed in connection with cleaning etc. In the hearing aid, the surface is treated to be dirt repelling.



Figur 5: Automotive(Interior maintenance, exterior maintenance and accessories.)

The main part of 'Automotive'-products is exterior maintenance products such as sealing, anti-dim agents and vax. Besides, there are a couple of petrol/diesel-additives to be mixed in the tank by the consumer. The market is governed by a few importers and it is presently a most popular type of consumer products, and the direct contact has provided considerably more products on the Danish market to the survey compared to the products identified through the Woodrow Wilson database.

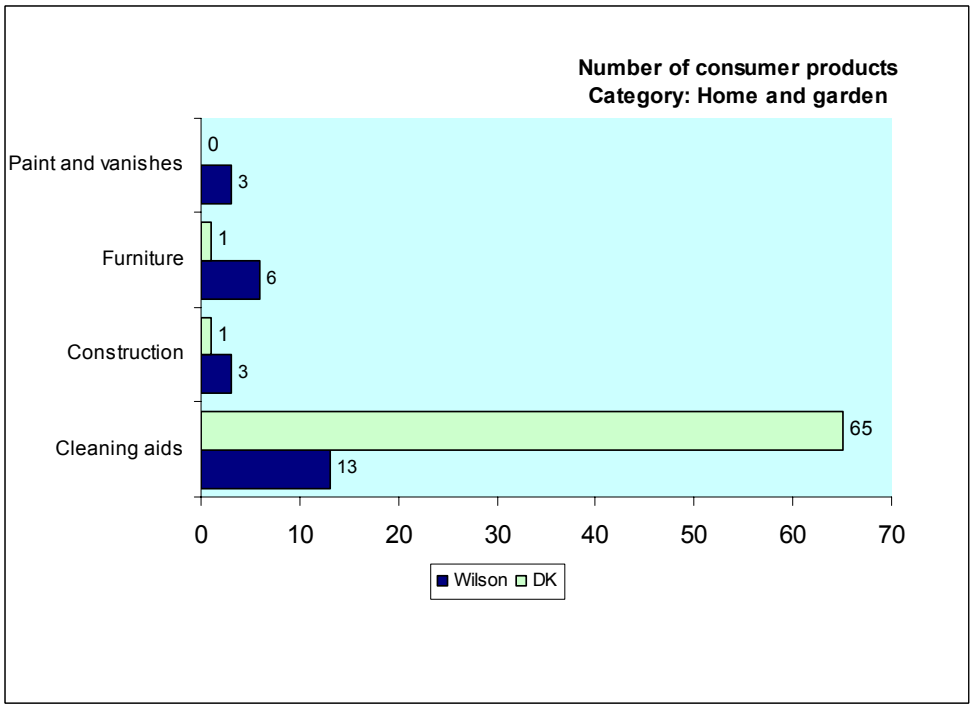


Figure 6: Home and garden (cleaning, building materials; home furnishings; paint.

In the category 'Home and garden', the main part of the products are intended for cleaning and surface treatment. It is a question of definition if a product is intended for surface treatment or cleaning, as most surface

treatments substitutes cleaning or minimizes cleaning. Due to this they are placed under the same category 'Cleaning aids'.

Surface treatment and cleaning products especially for cars are categorized under 'Automotives'. Just as is the case with the category 'exterior car maintenance' there are more products on the Danish market in the category than registered in the Woodrow Wilson database. This is also due to the direct contact with the importers of the products. One product in the sub category furniture is a furniture textile which has become repelling after treatment with a nanoproduct.

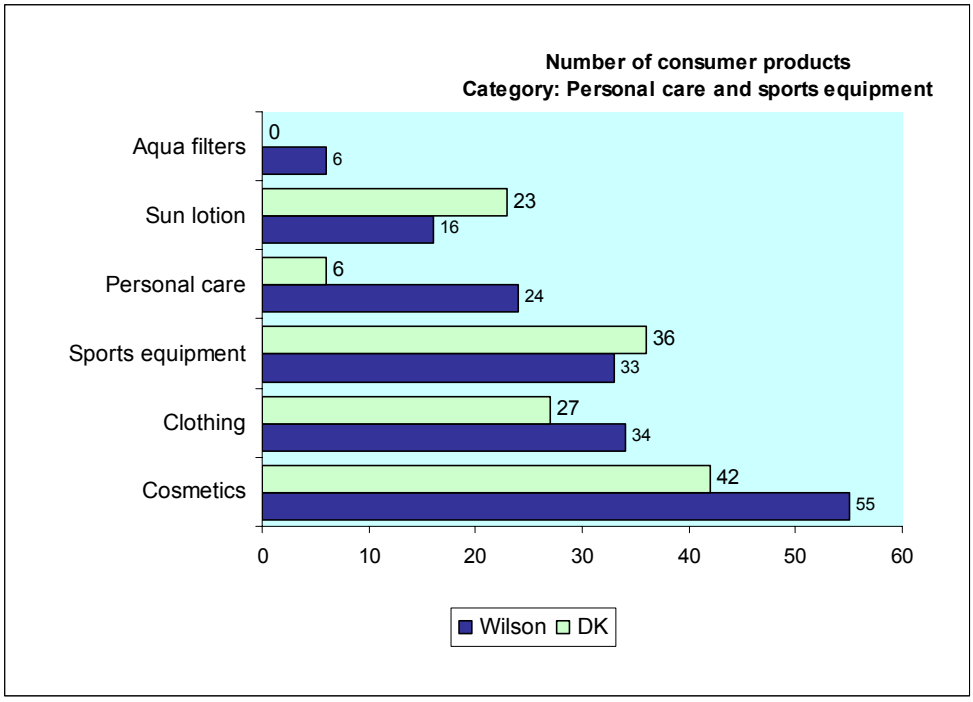


Figure 7: Personal care and Sports equipment (tøj; kosmetiske produkter; filtration; personlig pleje; sportsartikler; solcreme)

Next to 'Cleaning aids' the category 'Personal care and sports equipmet' is the category with most products and of this 'Cosmetics' is the largest category. As it appears from figure 7, the main part of the products registered in the Woodrow Wilson database can also be found on the Danish market either purchased directly or from a web shop. Generally, there is not much specific available information on the content of nanoparticles of the products, typically titanium dioxide or zinc oxide. In other cases, the content is nanoemulsions or ingredients in nano-sized capsules intended for care products to go deeper into the skin.

In sunscreen lotions titanium dioxide in the nanosize range is used as UV filters. Titanium dioxide was assessed by the European Commission's Scientific Committee on Consumer Products (SCCP) to be safe for consumers when used in sunscreens in concentrations up to 25% regardless of the particle size.

The sub category 'Personal care' includes products that are not directly cosmetics, such as for instance products for treatment of hear loss, thin hair etc.

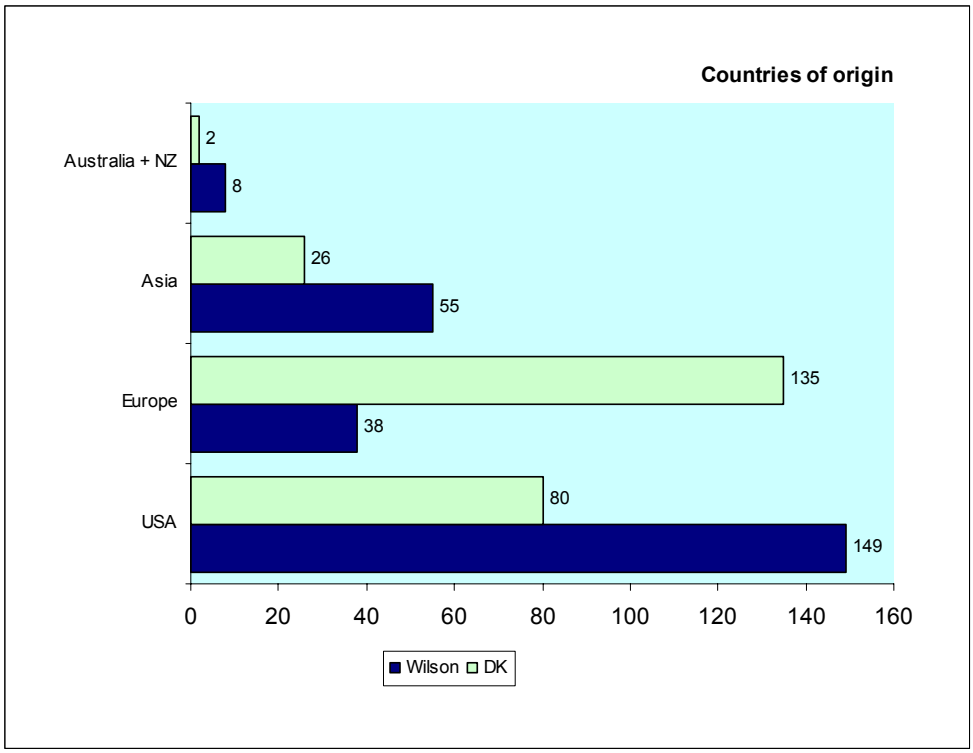
Clothing is another category where several products are sold from web shops. Primarily 'repelling clothes' are surface treated with the nanoproduct to prevent dirt from sticking to the clothes. Under this category also fall odourless socks and corresponding slippers containing nanosilver particles.

The sport articles found on the Danish market are primarily products structurally enhanced with nanomaterials, e.g. in tennis rackets and golf clubs.

3.4 Analyses of the survey data

3.4.1 Origin of the products

Most products identified on the Danish market originate in Europe and not the USA or Asia as the products registered in the Woodrow Wilson database do. Of the 135 European products on the Danish market, 90 comes from Germany and the remaining from England, Finland and France respectively. Three products are formulated in Denmark based on import of nanomaterials from the above countries.



Figur 8: Countries of origin for nano products.

The reason why a great number of articles of EU-origin exist is mainly that quite many surface treatment products from Germany have been surveyed in connection with the direct contact to Danish importers and searches on the internet. These products are not represented in the Woodrow Wilson database, which – even if it in principle covers the whole world – presumably is biased toward products from the American domestic market.

3.4.2 Nanomaterials in consumer products

It was not possible to identify the nanomaterial of the main part of the products (202 out of 243 products). Of the 41 known products, approx. half of the nanomaterials are found in cosmetics (six with zinc oxide and 13 with titanium dioxide, 10 with antibacterial silver in textiles and kitchen appliances, and 12 with carbon tubes or balls (seven with carbon tubes in sporting goods and five with fullerenes in cosmetics).

In sunscreen lotions titanium dioxide in the nanosize range is used as UV filters and this use was assessed by the European Commission's Scientific Committee on Consumer Products (SCCP) to be safe for consumers. Zinc oxide is presently not allowed as a UV filter in sunscreens. SCCP has demanded more data from the industry to assess the safe use the ultrafine particles. In chapter 4, human exposure has been assessed. Zinc oxide is accepted for use as a colouring agent in cosmetic products.

Silver is used in the surveyed products as a disinfectant attached to the fibres used for garment production or released in a nanotechnological process in laundry machines. It is regarded as a biocide and silver (CAS no. 7440-22-4) is also registered on the EU's liste of existing biocides, i.e. biocides on the market before 2000. Silver is under biocide risk assessment in the EU.

In the EU it is decided to treat fullernes as a new substance with the associated consequence that it must be registered. It is assumed that the present products with fullerenes are imported with products formulated outside the EU. In that respect there is no requirement for registration of the substance.

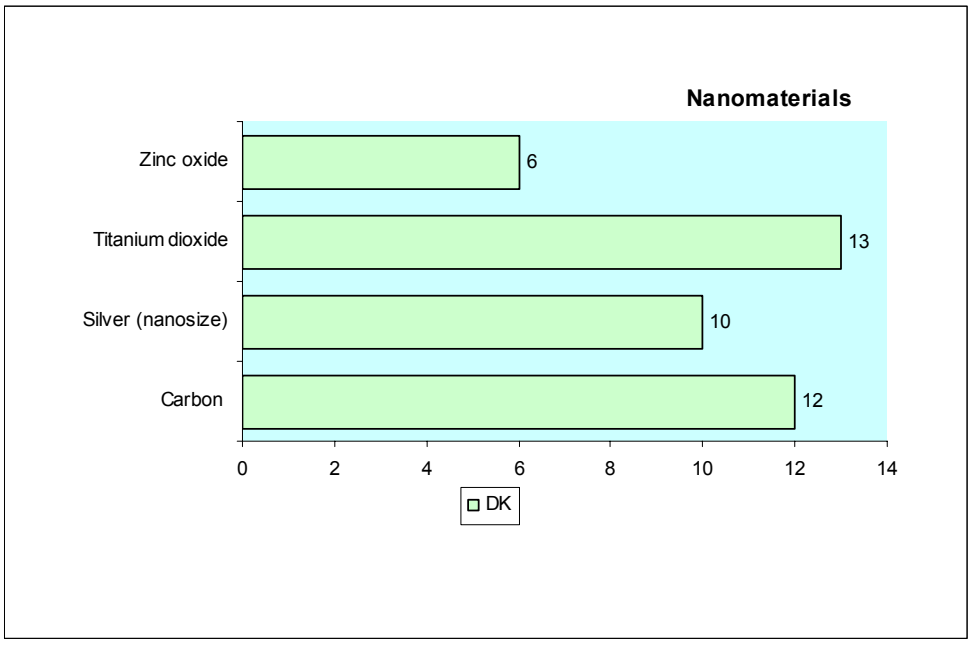


Figure 9: Identified nanomaterials in products (in total 41 in Danish products)

3.4.3 Categorization of products after type of nanomaterial

In the figure below, a categorization of the surveyed nanoproducts has been undertaken. It has been assessed whether the nanomaterial of each individual product contain 'nanoparticles encapsulated in solid materials', 'nanoparticles

suspended in liquids' or 'surface-bound nanoparticles', please refer to the categorization tool from NanoDTU (Hansen et al. 2007) and section 1.4. The consumer products that can be defined as articles and also categorized as 'surface-bound nanoparticles' are assumed to fall under a group with expected low exposure (see Chapter 4).

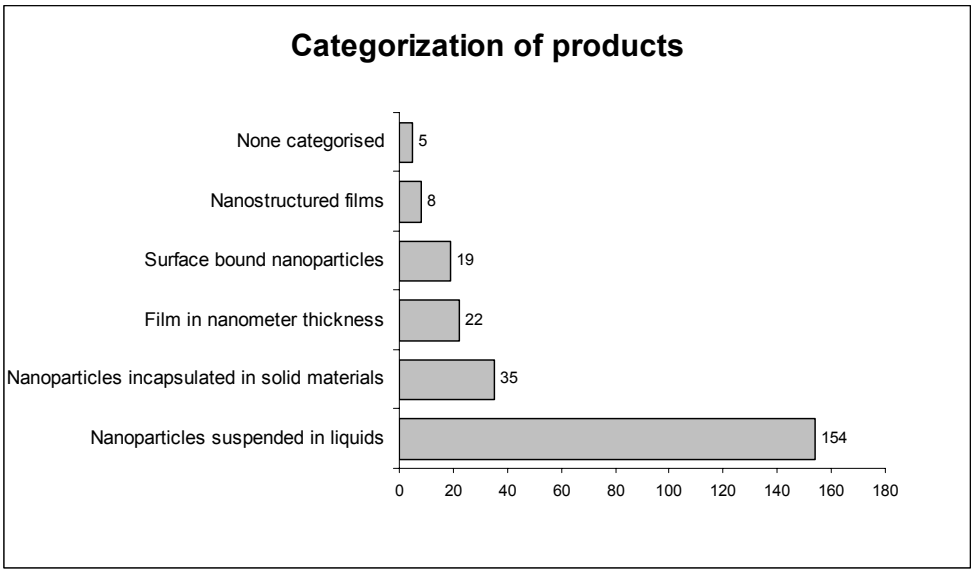


Figure 10: Number of Danish consumer products categorized on type of nanomaterial.

The nanomaterial in the vast majority of products on the Danish market falls under the category 'Nanoparticles suspended in liquids' (154 pcs.) which includes the many products for surface treatment. The remaining products are categorized in 'Nanoparticles encapsulated in solid materials', 'Film of nanomenter thickness', 'Surface-bound nanoparticles' and 'Nanostructured film', in total 81 products. In chapter 4, human exposure has been assessed based on the categorization.

Table 3: Categorization of Danish consumer products based on type of nanomaterial and group of articles

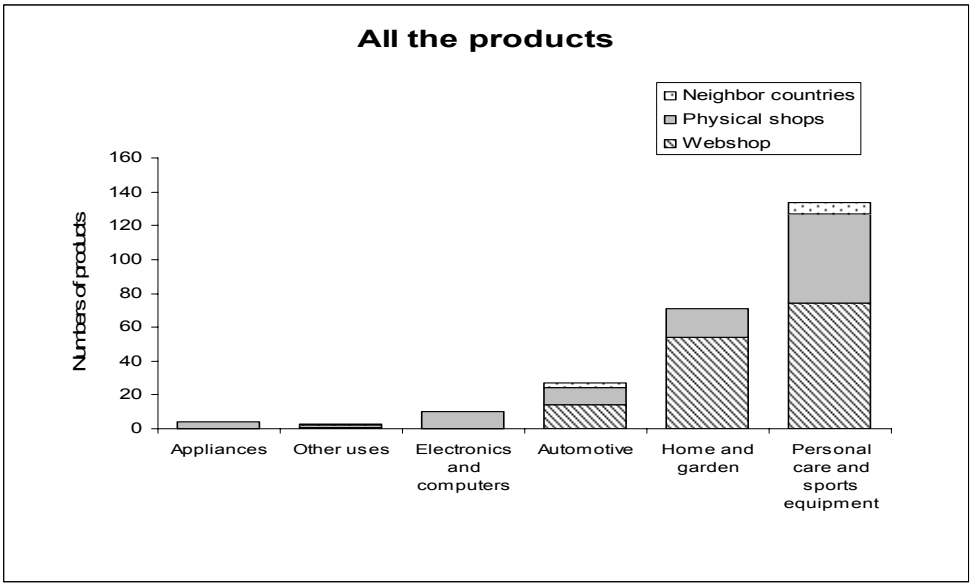
	Appliances	Other uses	Electronics and computers	Automotives	Home and garden	Personal care and sports equipment	*Total*
Nanoparticles suspended in liquids		3		24	58	69	*154*
Nanoparticles encapsulated in solid materials					5	30	*35*
Film in nanometer thickness			1		1	20	*22*
Surface-bound nanoparticles	4		1	1	3	10	*19*
Nanostructured films			8				*8*
Not categorized						5	*5*
Total	*4*	*3*	*10*	*25*	*67*	*134*	*243*

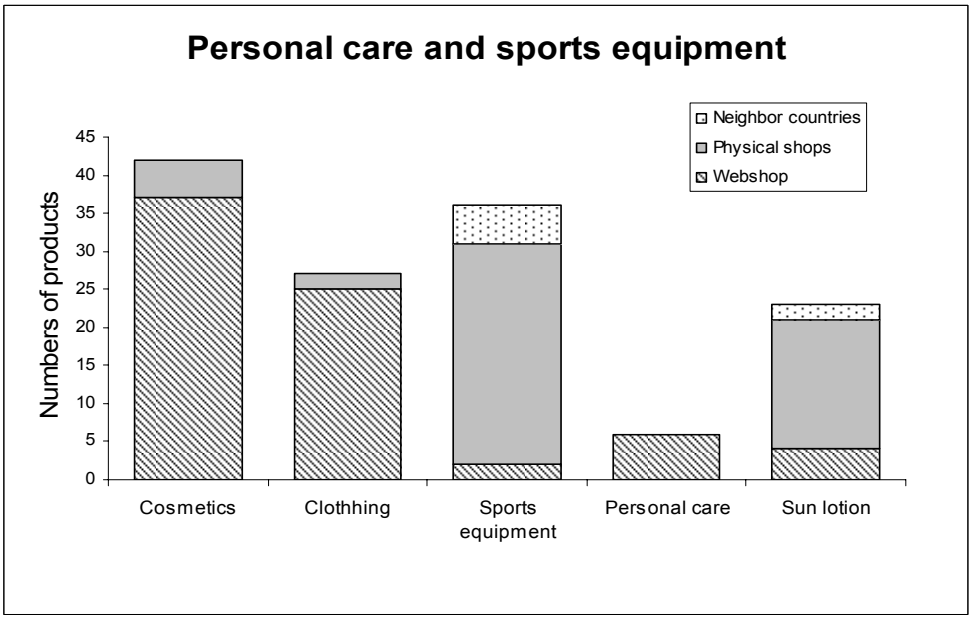
The table shows that most products contain particles suspended in liquid and next after this nanoparticles encapsulated in solid materials. For products containing particles in liquids exposure will be possible, whereas the risk of exposure to nanoparticles encapsulated insolids e.g. golf balls is expected to be limited. Approximately half of the products with nanoparticles suspended in liquids are found in the category 'Home and garden' including mainly products for surface treatment and cleaning (Cleaning aids). The other half is found in the category 'Personal care and sports equipment'. In this category cosmetics are the products typically containing nanoparticles suspended in liquids. With respect to nanoparticles encapsulated in solid material, sporting goods such as for instance tennis rackets, golf clubs and ski represent the main part of the products.

3.4.4 Where to buy the products?

A great part of the consumer products are sold from web shops in Denmark and abroad, especially products for surface treatment within the product types 'Automotives', 'Home and garden' and 'Personal care and sports equipment', while a smaller part is shelved in Danish shops. Especially electronic products, sun lotions and sport articles are available in physical shops.

Within the area 'Personal care and sports equipment' clothing and cosmetics are primarily sold from web shops, whereas sporting goods are sold from the physical shops. Sun lotion, also a big area, is sold from the physical shops. Nanoparticles have been applied as physical sun screens in sun lotions for many years and consequently they are very well established on the market. In the other great category 'Home and garden', 21 identified cleaning and surface treatment products are sold from the shops and more than double the number from the web shops.





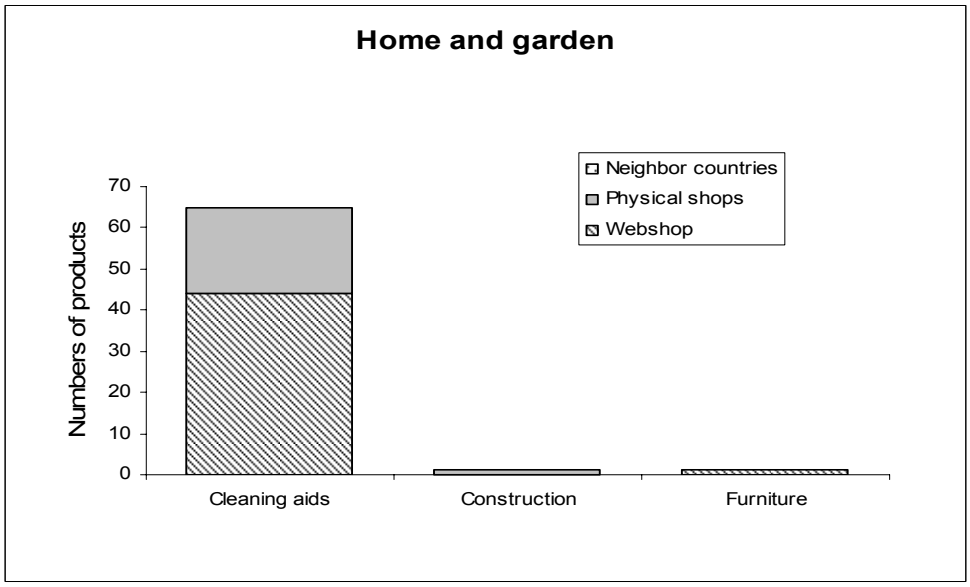


Figure 11: Consumer products found in neighbouring countries, physical shops or web shops.

4 Application and exposure

4.1 Exposure assessment

The legislation does not specifically demand declaration of the content of chemical substances or nano-sized structures. The identification of nanoproducts in this project is most often based on claims. Therefore, it may include products using the designation 'nano' for products that is applied in a nano layer and as such do no contain nano-sized chemical substances.

In the present project, the nanomaterial of most of the identified products is not known[4]. As far as the few known nanomaterials are concerned, uptake, transformation, excretion and the toxicological effects of the substances still remain to be fully examined. Thus, it is not possible to determine the critical effects[5] of the substances which are the basis of a risk assessment.

Therefore, the surveyed products in the project are divided on the basis of expected exposure in the application phase. A proper risk assessment of the products awaits the availability of further toxicological information on the substances.

Exposure assessment is a crucial element of a risk assessment. To be complete, an ideal exposure assessment must cover the complete life cycle of the product from production via application to discharge. This report focuses on exposure in the application phase – exposure after application, e.g. by tear and wear of the surface or discharge has not been taken into consideration.

With respect to consumer exposure, intentional use and forseable other use of a product are normally taken into account - however not accidental exposure or misuse. Consumer exposure may be of shorter or longer duration depending on type of product and mode of application. It is important to establish an exposure scenario as close to reality as possible.

4.2 Method – Grouping of surveyed products

In this project, the grouping of the surveyed products is based on considerations on expected exposure in the application phase and the categorization in section 1.4.

The objective of this grouping is to prepare a list on products that:

- are expected to cause exposure,
- may cause exposure, and

[4] Sunscreen products often contain titanium dioxide or zinc oxide. Titanium dioxide was assessed by the European Commission's Scientific Committee on Consumer Products (SCCP) to be safe for consumers when used in sunscreens in concentrations up to 25% regardless of the particle size (SCCP, 2000). Zinc oxide is not allowed for use as a UV filter in cosmetic products because sufficient documentation has not been presented to the SCCP (SCCP, 2005).

[5] Critical effect: The unwanted effect that is present at the lowest dose.

- are not expected to cause exposure to the consumer

Most attention should be given to the products that are expected to cause exposure. In this project with a great number of products to be systematized, the exposure assessment has been carried out in a simplified manner.

Consumer products that can be defined as articles[6] do not often have intended release of chemicals (however with few exceptions such as fragrance chemicals that are released from a fragrance napkin). Consequently, the first pragmatic categorization is based on the definition of the consumer products as either an article or a chemical product.

Consumer products, defined as articles and categorized as 'suspended in solid' (e.g. a tennis racket) are not expected to cause exposure to the consumer (**No** exposure). For consumer products defined as articles and categorized as 'surface-bound nanoparticles' (eg. socks produced from polypropylene impregnated with nano silverparticles) release is difficult to estimate. The nanoparticles are supposed to be effective in the article, but a certain tear and wear and consequent release must however be anticipated (**Possible** exposure)

The remaining products that are not articles and can be categorized as 'nanoparticles suspended in liquids' must be expected to cause an exposure in the application phase (**Expected** exposure). This would also apply to products that can be categorized as 'free airborne nanoparticles'. However, in the survey project, no examples of this type of products have been found.

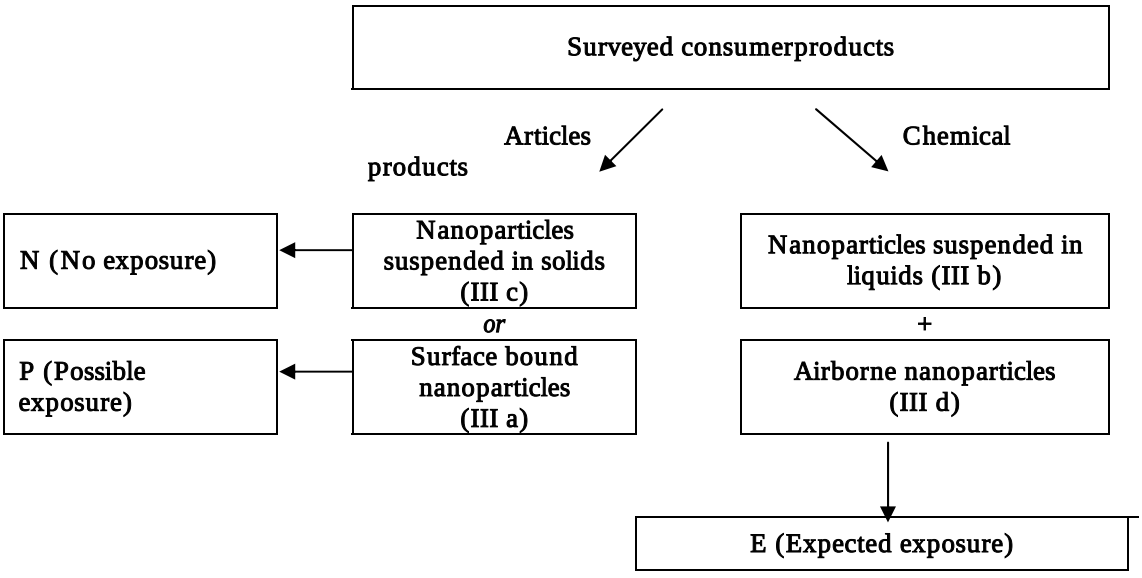


Figure 12: Concept for relative exposure to products depending on type of nanomaterial.

[6] An article is a product which during the production phase has been given a special form, surface or design which to a higher degree than its chemical composition determines its function.

4.2.1 Consumer products not causing exposure

The consumer products defined as articles and categorized as 'Nanoparticles suspendes in solids' belong to a group with expected low exposure. This mainly applies to sports equipment, where nanoparticles eg. are encapsulated in the core of a golf ball and are thus not expected to cause consumer exposure. These products are marked with an **N** (**N**o exposure) in Attachment C.

4.2.2 Consumer products possibly causing exposure

It is not possible to estimate a daily or a yearly consumption of articles categorized by the categorization tools in 'Surface-bound nanoparticles', such as for instance socks containing silver nanoparticles and refrigerators with silver coating. In these products, the silver particles are not meant to be released**,** as they are supposed to be effective in the sock or on the surface. However, a certain wear and tear and therefore release must be anticipated. In literature**,** there are no data on release of particles from this type of products. Thus, no indication of exposure can be given and the products are marked with a **P** (**P**ossible exposure) in Attachment C.

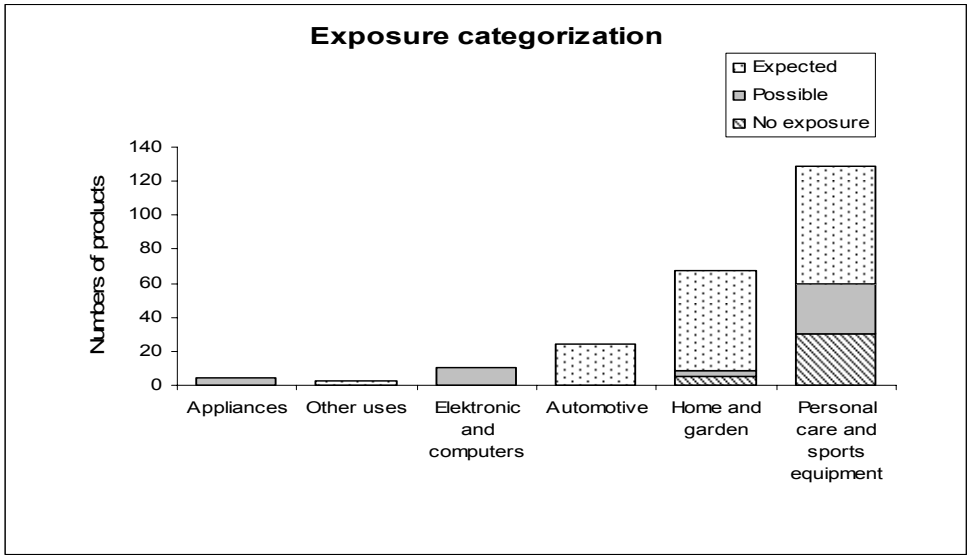
4.2.3 Consumer products with expected exposure

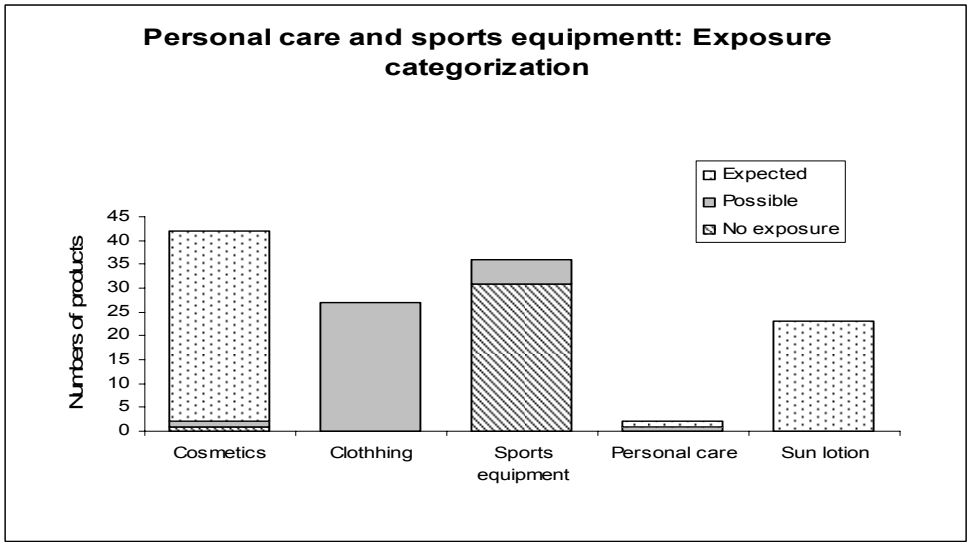
For the remaining products that are not articles and can be categorized as 'Nanoparticles suspended in liquids', the humane exposure will at first be quantified based on the expected applied quantity of the product compared with the application frequency, section 4.3. These products have been marked with an E (**E**xpected exposure) in Attachment C.

This quantification can be based on topical application data or alternatively, default values from Technical Guidance Document (TGD) on Risk Assessment for Existing Substances (European Commission, 2003). In this chapter the internal prioritization in the product groups in question is discussed, exclusively based on exposure of the complete product.

In Attachment B preliminary scenarios are shown including an estimated quantification of the exposure to the active substance (chemical nano-sized substance) in the product. The estimate comprises four different types of products of the group of expected exposure. The four products represent a facial crème, a sunlotion, a spray product for indoor surface treatment and a liquid product for outdoor surface treatment.

The quantification, which is an estimate of the consumer exposure, is based on a number of assumptions and preconditions and should be adjusted when more precise product information is available.





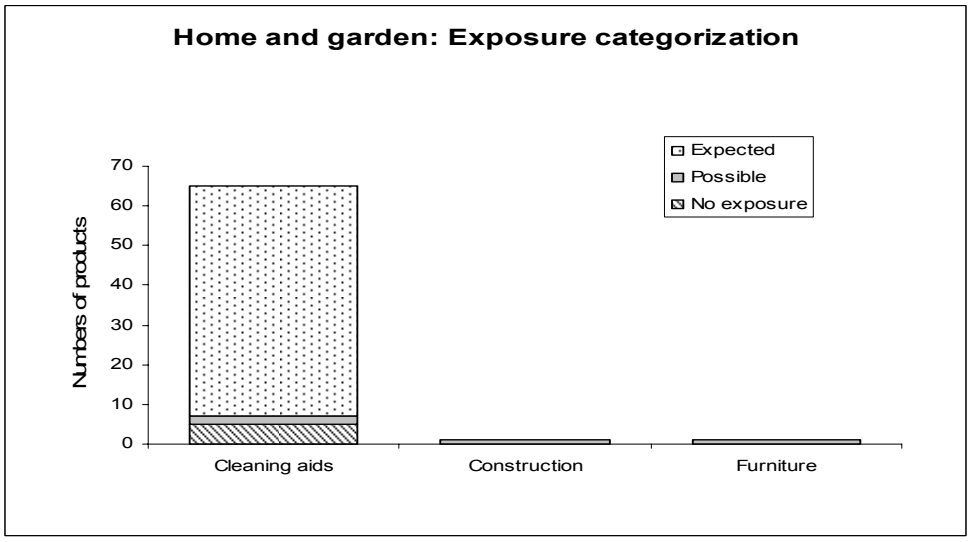


Figure 13: Expected possible or no exposure based on category and type of product

4.3 Quantification of exposure based on applied quantity of the product

The products with expected exposure are grouped in two main groups:

- Cosmetics
- Products for surface treatment

The quantification is solely based on applied quantity of the products regardless of the variation of the content of active substance in the products.

4.3.1 Cosmetics

The Technical Guidance Document (TGI) contains default values for cosmetics (products for facial care, body care, and products for sun protection) and indicates typical quantities and frequency of application. Default values are taken from part 1, appendix II 'Consumer Exposure' of the Technical Guidance Document on risk assessment for existing substances (European Commission, 2003). The cosmetics in question are products with intended exposure that are not diluted or rinsed off after use. It is possible to calculate an expected daily and yearly exposure of the products.

Table 4: Calculation of daily and yearly applied quantity based on typical application modes (European Commission, 2003)

Type of product	Quantity/ application (g)	Frequency [a)]	Daily application of product (g/day)	Yearly application of product (g/year)
Facial lotion	0.8[d)]	Once daily all year	0.8	292
Body lotion	7.5	1- 2 times daily all year	15	5475
Sun lotion	8.0[e)]	2-3 times daily for 2-3 weeks a year	24	504
Sun screen product for lip care	0.01[b)]	2-3 times daily for 2-3 weeks a year [c)]	0.03	0.63

a. If the frequency is indicated as an interval, the upper value has been used to calculate the daily and yearly dose of the product.
b. Quantity/application based on data from lipstick
c. Frequency based on frequency for sun lotion
d. If a facial lotion containing nanoparticles is applied as both night and day lotion, the quantity is 1.6 g.
e. With reference to the recommendation of the Commission of 22 September on the effectiveness of sun protection preparations, they must be applied in quantities corresponding with the quantities used in the tests in order to reach the protection level indicated together with the sun protection factor.The quantity/application mentioned is approx. 36 g for an average-sized adult. This is more than 4 times higher than the value indicated in the TGD corresponding to exposure to the active substance, which is more than 4 times higher for humans applying the recommended quantity.

Assuming that the concentration of the active substance is the same in the different cosmetic products in table 4, the use of for examble a body lotion, will cause an exposure that is 20 times higher than the use of a facial creme.

4.3.2 Products for surface treatment

It is more difficult to quantify an expected daily and yearly exposure of the products of the other group not yet comprised by the TGD. The default values of ordinary product types for surface cleaning indicated by TGD can be seen in the below table.

Table 5: Values for 'habits and practicises' in the EU for products used for surface cleaning (European Commission, 2003)

Physical State	Quantity/application (g)			Frequency of application (number/week)			Time/application (min.)		
	Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.
Liquid [a)]	30	60	110				10	-	20
Spray	5	-	30	1	2	7	2		10

[a)] Diluted by. 5 l washing water

The surveyed products are marketed as products giving a dirt repelling and maintenance-free surface for a longer period than ordinary (nano-free) products for surface cleaning. From distributors of the surveyed products the durability and consequently the required application frequency depend on the wear and tear of the treated surface and possibly also on the concentration of the active substance in the product. The TGD default values are not considered applicable to quantify the use of this kind of products.

For liquid products, which for instance are applied with a cloth, skin exposure is a possibility. For spray products exposure both by inhalation and by dermal contact has to be considered. The degree of exposure by inhalation depends among other things on the duration of the application that varies according to the size of the treated surface and wheater it is a product for indoor or outdoor use. Therefore, it is not possible to state a generic value for the daily and yearly applied quantity of surface treatment products is not possible.

Attachment B shows scenarios of the human exposure. The scenarios are based on four fictive products representing a facial lotion, a sun lotion, a liquid product for outdoor surface treatment and a spray product for indoor surface treatment. The calculations are preferably based on default values and formulas indicated in Part 1, Appendix II – 'Consumer exposure' of Technical Guidance Document (TGD) on risk assessment for existing substances (European Commission, 2003). If no data were available in the TGD, the default values were estimated based on contact with relevant actors and partly as values estimated by DHI.

5 Conclusions

5.1 Results of the survey

The trade associations and the Danish nano research institutions have great expectations to business-to-business products and to consumer products. Presently, there are only Danish manufactorers who formulate products containing nanomaterials.

Based on interviews, searches of importers and distributors in the Woodrow Wilson database and of web shops selling these products in Denmark showed that in general approximately two out of three American registered consumer products totally 243 out of 356 are for sale in Denmark.

Products especially within the areas of surface treatment, cosmetics and sports equipment are marketed. In the market for surface treatment of car and house items, which is very dynamic in Denmark, considerably more products have been surveyed in Denmark than have been registered in the USA.

More than two thirds of the products on the Danish market – 154 pcs. - are different liquid products partly for surface treatment of a great number of materials such as glass, concrete, metal (especially car maintenance) glass fibres and textiles, partly skin protection products, especially sun lotions. The remaining products are especially sporting goods- and clothing, in which the nanomaterial is encapsulated in the surface of the product, e.g. golf balls. No products containing free airborne nanoparticles were found.

More than half of the consumer products on the Danish market are products from Europe. Of the 135 European products on the Danish market, almost 100 come from Germany. The remaining comes from England, Finland and France. Three of them are formulated in Denmark.

In 202 out of 243 products it was not possible within this project to identify the nanomaterials in the product. However, of the 41 known nanomaterials, half of them were found in cosmetics products (six products with zinc oxide and 13 with titanium dioxide[7]), 10 with antibacterial silver[8] in textiles and kitchen appliances, and 12 with carbon dioxide tubes or balls (seven with carbon tubes in sporting goods and five with fullerenes[9] in cosmetics).

[7] Titanium dioxide is used as a UV blocker in sunscreens. It was assessed by the European Commission's Scientific Committee on Consumer Products (SCCP) to be safe for consumers when used in sunscreens in concentrations up to 25% regardless of the particle size. Zinc oxide is not allowed for use as a UV filter in cosmetic products because sufficient documentation has not been presented to the SCCP.

[8] Silver in a nanoform is used as a biocide. Biocidal silver is under EU risk assessment.

[9] The European Commission has decided that fullerenes must be treated as a 'new' substance and must be registered. It is assumed that the fullerenes are imported in products, not produced in the EU.

A great part of the consumer products are sold from web shops in Denmark and abroad, especially products for surface treatment within the product categories `car accessories', home and gardening' and health and fitness, whereas a lesser part are found in Danish shops.

A special example is paints. In certain black paints are applied 'carbon black' (20-100 nm) as colouring agent, and paints with the thickening silica in nano size (down to approx. 10 nm). Both these materials have been used for a number of years, but are now recognized as nanomaterials. The individual products containing these materials have not been calculated.

5.2 Consumer exposure to products containing nanomaterials

No consumer products with free airborne nanoparticles have been foundd. An assessment shows that the risk of exposure to the consumers is greatest from products of the category 'Nanoparticles suspended in liquids', because it is a liquid product for e.g. surface treatment or cosmetic application to the skin. Products in spray form must be expected to cause exposure both by inhalation and by dermal contact – however, only four spray products were found (with pumps, not with propellants.)

According to the actors of the market, nanomaterials do no appear in the products in concentrations demanding labelling or classification. Thus, there is no available information on the active nanomaterial in the products.In cosmetics all ingredients must be declared, but there is no requirement to disclose whether the substance is on nanoform.

5.3 What are the overall expectations?

The Danish development companies do not launch products directly aiming at the retail trade, and the Danish consumers will instead be affected by the development of the markets in the USA, Asia and other EU countries, especially Germany.

Based on the development in the USA we can expect a quick introduction of products based on nanomaterials or nanotechnology in trades characterized by high demands of material's performance and/or keen competition. In these trades (sports equipment, cosmetics, domestic appliances, electronics and textiles) a technological ascendancy can provide market advantages.

Today, nanomaterials are typically expensive and are used in 'high-end'-products, but the prices of for example carbon tubes to be mixed in the plastic materials to increase the strength are already decreasing and this may extend the application segment. Also the many products for surface treatments generally will undoubtedly be widely applied, if the expectations to the effects of the products are fulfilled.

Many producers of cosmetics seem to launch products containing nanotechnology, especially liposomes, fullerenes and sunscreens. The categories electronics and kitchen appliances also aim at nanotechnology, especially antibacterial coatings/treatments for washing machines and refrigerators.

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Attachment A Survey Methodology

Methodology for the survey of a generic product

To make a survey of the use of nanotechnology in 2006 is the same as to survey and predict the application of plastic materials in the beginning of the 1950s- Another difficulty is that the technology is not limited to individual trades.

Earlier surveys have been carried out by for example contacting specific trade associations to collect information about the individual types of product. This is not possible with nanoproducts, as they can be developed and applied for all purposes, and the survey would be aimed at the entire Danish retail market. Therefore, this project is based on modified approach to survey methods. Information of relevant products has been collected by combining the following activities representing both a "top-down and a bottom-up approach".

Identification of producers and suppliers	Identification of products
Nano-centers and innovation institutions	The Product Registry (DEPA)
Trade associations	Internet searches
EU trade associations	Media searches
	Company contacts

Top-down approach to producers and suppliers

The development of nanotechnology in Denmark takes place particularly in the Nano-Science Centre, the University of Copenhagen, in NANO, the Universities of Aarhus and Aalborg and in NanoDTU, the Technical University of Denmark. Many of these companies working with nanotechnology in Denmark are spin-offs from the universities and the mentioned centres and the trade is cooperating closely on this area. The Information on new products and applications especially with respect to Denmark has been collected from these centres.

Different trade associations that are expected to apply nanoparticles in their products have been contacted: The Association of Danish Cosmetics, Toiletries, Soap and Detergent Industries (SPT), the Association for Glue and Filler, the Danish Paintmakers' Association (FDLF), the Danish Association for Trade and Distribution of Chemicals, Federation of Danish Textile and Clothing.

A contact person of the trade associations has been interviewed by telephone and a specific spreadsheet with inquiries about information of the following individual products: Name of company; name of product, type of product; functional category; physical state of the product; mode of application, percentage content of active nanomaterial, possibly CAS No., possibly other substances in the product, suppliers, importers and distributors of the product.

Bottom-up approach to products

During the survey, a dialogue with suppliers and producers of nanoproducts has been established. Some producers have been contacted to establish a dialogue about survey of the products on the Danish market.

A screening of the market has been made through internet searches and searches in other relevant media. Information can be gained from a list of selected imported products that are generated via information collected in e.g. www. Statistikbanken.dk and www.nanosalg.dk.

The originally suggested bottom-up survey method based on a contact with Danish producers and suppliers of products containing nanoparticles or built on nanotechnology did not prove satisfactory. The primary reason to this is the increasing sale from the internet. Therefore the survey of consumer products is primarily based on information in the database "A Nanotechnology Consumer Products Inventory" (http://www.nanotechnproject.org/44/consumer-nanotechnology) prepared by "The Project on Emerging Nanotechnologies" which is a cooperation between The Woodrow Wilson International Center for Scholars and Pew Caritable Trusts. Most of the products in this database (pt.276) which are continuously updated fulfill the following criteria: The products can be purchased directly by the consumers. It has been identified by the producer or another source as based on technology and the information on content of nanoparticles in the product seems reasonable. The products in the database are categorizes as follows:

- Appliances (Heating, cooling and air; large kitchen appliances; laundry and clothing care)
- Automotive (Exterior; maintenance and accessories)
- Goods for Children (Basics; toys and games)
- Electronics and Computers (Audio; cameras and film; computer hardware; display; mobile devices and communications; television; video)
- Health and Fitness (Clothing; cosmetics; filtration; personal care; sporting goods; sunscreen)
- Home and Garden (Cleaning; construction materials; home furnishings; luxury; paint)
- Cross-Cutting (Coatings).

The survey of DHI has been performed by investigating if the product available in the database is also marketed on the Danish market or possibly can be purchased from a web shop. We have registered, if the product that are not presently sold in Denmark are sold in our neighbouring countries and may be imported through 'border trade' or if they can be expected to be introduced to the Danish market later on. Besides, a number of products have been identified by direct contact to Danish producers of nanotechnological consumer products.

Through DEPA, one of our contacts within the authorities, we have investigated, if they have received notifications/inquiries in accordance with relevant Statutory Orders in the area, e.g. classification and labelling, articles or the Product Register.

The National Research Centre for the Working Environment has been contacted. The institute has established a knowledge database on application and exposure to nanotechnology in the working environment.

Attachment B Exposure

Quantification of human exposure to the active substance in four fictive products.

This attachment describes scenarios of human exposure which are based on four fictive products. The products represent a facial lotion, a sun lotion, a fluid product for outdoor surface treatment, and spray product for indoor surface treatment.
The calculations are based on default values and formulas taken from part 1, appendix II – "Consumer Exposure", in Technical Guidance Document (TGD) on risk assessment for existing substances (European Commission, 2003). If the TGD did not contain any data, the default values were based partly on contact with relevant actors and partly on values estimated by DHI.

With respect to the concentration of the active substance, very few producers/distributors have been able to give information about the content of the substance in the products. Thus, the values indicated in the tables below the individual scenarios, is the best possible estimate that can be acquired from the very sparse information received by DHI (DHI, 2006). In cases when the producer has stated an order of magnitude and not a definite value, the estimate is based on a worst case scenario using the highest value. For the scenario of the facial lotion no information at all could be acquired about the content of active substance. As the content in the facial lotion is expected to be lower than in the sun lotion, where the active substance is intended to act as a sun filter, the value 0.1 % has been used. However, this value must be considered more arbitrary than the values
for sun lotion and the product for surface treatment.

Scenario for cosmetics – facial day lotion

The route of exposure for cosmetic products will mainly be dermal contact. Intake of smaller quantities by contact with the area around the mouth is not taken into consideration. As the product is a "leave on" product, which should neither be diluted when used nor washed off, the quantity of active substance on the skin (A_{der}) can be estimated as follows:

Equation 1: $$A_{der} = Q_{pro} * F_{pro}$$

Thus, the potential uptake per kilogram body weight per day is derived as:

Equation 2: $$U_{der,pot} = \frac{A_{der} * n}{bw}$$

Table 4 Explanation of symbols and default values

Symbol	Explanation	Default values	Unit	Reference
A_{der}	The quantity of active substance on the skin per application		mg	(European Commission, 2003)
Q_{pro}	The quantity of product per application for an adult	800 mg	mg	(European Commission, 2003)
F_{pro}	Concentration of active substance in the product	0.1	%	(DHI, 2006)
$U_{der,pot}$	Potential daily uptake of quantity of active substance		mg/kg bw/day	
n	Number of applications per day	1	Number/day	(European Commission, 2003)
bw	Body weight	60 for adult women and 70 for adult men	kg	(European Commission, 2003)

Based on equation 1, the quantity of active substance on the skin per application for a facial day lotion containing 0.1% of nano material, can be calculated:
A_{der} = 0.8 mg.
The potential daily uptake of active substance can be calculated:
$U_{der,pot}$ = 0.013 mg/kg bw/day for women.
Use of both a facial day lotion and night lotion containing 0.1% nano material is equal to application twice a day and consequently $U_{der,pot}$ will be 0.026 mg/bw/day.

Scenario for cosmetics – Sun lotions

The route of exposure is as for the facial lotion mainly by dermal contact. Intake of smaller quantities by contact with the area around the mouth is not taken into consideration. As the product is a “leave on” product, which should neither be diluted when used nor washed off, the quantity of active substance on the skin (A_{der}) can be estimated as shown in the above Equation 1 and 2.

The conversion of the value of applied sun lotion in an adult compared to a child is shown in Equation 3.

Equation 3: $$Q_{pro,child} = \frac{k_{child}}{k_{adult}} * Q_{pro,adult}$$

Table 5 Explanation of symbols and default values

Symbol	Explanation	Default values	Unit	Reference
A_{der}	The quantity of active substance on the skin per application		kg	(European Commission, 2003)
$Q_{pro,adult}$	The quantity of product per application for an adult	8000	g	(European Commission, 2003)
$Q_{pro,adult}$	The quantity of recommended product per application for an adult	36000	mg	(European Commission, Recommendation, 2006)
$Q_{pro,child}$	The quantity of product per application for a child	2600	mg	(European Commission, 2003)
$Q_{pro,child}$	The quantity of recommended product per application for a child	12000	mg	(European Commission, Recommendation, 2006)
F_{pro}	Concentration of active substance In the product	2	%	(DHI, 2006)
$U_{der,pot}$	Potential daily uptake of active substance		kg/kg bw/day	
n	Number of applications per day	3	Number/day	(European Commission, 2003)
bw	Body weight	12.34 for a 2 year old child	kg	(Lentner C.,1981)
K_{child}	Body area of a 2 year old child, weighing 12,34 kg and 86,8 tall	0.55	cm^2	(Lentner C.,1981)
K_{adult}	Body area of an adult (woman)	1.69	cm^2	(European Commission, 2003)

With reference to the default values indicated in the TGD for the quantity of the actually applied sun lotion the following exposure can be calculated:

The quantity of the active substance on the skin per application of sun lotion containing 2% of nanomaterial for a 2 year old child can be calculated:
A_{der} = 52 mg.
The potential daily uptake of active substance per day for a two year old child can be calculated as $U_{der,pot}$ = 12,6 mg/kg bw/day.

To reach the protection level indicated by the sun protection factor, the quantity of applied sun protection lotion must be equal to the quantity used in the test, which is approx. 36 g for an average adult. This amount exceeds the quantity which the consumers normally use (Commission Recommendation,2006).This quantity is equal to 4.5 times more sun lotion than what TGD stipulates is the actual use. For consumers that apply the recommended quantity, the quantity of active substance on the skin per application of sun lotion containing 2% of nanomaterials can be calculated as follows: A_{der} = 234 mg for a 2 year old child.

Daily uptake of active substance can be calculated as:
$U_{der,pot}$ = 56.7 mg/kg bw/day for a 2 year old child.

Scenario of liquid products for outdoor surface treatment

As an example a product for surface treatment of car glasses is chosen.
In this scenario it is assumed that all glasses of the car will be treated. Based on personal communication, the estimated total glass area of a standard passenger car is 5.4 m^2 (Carglass, 2006). It is assumed that the product is applied with a cloth and that it is not diluted before use and thus a dilution factor is not required in the scenario. It is also assumed that the nanomaterial is not volatile and therefore exposure by inhalation can be excluded. The route of exposure will mainly be dermal contact. The scenario is based on many assumptions, as it has been impossible to collect more precise product data. The below is an example on how a scenario can be established. The estimated values below cannot be used as basis for a risk assessment of this type of products without more precise product information

The total quantity of active substance for treatment of all car glasses of a standard passenger car can be estimated using equation 4 and 5, and the below default values.

Equation 4: $$A_{der} = Q_{pro} * F_{pro} * f$$

Equation 5 $$U_{der,pot} = \frac{A_{der} * n}{bw}$$

Table 6 Explanation of symbols and default values

Symbol	Explanation	Default values	Unit	Reference
A_{der}	The quantity of active substance on the skin per application		ml	(European Commission, 2003)
Q_{pro}	The quantity of product per application for an adult	10 ml/ m^2 * 5.4 m^2 = 54 ml	ml	(DHI, 2006),(Carglass, 2006)
F_{pro}	Concentration of active substance In the product	0.1	%	(DHI, 2006)
f	Allocation factor for the part of the applied quantity of the product with dermal contact	1	%	(DHI, 2006)
$U_{der,pot}$	Potential Uptake of active substance per year		ml/kg bw/year	
n	Number of application per year	2	Number/year	(DHI, 2006)
bw	Body weight	60 for adult women and 70 for adult men	kg	(European Commission, 2003)

The quantity of active substance on the skin per application of a surface treatment product containing 0.1% of nanomaterial can be calculated as: A_{der} = 5.4 * 10^{-4} ml using an allocation factor of 1%.
The potential uptake of active substance per application thus can be calculated as 8 * 10^{-6} ml/kg bw/application for men.

The potential uptake of the active substance per year provided two yearly applications are $U_{der,pot}$ = 1.5 * 10^{-5} ml/kg bw/year.

Based on an assumed mass density of 1 g/ml, the potential uptake of active substance in a person per application corresponds to 8* 10^{-3} mg/kg bw/application and per year to 1.5 * 10^{-2} mg/kg bw/year (based on two applications per year).

Scenario for a spray product for indoor surface treatment.

In this scenario, a spray product is used for surface treatment of tiles in a bathroom. Liquid aerosols are formed when liquid vapours condense or through mechanical liquefaction, e.g. by atomization with a nozzle and when a liquid jet hits an obstacle (The Danish Working Environment Service, 1983). Thus, it is not expected that a certain formation of aerosols can be avoided and a scenario should account for both exposure by inhalation and dermal contact when the product is applied with a cloth. The product is applied undiluted and consequently a dilution factor is not required in the scenario. Based on personal communication with the Danish Building Research Institute (SBI) there are many small 'wet rooms' in Denmark with a floor area of approximately 3 m^2. Therefore, an estimated room volume of 7.5 m^2 corresponding to a floor area of 3 m^2 and 2.5 m's distance to the ceiling is assumed to be a reasonable scenario (SBI, 2006). The total surface area of this room will be approximately 20.5 m^2. Assuming that the floor and 2 of 4 walls are tiled, it is equivalent with an area of 11.75 m^2.

As is the case with the example of outdoor surface treatment, the scenario of indoor surface is based on a number of assumptions, because of lack of precise product data. Above is shown an example of how to establish a scenario. Therefore, the estimated values above cannot be used for a risk assessment of this type of products, unless more precise product information is available.

The total applied quantity of the active substance with dermal contact and the potential uptake during treatment of tiles in a bathroom can be estimated by applying equation 4 and 5 and the default values in table 7:

Table 7 Symbol explanation and default values

Symbol	Explanation	Default values	Unit	Reference
A_{der}	The quantity of active substance on the skin per application		ml	(European Commission, 2003)
Q_{pro}	The application of product per application	10 ml/ m^2 * 11.75 m^2 = 117.5 ml	ml	(DHI, 2006), (SBI, 2006)
F_{pro}	Concentration of the active substance in the product	0.1	%	(DHI, 2006)

f	Allocation factor to calculate the part of the applied quantity with dermal contact	1	%	(DHI, 2006)
$U_{der,pot}$	Potential Uptake of active substance per year		ml/kg bw/year	
n	Number of applications per year	2	Number/year	(DHI, 2006)
bw	Body weight	60 for adult women and 70 for adult men	kg	(European Commission, 2003)

The amount of active substance on the skin per application of a surface treatment product containing 0.1% of nanomaterial can be calculated:
A_{der} = 1.18 * 10^{-3} ml using an allocation factor of 1%.
The potential uptake of active substance per application can be calculated as 2 * 10^{-5} ml/kg bw/application for women.
The potential uptake of the active substance per year, based on 2 yearly applications, will then be:
$U_{der,pot}$ = 4 * 10^{-5} ml/kg bw/year.

To estimate the inhaled quantity of the substance the below equations should be used:

Equation 6 estimates the concentration in the air after application of a product (Q_{prod}).

Equation 6: $$C_{inh} = \frac{Q_{pro} * Fc_{pro}}{V_{room}}$$

Equation 7 estimates the inhaled quantity of the active substance based on the estimated concentration in air calculated in equation 6.

Equation 7: $$I_{inh} = \frac{F_{resp} * C_{inh} * IH_{Air} * T_{Contact}}{bw}$$

Table 8 Explanation of symbols and default values

Symbol	Explanation	Default values	Unit	Reference
Q_{pro}	Quantity of product per application.	117.5 ml	ml	(DHI, 2006), (SBI, 2006)
Fc_{pro}	Concentration of active substance in the product	0.1	%	(DHI, 2006)
V_{room}	Room area	7.5	m^3	(SBI, 2006)
F_{resp}	Respirable part of inhaled substance	1	%	(DHI, 2006)
IH_{Air}	Respiratory rate	26	m^3/day – light activity and short time exposure	(European Commission, 2003)
$T_{Contact}$	Duration of contact per application	40	Min.	Based on the maximum value of the TGD (European Commission, 2003): 3 g spray is applied in 1 min. Assuming that the density is 1 g/ml, the application time of 117.5 will be 40 min.
bw	Body weight	60 for adult women and 70 for adult men	kg	(European Commission, 2003)
n	Number of applications per year	2	Number/year	(European Commission, 2003)
I_{inh}	Inhaled quantity of substance per application		ml/kg bw/application	
C_{inh}	Concentration of substance in the room		ml/m^3	(European Commission, 2003)

The concentration in the air after application of a surface treatment product containing 0.1 % of nano material in a bathroom with the above assumptions can be calculated as $C_{inh} = 0.016$ ml/m^3.

The estimated inhaled quantity of the substance per application can be calculated as: $1.9 * 10^{-6}$ ml/kg bw/application for women.

The quantity of an active substance to be inhaled per year based on 2 applications per year can be calculated as $3.8 * 10^{-6}$ ml/kg bw/year.

The total exposure by dermal contact and inhalation, per application of a spray product, can be calculated as follows: ($2 * 10^{-5}$ ml/kg bw/application +

1.9 * 10^{-6} ml/kg bw/application) = 2.19 * 10^{-5} ml/kg bw/application for a woman.

The total exposure per year for a woman based on exposure by dermal contact and inhalation by application of a spray product twice a year can be calculated as follows: (4 * 10^{-5} ml/kg bw/application + 3.8 * 10^{-6} ml/kg bw/application) = 4.38 * 10^{-5} ml/kg bw/application.

Based on an assumed density of 1 g/ml, the total quantity of potential uptake of active substance in a woman per application corresponds to 2.19 * 10^{-2} mg/kg bw/application and per year to 4.38 * 10^{-2} mg/kg bw/application (based on 2 applications per year).

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Attachment C Survey of consumer products in Danmark 2006

Attachment C contains a list of the surveyed producs containing nanomaterials. Only consumer product that can be purchased in Danmark or through a web shop. The country of origin of the products is indicated and not the ingredients, as this information is not available. This means that some of the mentioned companies produce products with nanomaterials but not the nanomaterial itself. The products are categorized in the exposure categories N: No; P: Possible; E: Expected exposure.

Personal care and sports equipment > Cosmetics

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
KOSÉ® Corporation	Japan	Rutína nano-force (5 products)	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
KOSÉ® Corporation	Japan	Rutína nano-white	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
La Prairie	Switzerland	Caviar Ampoules	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
Lancome®	France	Hydra zen® cream (SPÉCIAL PEAUX SÈCHES)	Yes	Not indicated	Suspended in liquids (IIIb)	E
Lancome®	France	RÉNERGIE MORPHOLIFT (3 products)	Yes	Nanoparticles of silica and proteins	Suspended in liquids (IIIb)	E
L'Oreal®	France	RevitaLift® Double Lifting	Yes	Not indicated	Suspended in liquids (IIIb)	E
Arbonne International, LLC	USA	NutriMinC® RE[9]	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
Arbonne International, LLC	USA	NutriMenC™ RE[9]	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
Beyond Skin Science, LLC™	USA	Eternalis™ products	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
Enprani®	Korea	Innermost (8 products)	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
DERMAdoctor®	USA	POUTlandish Hyper Moisturizing Lip Paint & Treatment	Web-shop	Zinc Oxide	Suspended in liquids (IIIb)	E
MyChelle Dermaceuticals	USA	Revitalizing Night Cream	Web-shop	Fullerenes	Suspended in liquids (IIIb)	E

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
SIRCUIT® COSMECEUTICALS INC.	USA	SIRCUIT®WHITE OUT	Web-shop	Fullerenes	Suspended in liquids (IIIb)	E
SIRCUIT® COSMECEUTICALS INC.	USA	SIRCUIT®O.M.G.™ serum	Web-shop	Fullerenes	Suspended in liquids (IIIb)	E
SIRCUIT® COSMECEUTICALS INC.	USA	SIRCUIT®Sircuit Addict™	Web-shop	Fullerenes	Suspended in liquids (IIIb)	E
Zelens Dermatological (UK) Ltd.	UK	Zelens® Fullerene C-60 Day and Night Cream	Web-shop	Fullerene C60	Suspended in liquids (IIIb)	E
AmerElite Solutions®	USA	The CollagenFusion™ Botanical Skin Care System (6 produkter)	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
MOXIE for men	USA	D-fence™, Antioxidant Moisturizer with SPF 17	Web-shop	Zinc Oxide	Suspended in liquids (IIIb)	E
Ishizawa Laboratories Co., Ltd.	Japan	Nanoce moisture Liquid Foundation	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
G.M.Collin	France	Soothing Moisturizing Lotion Nanoemulsion 10^{-9}	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
G.M.Collin	France	Sun Veil SPF 15 Urban Protection	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
AmorePacific®	Korea	TIME RESPONSE®Skin Renewal Creme	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
Greenyarn LLC.	USA	Soft cloth mask	Web-shop	Not indicated	Surface bound (IIIa)	P
KleinBecker StriVectin™	USA	StriVectin™-NE NanoExfoliant For The Hands™	Web-shop	Not indicated	Suspended in solids (IIIc)	N

Personal care and sports equipment > Sun lotion

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
Blumøller	Denmark	Neutral solfaktor 15	Yes	Titanium dioxide	Suspended in liquids (IIIb)	E
Blumøller	Denmark	Neutral solfaktor 22	Yes	Titanium dioxide	Suspended in liquids (IIIb)	E
Dermatone Laboratories	USA	Lips 'n Face Protection Crème with Z-COTE, Transparent Zinc Oxide	No, Sweden	Zinc Oxide	Suspended in liquids (IIIb)	E
Dermatone Laboratories	USA	Dermatone's Sunblock Crème	No, Sweden	Zinc Oxide og Titanium Dioxide	Suspended in liquids (IIIb)	E
Innovative® Skincare	USA	IS Clinical SPF 20 Moisturizing Treatment Sunscreen	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
NuCelle® Inc.	USA	SunSense™ SPF 30+ Sunscreen	Web-shop	Zinc Oxide	Suspended in liquids (IIIb)	E
Persano	Denmark	Matas sun products (15 pcs.)	Yes	Titanium dioxide	Suspended in liquids (IIIb)	E
Rosacea Care	USA	SUNSCREEN "30"	Web-shop	Zinc Oxide	Suspended in liquids (IIIb)	E
SkinCeuticals®	USA	Defense Sunscreen Products	Web-shop	Zinc Oxide	Suspended in liquids (IIIb)	E

Personal care and sports equipment > Personal care

Name of company	Country of origin	Name of product	Sold in DK	Nanomateriale	Categorization of product	Exposure categorization
Nanogen	UK	Nanogen® Nanofibers	Webshop	Not indicated	Suspended in liquids (IIIb)	E
Nanogen	UK	Nanogen® Nanogaine	Webshop	Not indicated	ikke kategoriseret	
Nanogen	UK	Nanogen® Nanoguard	Webshop	Not indicated	ikke kategoriseret	
Nanogen	UK	Nanogen® Nanothick	Webshop	Not indicated	ikke kategoriseret	
Toasty feet	USA	Toasty feet (Isolating soles)	Webshop	Not indicated	Ikke kategoriseret	
Wilkinson sword	UK	FX Diamond® Razor by Wilkinson Sword® Ltd	Webshop	Not indicated	Surface bound (IIIa)	P

Personal care > Sports equipment

Name of company	Country of origin	Name of product	Sold in DK	Nanomateriale	Categorization of product	Exposure categorization
Nanowax	Germany	Vax products for treatment of e.g. ski (5 products)	No, Germany and Sweden	Not indicated	Suspended in liquids (IIIb)	E
Orca	NZ	Wet suit with nano silicone coatning	webshop	nano silicone	Film (IIb)	P
Accuflex	USA	AccuFlex evolution Golf shaft	Yes	Cabon nano-tubes	Suspended in solids (IIIc)	N
Babolat	France	Babolat® NS™ Drive Tennis Racket	Yes	Cabon nano-tubes	Suspended in solids (IIIc)	N
Babolat	France	Babolat® NS™ Tour Tennis Racket by Babola	Yes	Cabon nano-tubes	Suspended in solids (IIIc)	N
Atomic Snow	Finland	Atomic Snow® Izor Skis	Yes	Cabon nano-tubes	Suspended in solids (IIIc)	N
Head®	Germany	Tennis rackets (5 products)	Yes	Nano titanium	Suspended in solids (IIIc)	N
NanoDynamics	USA	Golf balls	webshop	Not indicated	Suspended in solids (IIIc)	N
Nitro	USA	snowboards	Yes	Not indicated	Suspended in solids (IIIc)	N
Montreal Sports Oy	Finland	Hockey sticks	Yes	carbon nanotubes	Suspended in solids (IIIc)	N
Grafalloy®, Inc.	USA	Shafts for golf clubs	Yes	carbon nanotubes	Suspended in solids (IIIc)	N
Wilson	USA	Badminton and tennis rackets (10 products)	Yes	silicon dioxide	Suspended in solids (IIIc)	N
Wilson	USA	Golf balls	Yes	Not indicated	Suspended in solids (IIIc)	N
Wilson	USA	Golf club	Yes	Nano carbon and titanium	Suspended in solids (IIIc)	N
Yonex	USA	Badminton and tennis rackets (5 products)	Yes	Not indicated	Suspended in solids (IIIc)	N

Personal care > Clothing

Name of company	Country of origin	Name of product	Sold in DK	Nanomateriale	Categorization of product	Exposure categorization
Dockers®	USA	Dockers®Go Khaki®	Yes	Not indicated	Film (IIb)	P
Eddie Bauer	USA	Shirts and trousers (8 products)	Web-shop	Nano-Tex treatment	Film (IIb)	P
Fjällräven	Sweden	Fjällräven Fairbanks jakke	Yes	Nano-Tex treatment	Film (IIb)	P
Greenyarn LLC.	USA	Wristband, elbow guard, knee guard (3 produkter)	Web-shop	Not indicated	Surface bound (IIIa)	P
Greenyarn LLC.	USA	Socks	Web-shop	Not indicated	Surface bound (IIIa)	P
Greenyarn LLC.	USA	Insole	Web-shop	Not indicated	Surface bound (IIIa)	P
Jack Wollfskin	Germany	2 sorts of trousers with Nano-Tex	Web-shop	Not indicated	Film (IIb)	P
JR Nanotech PLC	Sold in UK,	SoleFresh™ socks	Web-shop	nano-silver	Surface bound (IIIa)	P
L.L.Bean	USA	Dirt- and water repelling trousers (4 products + innumerable colours)	Web-shop	Nano-Tex treatment	Film (IIb)	P
Lands' End	USA	Trousers and shorts (2 products)	Web-shop	Nano-Tex treatment	Film (IIb)	P
Lee Jeans	USA	Trousers Nanocare	Web-shop	Not indicated	Film (IIb)	P
Sharper Image®	USA	Antibacterial Silver Athletic and Lounging Socks	Web-shop	silver nanoparticles	Surface bound (IIIa)	P
Sharper Image®	USA	Contour-Foam™ Silver Slippers	Web-shop	silver nanoparticles	Surface bound (IIIa)	P

Home and garden

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
TCNano	Germany	TCNano glass	Yes	Not indicated	Suspended in liquids (IIIb)	E
TCNano	Germany	TCnano all One	Yes	Not indicated	Suspended in liquids (IIIb)	E
TCNano	Germany	TCnano E2U Lak	Yes	Not indicated	Suspended in liquids (IIIb)	E
TCNano	Germany	TCnano Textile	Yes	Not indicated	Suspended in liquids (IIIb)	E
TCNano	Germany	TCnano Facade	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Basic??	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Universal clearing up	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	MultiCover	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Bath and tiles	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Chromium and stainless	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Wood and stone	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Textiles and leather	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Selfcleaning glass	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Antidim glass	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Synthetic material	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Antidim synthetic material	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Not absorbing floor sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Absorbing floor sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	1 Marine sealing K	Yes	Not indicated	Suspended in liquids (IIIb)	E

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
Nanocover	Germany	2 K Marine sealing	Yes	Not indicated	Suspended in liquids (IIIb)	F
Nano-Tec Danmark	Germany	Anti gliding product	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano sealing cheramics/enamel	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano sealing stainless steel	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Textile sealing (15 washes at 60° C	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Tired of sour shoes	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano alga remover	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano leather sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Textile sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Synthetic - gel-coat m.m. 10 kvm	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Synthetic cleaner	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Bath and toilet	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Chrom	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Cheramics& Enamel 10 kvm	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Chrom and stainless and copper, brass etc. m.m.	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Leather	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Tekstil vask til bil 500 ml	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	WIndow glass	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Desinfection 100 ml	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Metal permanent	Yes	Not indicated	Suspended in liquids (IIIb)	E

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
NanoreN	Germany	Floor brickwork	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Terracotta	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Wood stone facade 500ml	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Anti.graffiti 5000ml	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Calcium remover	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	RInse product for lacquer and synthetics	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano, wood, stone	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano stainless steel	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	nano bath, tiles.	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano glass / windows	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano textile	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano for textile TL1.1	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	nano textile	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	nano textile	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano for leatherTL4	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	nano floor.	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	nano for metal	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	nano plants.	Yes	Not indicated	Suspended in liquids (IIIb)	E
Shenzhen Become Industry & Trade Co., Ltd.	China	Air Sanitizer	Web-shop	Silver	Suspended in liquids (IIIb)	E

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
NanoFilm® Ltd.	USA	Clarity Defender™ Automotive Windshield Treatment	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano sponge	Yes	Not indicated	Surface bound (IIIa)	P
LG® Electronics	Korea	LG® Vacuum Cleaner	Yes	Sølv	Surface bound (IIIa)	P
Pilkington plc	USA	Pilkington Activ™ Self Cleaning Glass	Yes	Not indicated	Film (IIb)	P
JCPenney® Company, Inc.	USA	350TC Nano-Tex® Sheet Set by Studio	Web-shop	Not indicated	Surface bound (IIIa)	P
NanoreN	Germany	Nano earth	Yes	Not indicated	Suspended in solids (IIIc)	N
NanoreN	Germany	Rinser	Yes	Not indicated	Suspended in solids (IIIc)	N
NanoreN	Germany	Speed	Yes	Not indicated	Suspended in solids (IIIc)	N
Nanosalg	Germany	synthetic nano	Yes	Not indicated	Suspended in solids (IIIc)	N
Nanosalg	Tyskland	nano safety helmet	Yes	Not indicated	Suspended in solids (IIIc)	N

Automotive

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
Eagle One	USA	Eagle One Nano-Polish™	Yes	Not indicated	Suspended in liquids (IIIb)	E
Eagle One	USA	Eagle One Nanoprotectant™	Yes	Not indicated	Suspended in liquids (IIIb)	E
Eagle One	USA	Eagle One Nanowax®	Yes	Not indicated	Suspended in liquids (IIIb)	E
Eagle One	USA	Eagle One Nanowax® Spray	Yes	Not indicated	Suspended in liquids (IIIb)	E
Kleinmann GmbH	Germany	Nano rim-sealant	No, Sverige	Not indicated	Suspended in liquids (IIIb)	E
Kleinmann GmbH	Germany	Nano textile- / leather-sealant	No, Sverige	Not indicated	Suspended in liquids (IIIb)	E
Kleinmann GmbH	Germany	Nano Anti-mist	No, Sverige	Not indicated	Suspended in liquids (IIIb)	E
Kleinmann GmbH	Germany	Nano spray windscreen sealant	No, Sverige	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Carglasses	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	Alu-rim sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	1 Laquer sealing K	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanocover	Germany	2 Laquer sealing K	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Auto laquer - fælge	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	WIndscreen treatment	Yes	Not indicated	Suspended in liquids (IIIb)	E
NanoreN	Germany	Lacquer cleaner	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	PD-5 -nanotechnology	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano sealed windscreen	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	Nano sealing for car windscreens	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	nano textile	Yes	Not indicated	Suspended in liquids (IIIb)	E

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
Nanosalg	Germany	Nano car and rim paint	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nanosalg	Germany	RInse product for lacquer and synthetic material	Yes	Not indicated	Suspended in liquids (IIIb)	**E**
Nano-Tec Danmark	Germany	Sealing for car windscreen	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano rim sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano synthetic sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano lacquer sealing	Yes	Not indicated	Suspended in liquids (IIIb)	E
Oxonica Energy Oxonica® Ltd.	England	Envirox™ Fuel Borne Catalyst	Yes	Not indicated	Suspended in liquids (IIIb)	E
Turtle Wax®, Inc.	USA	Turtle Wax® F21™ Super Protectant Wax	Yes	Not indicated	Suspended in liquids (IIIb)	E
Nano-Tec Danmark	Germany	Nano sponges	Yes	Not indicated	Surface bound (IIIa)	P

Appliances

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
Samsung	Korea	Washing machine	Yes	Silverparticles	Suspended in liquids (IIIb)	E
Samsung	Korea	Washing machine	Yes	Silverparticles	Surface bound (IIIa)	P
Samsung	Korea	Refrigerators	Yes	Silverparticles	Surface bound (IIIa)	P
LG®	Korea	LG® Refrigerator	Yes	Silverparticles	Surface bound (IIIa)	P

Electronics and computers

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
Apple®, Inc.	USA	iPod Nano®	Yes	Not indicated	Structured film (IIc)	P
Eastman Kodak® Company	USA	Ultima® Photo Paper	Yes	Not indicated	Surface bound (IIIa)	P
LG® Electronics	Korea	LG® Antibacterial Mobile Phone	Yes	Silver	Structured film (IIc)	P
Pioneer®	USA	Pioneer® Organic Electroluminescent (OEL) Display	Yes	Not indicated	Structured film (IIc)	P
Pioneer®	USA	Pioneer® Organic Electroluminescent (OEL) Display	Yes	Not indicated	Structured film (IIc)	P
Samsung	Korea	Samsung® Organic Light Emitting Diodes (OLEDs)	Probably	Not indicated	Structured film (IIc)	P
Sanyo ®	Japan	Sanyo® Organic Electroluminscent (OEL) Displays	Ja	Not indicated	Structured film (IIc)	P
Siemens® Hearing Instruments	USA	Hearing Instrument	Ja	Nanocoated surface	Film (IIb)	P
Sony®	Japan	Sony® Corporation Organic Light Emitting Diodes (OLEDs)	Ja	Not indicated	Structured film (IIc)	P
Universal Display Corporation®	USA	Universal Display Corporation® Organic Light Emitting Diodes (OLEDs)	Probably	Not indicated	Structured film (IIc)	P

Cross cuttings

Name of company	Country of origin	Name of product	Sold in DK	Nanomaterial	Categorization of product	Exposure categorization
NanoFilm® Ltd.	USA	Clarity® Lens, Display and Optics Cleaners and Refreshers	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
Nano-protex mv.	AUS	Surface treatment products for glass cheramics, concrete, textiles.	Web-shop	Not indicated	Suspended in liquids (IIIb)	E
TCNano	Germany	TCnano Agro	Yes	Not indicated	Suspended in liquids (IIIb)	E