Bibliometric Analysis of Scientific Publications and Patents of Functional Textiles and Fibers

Overview

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AIT-IS-Report Vol. 90, May 2014

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Innovation Systems Department

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1 Introduction and Objectives

The EU-funded project 2BFUNTEX aims to exploit the untapped potential in functional textile structures and textile related materials. It will bring together all innovation actors in the field fostering a multidisciplinary approach between universities, research institutes, SMEs (in textile 95% of the companies are SMEs) and sector associations. Technological gaps and barriers will be identified resulting in a faster industrial uptake of added value functional materials with new functionalities and improved performance and resulting in creation of new business worldwide. Additional objectives are the mapping of technological needs, the identification of new joint international research disciplines and creation of multidisciplinary teams between universities, research institutes and SME research departments. International cooperation will be favoured to exploit the worldwide market expansion potential.

Work Packages 1 and 2 of 2BFUNTEX aim at creating an overview on technological and non-technological information on functional textiles and textile related materials in order to identify technology innovations, evaluate already existing networks and the potential in up to now unused collaboration. The information is derived from bibliometric analysis and an inventory of research activity of all partners involved is created. The advantage of these methods is based on the possibility of content-based structuring of the information, the identification of subtopics, the visualization of the contents, of structure and connections of the information.

1.1 Publication and Patent Analysis

To achieve the goals of the project scientometric and bibliometric methods can serve as a valuable tool for gaining an overview on a research topic and insight into scientific literature and patent applications, analysis and clustering in order to identify

- research fronts and their emerging topics and technologies as well as their dynamics,
- application of technologies through patent analysis, and
- key players, i.e. the most important organizations, top researchers and the connections between them

Scientific activity and the associated research output are reflected in the number of scientific publications issued worldwide in any field of research. Consequently, high numbers of scientific papers on a particular technology in a certain area indicate high scientific activities and specialization in this area, whereas low activities may result in technological dependencies on other regions concerning the particular technology. **Patent data** on the other hand is one of the most detailed and complete data source for the analysis of technology development with respect to time, country, or technologies [5] [6]. A big advantage of patent records is that this data directly represents technologies, not companies or proxies for technologies. Patents are representative of the magnitude, direction, and impact of the knowledge spilling out of universities towards potential uptake by industry.In this project networks of scientific literature and patents were created and the above listed information extracted, which served as basis for further discussions and support for multidisciplinary teams for identification of relevant players in their research field. Beside identification of topics and keyplayers networks have the added benefit of showing connections between topics or actors, thus identifying related topics or collaboration between organisations.

What is the value of scientometric resp. bibliometric method? The advantage of these methods is based on the possibility of content-based structuring of information, the identification of subtopics, the visualization of the contents, of structure and connections of information. Thus the application of bibliometric analysis helps to create an overview and can form basis for further discussions and development of new topics.

It is notable that the field of functional textiles is still a well-researched topic with both output in scientific papers and patents increasing. While scientific publications concentrate more on materials and processes, patents reveal more market trends and show a focus on textile machines rather than material. Apart from patent classes directly related to textiles (the highest range in patent classes are D06 – treatment of textiles and D01 natural or artificial threats) patent classes H01 – basic electric elements and C08 organic macromolecular compounds have the highest rates in patent application within the search of “functional textiles”. Market trends in scientific literature can

be detected in some minor topics, concentrating on cleaning materials or endovascular devices. More details on the identified topics are depicted in Figure 8 and Figure 9 in chapter 3.5.

1.2 The Research Questions

The basic idea is to get an **overview** of issues of “Functional Textiles” **in scientific literature and patent data** by mapping research and patent topics. Thus the analysis of the derived data includes the following research questions:

- Which **topics** are currently worked on in **science and research?**
- Which topics do we find in **patents** regarding functional textiles?
- Which of the **topics** are currently **emerging**?
- In which **parts of the world** are there activities?
- Which **organizations** are the most visible ones in those emerging topics?
- Which **academic scientists and industrial researchers** are most visible in these topics?
- Which other **themes** are closely connected to the identified topics?
- Are the identified **publication topics** also reflected in **patent analysis**?

2 Analytical Approach

2.1 Methodology

The focus of the investigation has been on the scientific and patenting activities on a general level in “Functional Textiles”. Scientometric and bibliometric methods support this analysis where science maps were generated.

The computation of science maps is based on the two dimensional representation of the co-occurrence matrix of terms in the relevant literature (reviewed journals, conference proceedings, patents). The representation of the inter-term relations is done via a spring model and by clustering algorithms. Depending on the question of investigation, the map renders descriptors (keywords), extracted noun phrases (e.g. extracted from Abstracts and titles), actors (authors, organizations) or a combination thereof. By defining appropriate indicators, it is possible to **identify emerging research** fields or **emerging or incumbent key players in the relevant scientific communities**. The calculations were done with the tool BibTechMon™, which was developed by AIT Austrian Institute of Technology GmbH [1], [2], [3].

The basis of the analysis is the data (see also 3.2 below). Critical point for the quality of the data is the applied search strategy, which was drawn up after consultation with experts and adjusted to reach the best possible results. Keywords were defined and publications matching these technologies in Web of Knowledge℠ were reviewed and verified with experts in order to refine the search strategy. This procedure was repeated and resulted in the best matching publications that were extracted and used for bibliometric analysis.

2.2 Data Acquisition

For the investigation of the activities in science the source “Web of Knowledge” is used. The Web of Knowledge℠ from Thomson Reuters is an online database and provides a citation databases and covers over 10,000 of the highest impact journals worldwide, including Open Access journals and over 110,000 conference proceedings with the focus on essential data across 256 disciplines.

For patent analysis patent data provided by the European Patent Office (EPO)[1] were used, which give a detailed picture of technology development in Europe and for developments that are relevant for the European market.

The search strategies for “FUNCTIONAL TEXTILES” were the following:

Search Strategy in Web of Knowledge

- Topic=(**functional** OR **wearable** OR **smart** OR **antibacterial** OR **electronic*** OR (**flame retardant**) OR (**self cleaning**) OR **permeability**) AND Topic=(**textil*** OR **clothes**) NOT Topic=(snake OR snail OR endotoxin* OR dye*)
- OR Topic=(***fibre OR *fiber**) AND Topic=(textil* OR cloth*) NOT Topic=(snake OR snail OR endotoxin* OR dye*)
- OR Topic=((**smart AND color***) OR (smart AND colour*) **AND textil***) NOT Topic=(COLORECTAL)

Time period: 1989 until 23.July 2012

Result: **8,931 recorded articles**

Patent online search in PATSTAT 2012/10

The following keywords were searched in **title of applications**:

- **Textile** AND (**functional** OR **wearable** OR **smart** OR **antibacterial** OR **electro** OR **plasma** OR **retardant** OR **cleaning**)
- **Fibre** (fiber) AND (**textile** OR **electro** OR **plasma**)
- **Textile** AND (**smart** AND **colo**(u)**r**)

Time period: 1990 until 01.April 2013

Result: **8,982 patents**

2.3 Analytical Concepts

The extracted data were structured and statistical analysis performed in order to get an overview of development of publications and patents along the timeline, countries and organizations with most publication activity in scientific articles and most cited IPC codes in patent analysis.

As a next step networks were calculated using the software BibTechMon™ which has been developed in AIT Austrian Institute of Technology [1] [2] [3]. The tool is based on the methodology of co-object analysis. In case of literature analysis an object (a node) is a paper. The “size” of a node is related to the number of cited references used in this paper. The more references a paper cites, the “bigger” the node is. Two papers share an edge if they cite the same reference. The more references two papers share, the closer they are related and thus are drawn together closer in the network. The nodes find their positions in the network graph based on their relations to all other nodes. This results in a network of nodes, where clusters of nodes dealing with similar topics are formed. Papers lying within these clusters can be studied whereby topics are identified and labeled. This results in a map of research areas and topics, with research fronts, clusters of highly cited papers, standing out.

In order to analyse the development of these research topics over time “portfolios” are calculated, where publication activity within one topic from one period (in our case 2002 -2006) is compared to the following period (2007-2011). The higher the share of the second period compared with the share of the first period the more active research in a topic is. Portfolios therefore show increasing or decreasing research activities of topics thus depicting “emerging” topics with increasing research activity over the observed period.

Regarding patents a similar analysis to identify research topic was carried out. In this map of patents the relation of each patent to another is according to the International Patent Class (IPC)

- [1] EPO Patstat April 2012 edition

codes they share with each other. If two patents share a lot of IPC codes the respective nodes “move” very close to each other in the network. This graph was also drawn up using BibTech-Mon™.

Within both network (scientific publication network and patent network) the height of peaks is a correlation to number of publications or patents in a given field. The position of themes to each other is an indicator for closely or unrelated topics; each topic is colour coded, subtopics have the same shade.

3 Results of Bibliometric Analysis

To gain an overview of the development of the topic under investigation some general statistics of the data sets are presented. The development of research in different countries as well as topics identified with BibTechMon™ are presented..

3.1 Development along the Timeline

Overall the publication and patenting activity in the field “Functional Textiles” has grown considerably over the last decades (Figure 1 and Figure 2). Figure 2 shows the development of approved patents in the last years and a drop is noticeable after the increase until 2008. The time lag between priority date (filing an application) and final grant of the patent can add up to several years. As a consequence, patent data issued after 2008 seems to be less reliable than data from the mid-2000s and in considering approved patents only we notice a time lag in the approved patents of about 3-4 years.

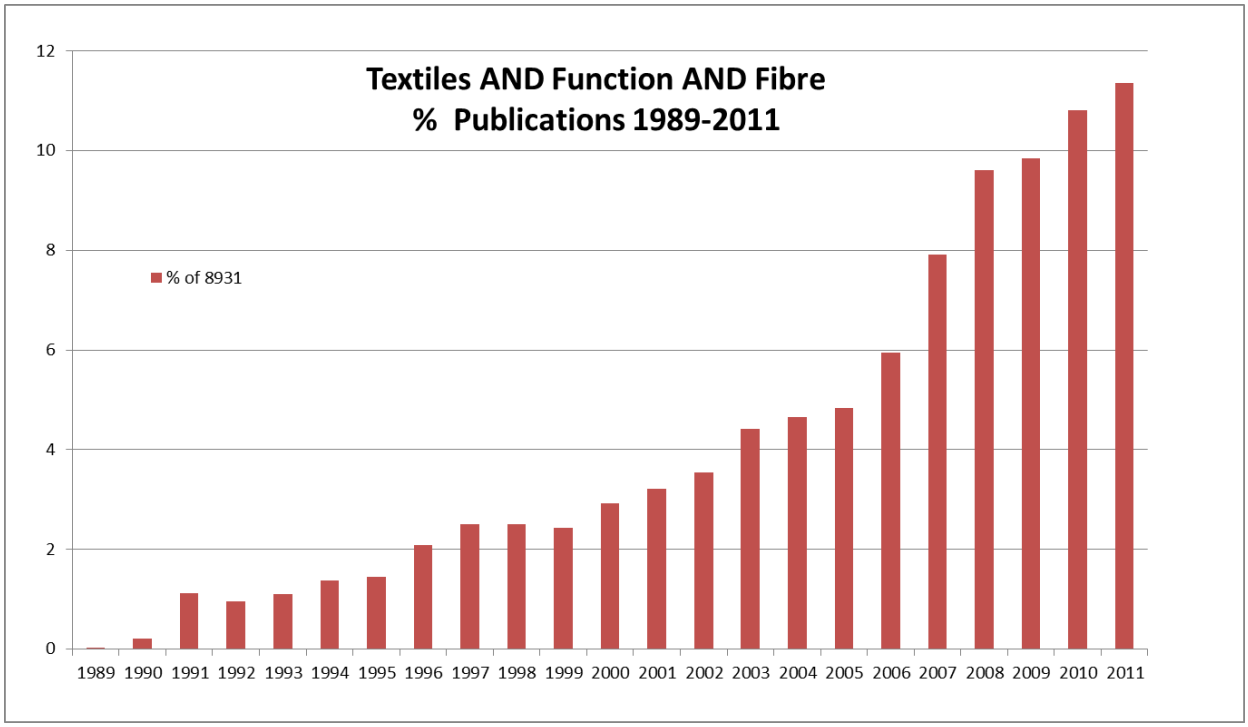

Figure 1: Share of articles in scientific literature on "Functional Textiles" (search strategy see chapter 2.2)

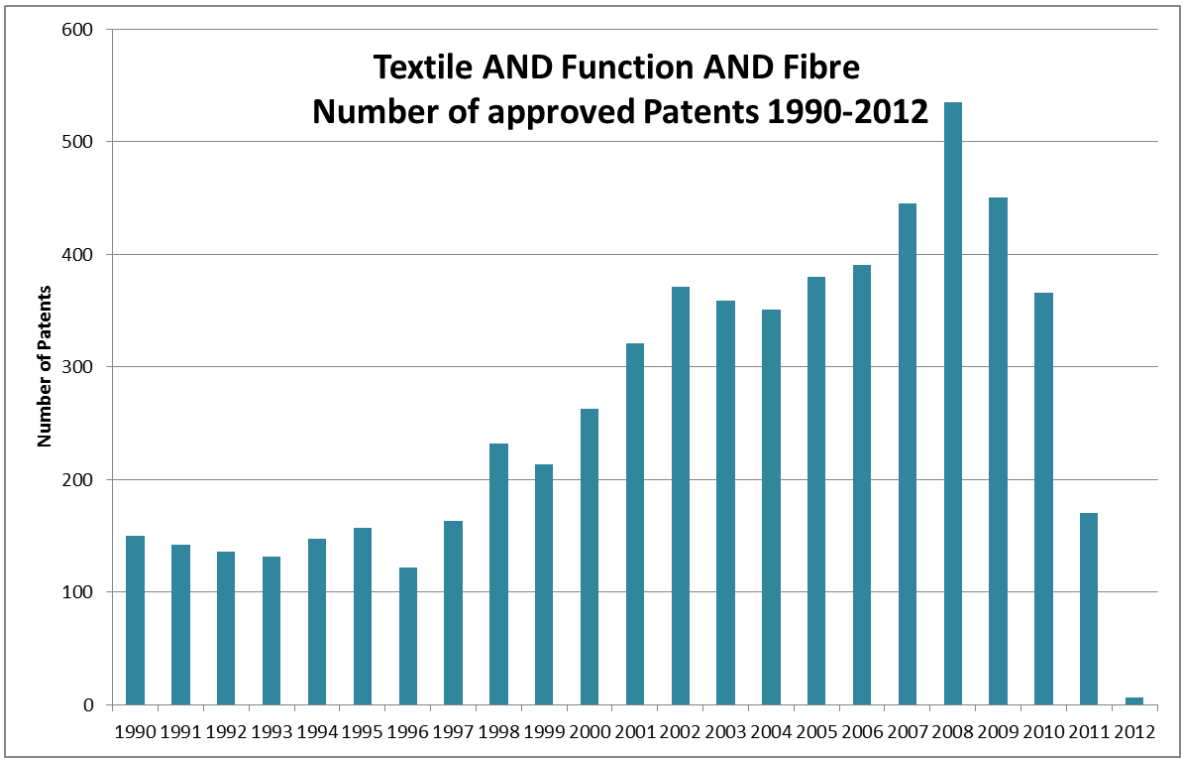

Figure 2: Share of approved patents in "Functional Textiles" in the years 1990-2012 (search strategy see chapter 2.2)

3.2 Regional Distribution among Continents and Countries

As the production of textiles is shifting more and more to eastern and far eastern countries the development of worldwide research activities was of major interest to the project team. A portfolio of continents was created to visualize the trends in publication activities (Figure 3). For calculation of the portfolio the data were divided into two time periods, 2002 – 2006, and 2007 – 2011. Then we calculated the share of a continent in the whole data set, which is presented by the size of the circle. The bigger the circle of a continent the higher the share of articles assigned to this continent regarding the whole data set is. The section on the abscissa represents the share of a continent of the second time period 2007- 2011. The section on the ordinate shows the variation between the share of the first time period 2002 – 2006 and the second one. The higher the share of the second period compared with the share of the first period the more positive the ordinate of the considered continent.

The most growth in the publication activities lies obviously in Asia also with a big share of all publications (size of the circle), and a high proportion for the second time period (part on the abscissa). Europe is strongly visible and represented with the biggest share of the whole data set as well as for the second period, but the activities in Europe have not increased (the midpoint of the circle is located on the abscissa). The low publication activities in South America, Africa, and Oceania are pretty stable.

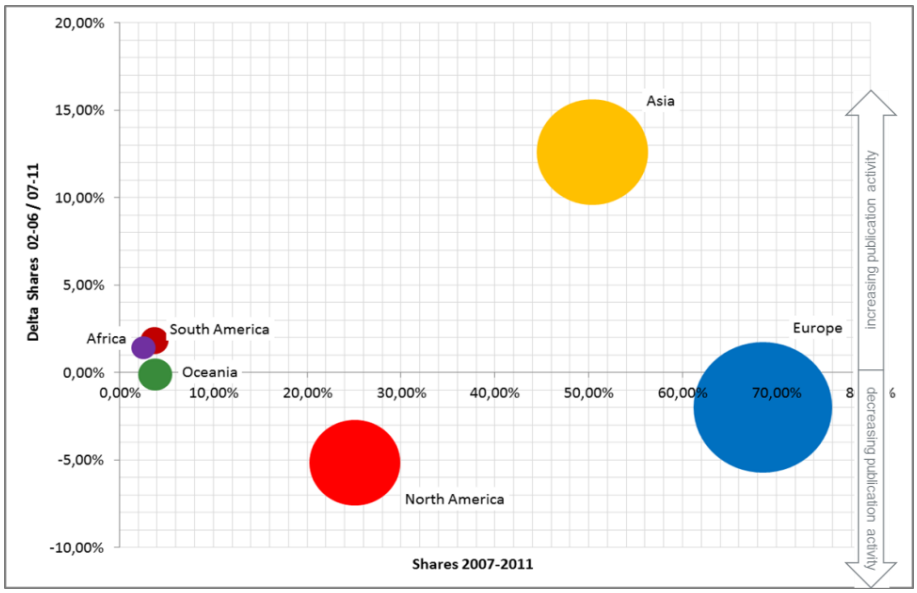

Figure 3: Portfolio analysis of publication activity across continents

A comparison on country level is presented in Figure 4, where also patent analysis is depicted. In both analyses USA and China are the strongest single countries, but if European countries are summarized they present the country with highest publication and patenting level. In patents we also find the class of International World Patents that were applied for not in a country but for the whole world.

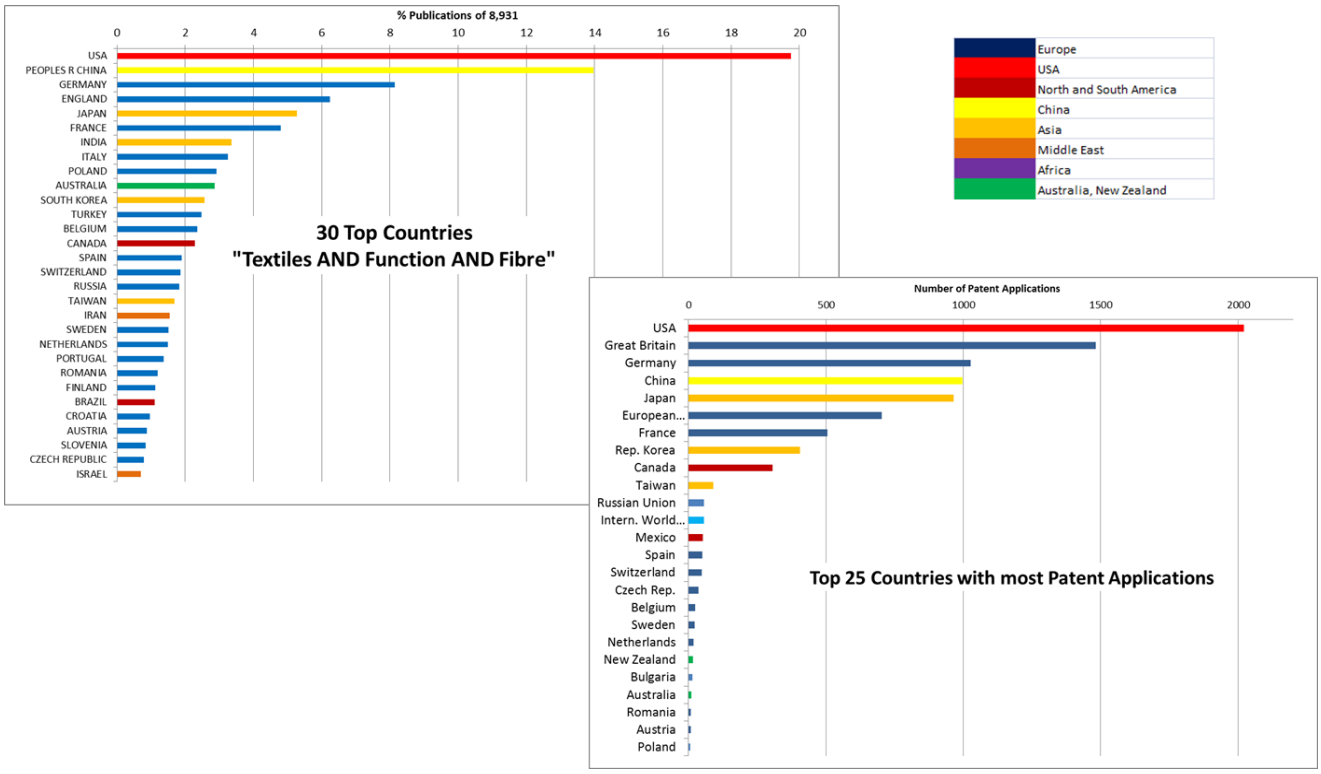

Figure 4: Country distribution of scientific publications (1989-2012) and patents (1990-2012)

3.3 Most Visible Organizations

The analysis of organizations is demanding as the spelling and notation of an organization's name is not unique in the data source. Organizations could have changed their names or organization structures over the considered time span of 10 years. Mergers and reorganizations of institutes and companies are not documented in the data sources. Therefore the available information of organizations in the specific data field was standardized manually. Even this work proofed to be a

challenge. As countries have different institutional structures on universities for instance, s the department is quoted, sometimes a business unit, or the institute, and often it is not possible to decide about the hierarchical role of them. Nevertheless standardization was performed to show the visibility of the organizations. Therefore the reader is asked to take these preceding thoughts into account for considering the analysis of organizations.

Figure 5 represents the 30 most visible organizations in scientific literature on “Functional Textiles and Fibers”. The chart unveils plainly that organizations from USA and Europe dominate these first 30 organizations. Europe is represented by 13 different organizations, the USA by eight. China provides the two most active universities with most publications and another two organizations on rank 10 and 23. Besides China two other Asian organizations appear among in the ranking, one Indian and one from Singapore.

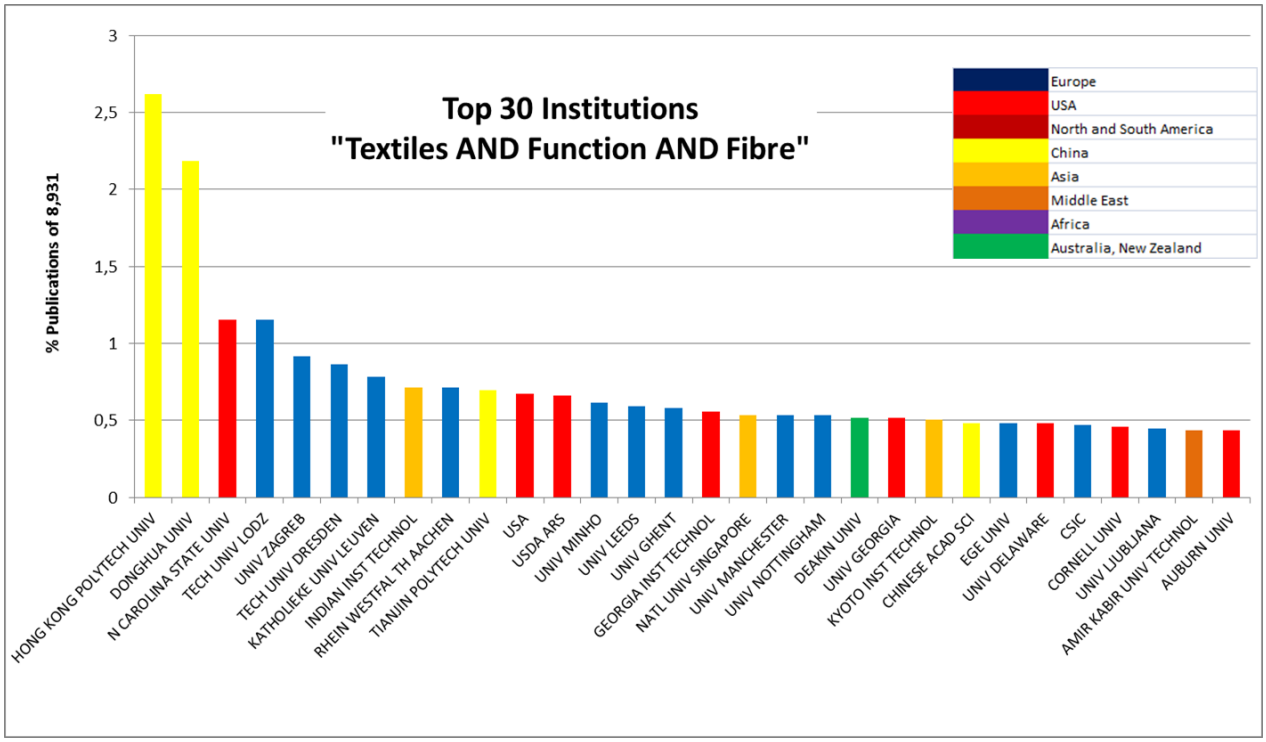

Figure 5: Most visible organizations in the data set “Functional Textiles”

3.4 Distribution of Patents in IPC Classes

Patent data is one of the most detailed and complete data source for the analysis of technology development with respect to time, country, or technologies [5][6][6]. A big advantage of patent records is that this data directly represents technologies, not companies or proxies for technologies. Patent data provides an elaborated classification scheme for these technologies - International Patent Classification (IPC) - which is more detailed than the taxonomies for publications or economic activities. Moreover, patents are the outcome of an innovation process and are, therefore, expected to be economically valuable in one way or another; either by using them, or by preventing their use by competitors. Otherwise, a company would not apply for patent. However, patents are not the only way of protecting intellectual property from the use by others. In some industries, firms also employ alternative mechanisms of protection, such as secrecy or lead-time over competitors [4]. Complementary marketing and manufacturing capabilities may also supplement or even replace patent protection.

The hierarchical structure of the International Patent Classification (IPC) comprises the following levels: Section, Class, Subclass, Main Group, and Sub-Group. Each level is denoted by an alpha-numeric code with several digits. Table 1exemplifies the structure.

Table 1. Overview of the hierarchical structure of the IPC Classification

A	**61**	**K**	**31**	**/**	**01**
Section	Class	Subclass	Main Group		Sub-Group

Figure 6 and Figure 7 illustrate the distribution of patents in functional textiles and fibres across patent sections and patent classes, which are also listed in Table 2. Most patent applications can be found in **section D (Textiles and Papers)**, but also important main classes are from **section H (Electricity), C (Chemistry, Metallurgy) and G (Physics).** Within these sections, the classes most frequently used for functional textile patents were:

- Section D (Textile and Papers): treatment of textiles (D06) and natural or artificial threads or fibres and spinning (D01) were mostly cited.
- Section H (Electricity): Basic electric elements (H01) and electric techniques (H05) and electric communication techniques (H04) are the main classes dealing with electricity.
- Section C (Chemistry): organic macromolecular compounds (C08), animal or vegetable oils or fats (C11) and dyes, paints and polishes (C09).
- Section G (Physics): optics (G02) or measuring and testing (G01).
- Section A (Humanities) mainly medical and veterinary science and hygiene (A61), also furniture (A47) and agriculture (A01).

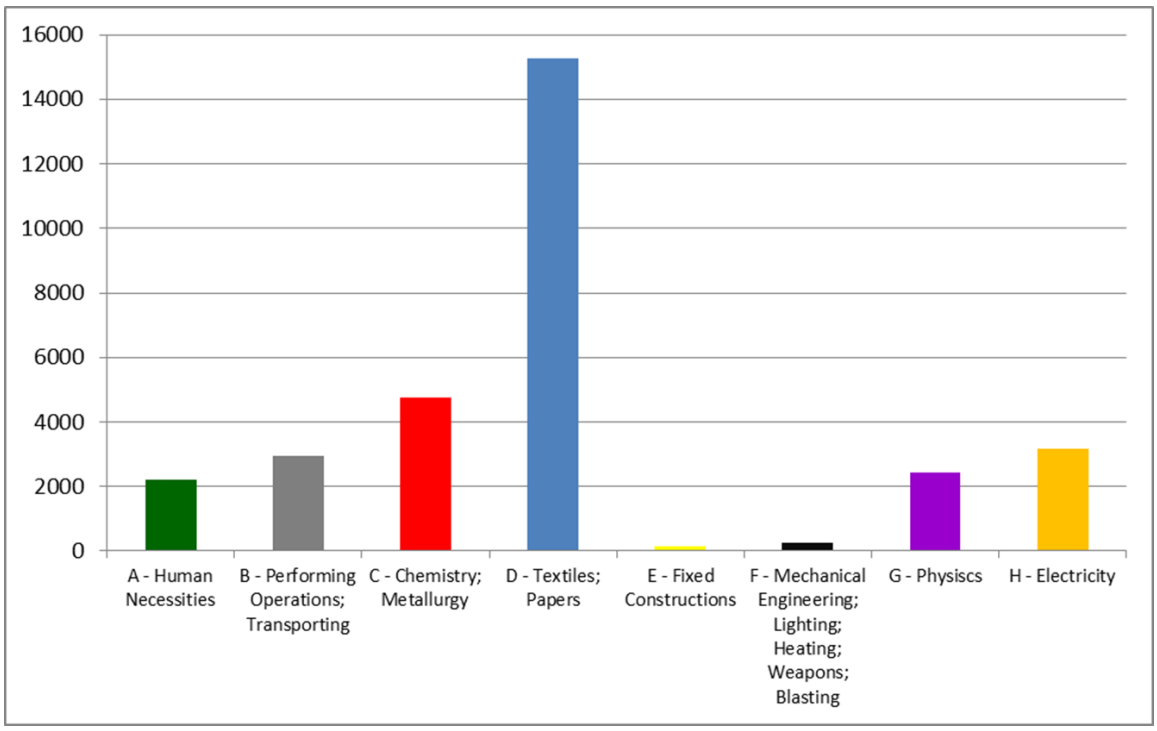

Figure 6: Distribution of "Functional Textiles" patents across patent sections

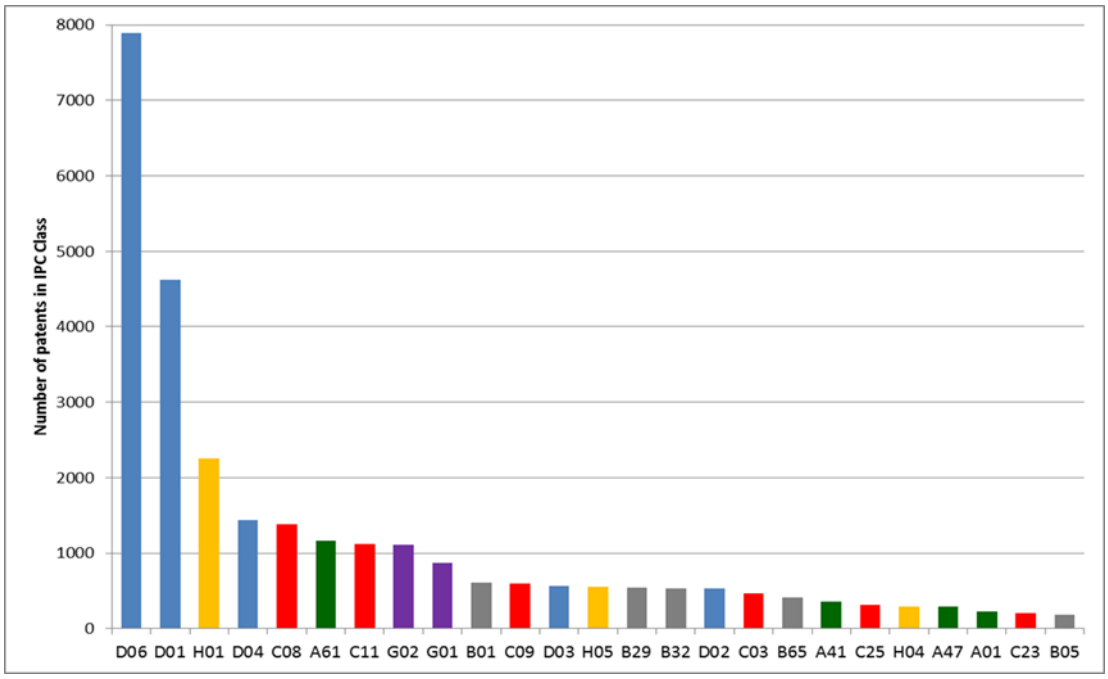

Figure 7: Distribution of "Functional Textiles" patents in patent classes

Table 2: Most mentioned patent main classes of "Functional Textiles" patents

Main Class	Description
D06	Treatment of textiles or the like; laundering; flexible materials not otherwise provided for
D01	Natural or artificial threads or fibres; spinning
H01	Basic electric elements
D04	Braiding; lace-making; knitting; trimmings; non-woven fabrics
C08	Organic macromolecular compounds; their preparation or chemical working-up; compositions based there-on
A61	Medical or veterinary science; hygiene
C11	Animal or vegetable oils, fats, fatty substances or waxes; fatty acids therefrom; detergents; candles
G02	Optics
G01	Measuring; testing
B01	Physical or chemical processes or apparatus in general
C09	Dyes; paints; polishes; natural resins; adhesives; compositions or applications of materials not otherwise provided for
D03	Weaving
H05	Electric techniques not otherwise provided for
B29	Working of plastics or of substances in a plastic state
B32	Layered products
D02	Yarns; mech. finishing of yarns or ropes; warping or beaming
C03	Glass; mineral or slag wool
B65	Conveying; packing; storing; handling thin or filamentary material
A41	Wearing apparel
C25	Electrolytic or electrophoretic processes; apparatus therefor
H04	Electric communication technique
A47	Furniture; domestic articles or appliances; coffee mills; spice mills; suction cleaners in general
A01	Agriculture; forestry; animal husbandry; hunting; trapping; fishing
C23	Coating metallic material; coating material with metallic material; chemical surface treatment; …
B05	Spraying or atomising in general; applying liquids or other fluent materials to surfaces, in general

3.5 Comparison of Topics in Scientific Literature and Patents

The calculation of a **portfolio** gives insight into the growth of **research activity** in different fields in the diverse area “Functional Textiles”. The fields were defined in the following way: First a **cluster analysis** was applied to the **network of co-citation analysis**. The references or citations respectively build a „knowledge base“ of a publication or an article. Therefore articles with a similar “knowledge base” cluster relatively clearly and hence build specific topics, so-called “**research fronts**”. The analysis of research fronts provides an excellent overview on “hot” topics in functional textile research (Figure 8). An extensive list of analysed topics can be found in the appendix. The following topics clearly stand out in this analysis:

- Functional Textiles
- Woven Textile Composites
- Electronic Textiles
- Electrospinning / Nanofibers

The height of the peaks correlated with the number of publications. The position of topics relative to each other indicates how close these topics are related. Figure 8 also shows a **portfolio analysis** which identifies increasing, decreasing or stable research topics. Green arrows indicate increasing research activity in the last five years, red arrows decreasing or stable activity. Additional charts of portfolio analysis are also included in the appendix (Figure 10 and details in Figure 11).

In **patent analysis** the networks of patents were calculated according to similarities in IPC codes cited by the patents, also resulting in clusters that were then identified and labelled. Comparison of literature and patent analysis showed the following overlapping topics:

- Carbon fibers for electrodes, batteries, fuel cells, nanofibers, microelectrodes
- Electronic Textiles – electroconductive fibers
- Functional Fibers and Textiles - applications
- Functional Finishing of Textiles (antimicrobial, bleach resistant, water repellent, flame retardant,…)
- Nanofibers, Electrospinning
- Woven Textile Composites (2D&3D, properties)

Patents also deal with textile machines, their development and improvement in all production steps as well as cleaning of textiles, starting from cleaning of fibres to finished products, like carpets or clothes. Also optical fibres and their application as well as carbon fibres used as electrodes and in fuel cells are among the identified topics in patent applications. Scientific literature on the other hand includes topics on fibre, their properties and functionalities.

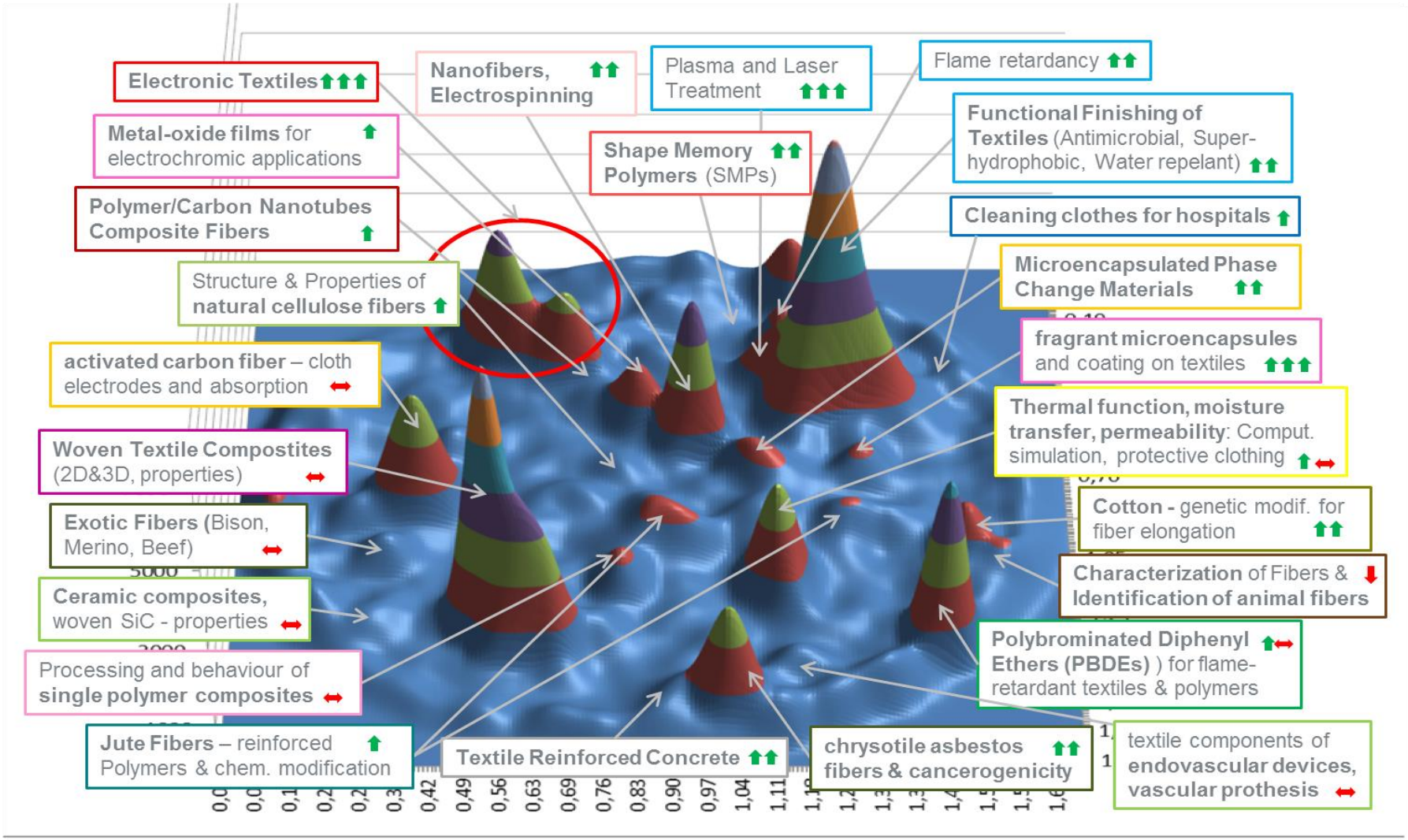

Figure 8. Analysis of Research Fronts in Scientific Publications on "Functional Textiles" 1989 to 2012. Depicted are 8,931 recorded articles. Arrows indicate the dynamic of research activity over the last 10 years: green arrows indicate that a topic is increasing, red arrows that a topic is decreasing or stable. The graph was drawn up using BibTechMon™.

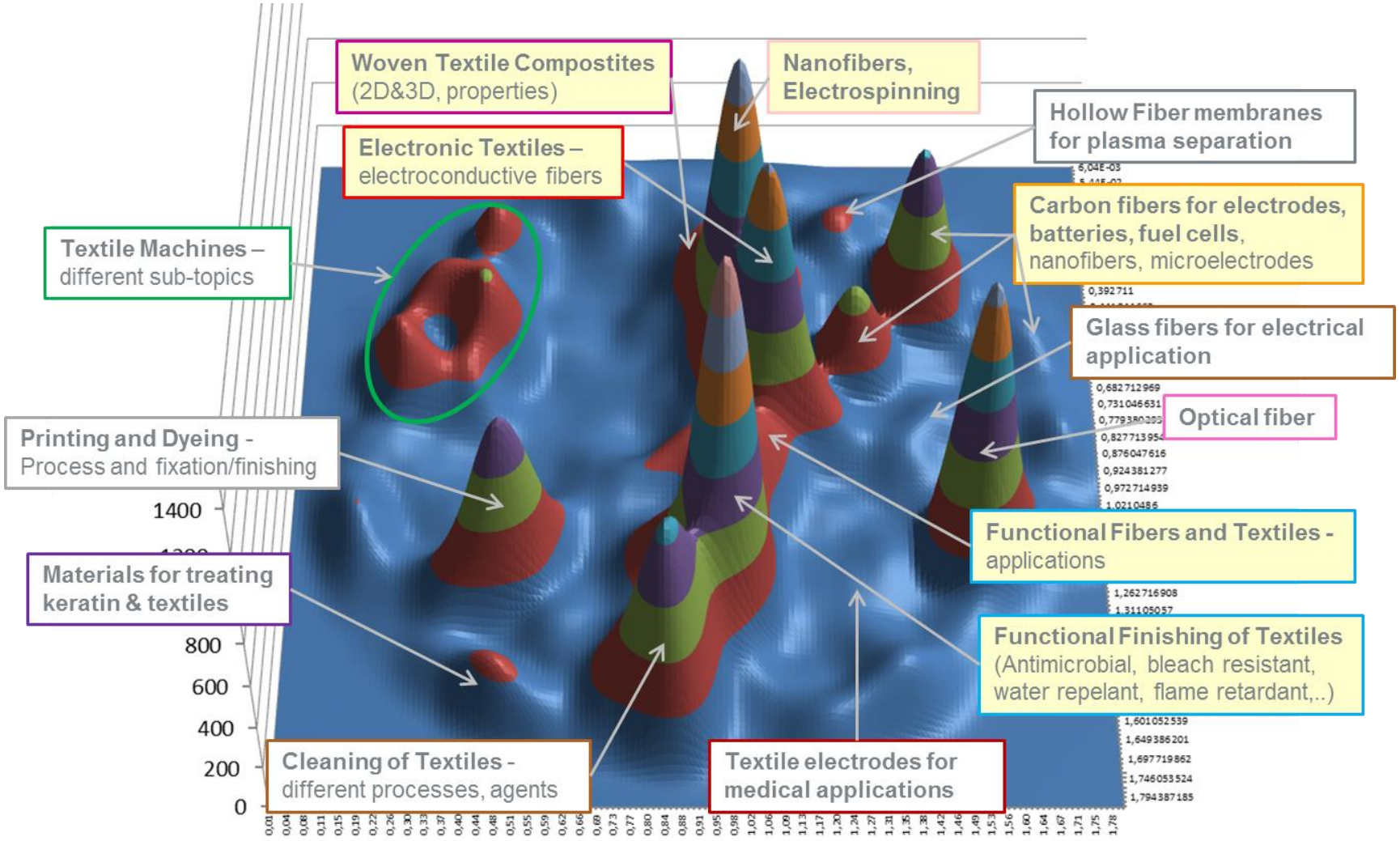

Figure 9. Patent Analysis of „functional textiles“ connected through IPC codes. If two patents share a lot of IPC codes they move close to each other. Height of peaks is a correlation to number of patents in a given field. The position of themes relative to each other is an indicator for close or not related topics. Each topic is colour coded, subtopics have the same shade. Yellow labels indicate topics, that also appear in the Research Front network (**Figure 8**). The graph was drawn up using BibTechMon™.

4 References

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5 Appendix

5.1 Analysed Topics in Scientific Literature

Fibre

- Characterization of Fibres Using Optical Techniques (RF 6)
- Chrysotile asbestos fibres & cancerogenicity (RF 7)
- Cotton - genetic modification for fibre elongation(RF 10)
- Exotic fibres - Production, properties and processing (superfine merino, American Bison, beef) (RF 19)
- Identification of speciality animal fibres (RF 25)
- Structure and properties of natural cellulose fibres - sea weed, cornstalks, sorghum, soy bean (RF 41)

Composites

- Adhesion between butyl rubber and polyester fabric (RF 3)
- Ceramic composites, woven SiC – properties (RF 5)
- Jute-Reinforced Polymer Composite (RF 26)
- Plant Fibre Formation and chemical modification of jute fibres /RF 33)
- Polymer/Carbon Nanotubes Composite Fibres (RF 36)
- Processing and behaviour of single polymer composites (RF37)
- Textile Reinforced Concrete (RF42)
- Woven composites - Permeability, modelling of Permeability, 3D (RF 45)
- Woven textile composites - 2&3D (RF 46)
- Woven, textile composites - mechanical behaviour, permeability, modelling, simulation (RF 47)

Properties

- Colour Prediction for Blends of Pre-coloured Wool (RF 9)
- Enzymatic modification of textiles (RF 17)
- Fabric smoothness, silk (RF 20)
- Relaxation in fabrics or fibres (RF 39)
- Yarn Strength Modelling using neural networks and computational methods (RF 48)

Electronic Textiles

- electronic textiles - (polymer) conductive fibres (RF 11)
- electronic textiles - flexible energy storage, supercapacitors (RF 12)
- electronic textiles - Stretchable Electronic Systems (RF 13)
- electronic textiles - wearable antenna (RF 14)
- electronic textiles -sensor systems for healthcare smart textile (RF 15)
- electronic textiles, smart textiles, e-textiles, conductive fibres, biomedicinal sensors (RF 16)
- Metal-oxide films for electrochromic applications (RF 27)

Technologies and Applications

- Cloth catalysts for water denitrification (RF 8)
- fragrant microcapsules and coating on textiles (RF 22)
- Hospital cleaning, cleaning clothes (RF 24)
- Microbial fuel cells, fibre brush anodes (RF 28)
- Microencapsulated Phase Change Materials (for thermo stabilisation) (RF 29)
- Modification of textiles with laser and plasma (RF 30)
- Nanofibers, Electrospinning - fibres with additional function, conductivity, pH (RF 32)
- Plasma treatment of textiles to change properties (esp. antimicrobial, hydrophobic,.. (RF 34))
- Prototype textile components of endovascular devices, new vascular woven prosthesis - models for predicting performance (RF 38)
- Shape-memory polymers (SMPs) (RF 40)

Functionalities

- Activated carbon fibre cloth electrodes (RF 1)
- Activated carbon fabrics, fibres - adsorption (RF 2)
- Antimicrobial, antibacterial, treatment, particles & finishings (RF 4)
- Flame retardancy, flammability, coatings & treatments (RF 21)
- Functional finishing textiles (Super hydrophobic, water repellent, antibacterial) (RF 23)
- Moisture sorption mechanism of aromatic polyamide fibres (RF 31)
- Polybrominated Diphenyl Ethers (PBDEs)) for flame-retardant textiles & polymers - Risk for health & Environment?(RF 35)
- Thermal function, heat, moisture transfer: Computational simulation, Engineering design, sensitive analysis (RF 43)
- Ventilation, permeability, thermal insulation, protective clothing (RF 44)

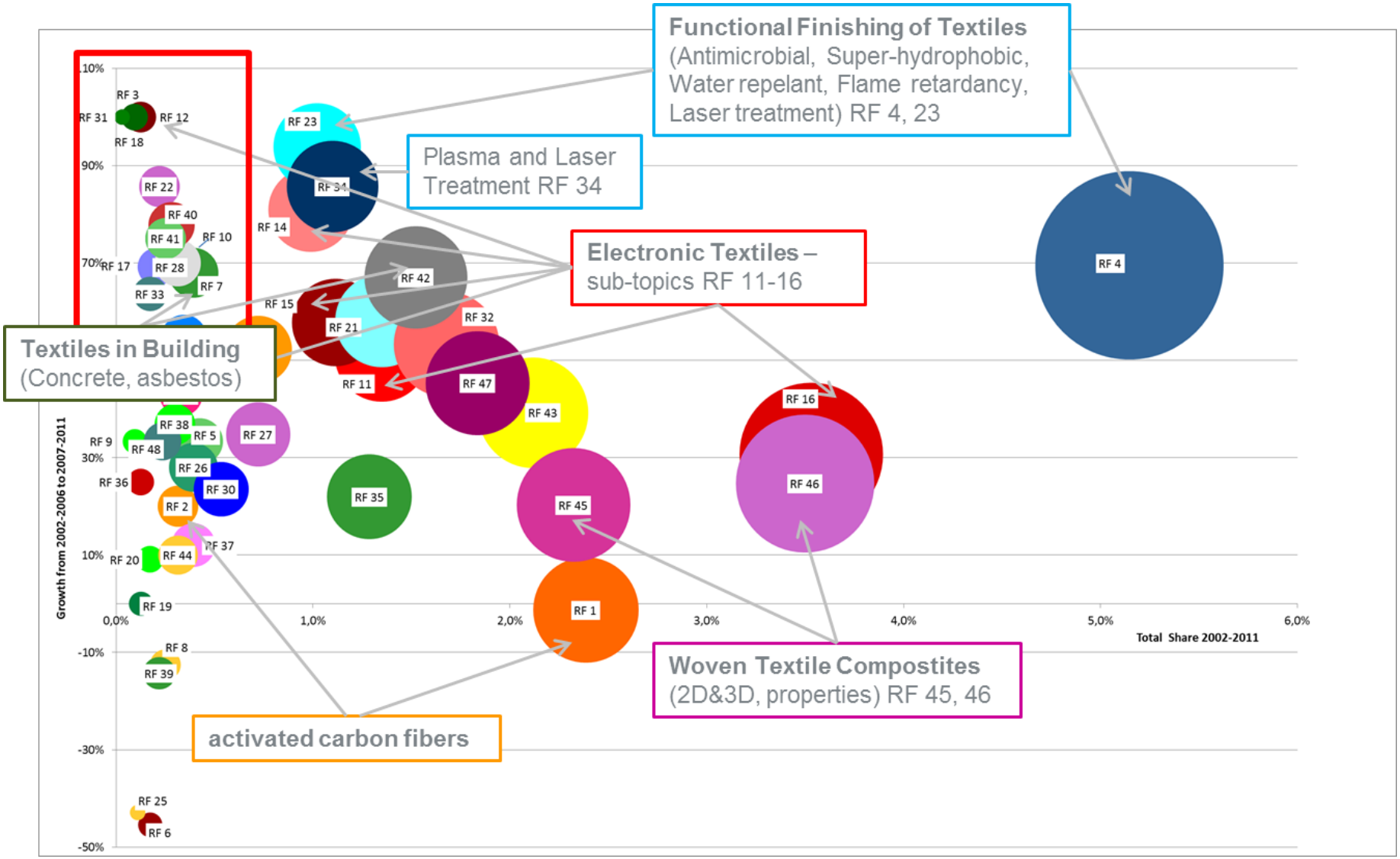
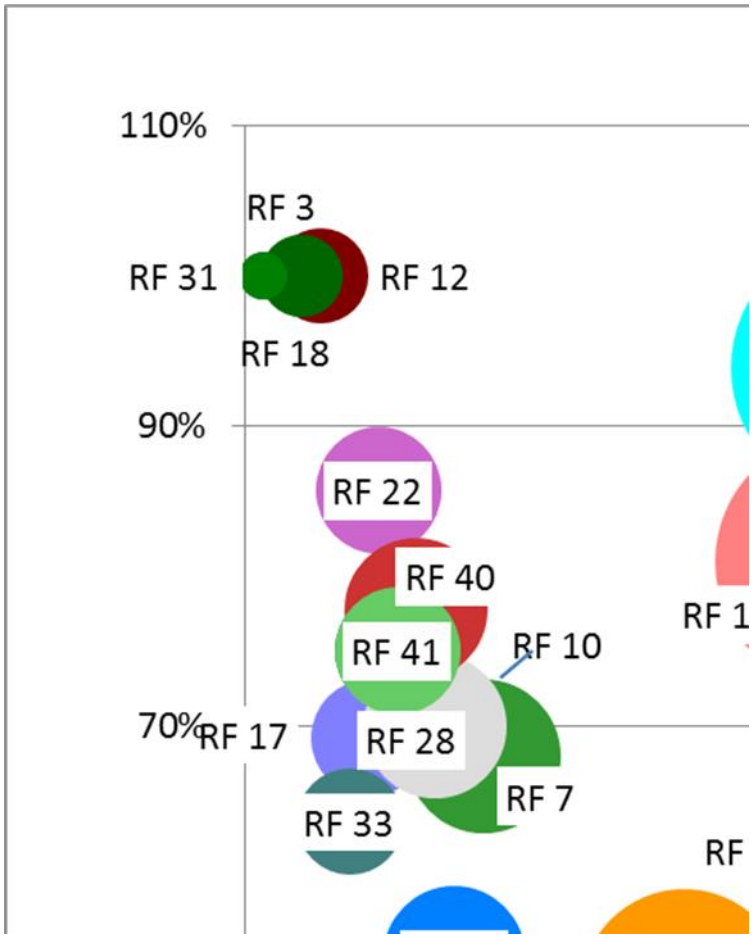


Figure 10: Portfolio analysis of identified topics in scientific literature. Size of circles: indicator for total number of publications, RF number see list of research topics appendix; x-axis: % of publications in the years 2007-2011; Y-axis: difference in % publication between the periods 2002-2006 and 2007-2011.



RF 3	Adhesion between **butyl rubber and polyester** fabric
RF 12	**Electronic textiles** - flexible energy storage, supercapacitors
RF 18	Estimation of **indigestible compounds** contents in cattle feed and faeces using bags made from different textiles
RF 22	**Fragrant microencapsules** and coating on textiles
RF 40	**Shape-memory polymers** (SMPs)
RF 41	Structure and properties of **natural cellulose fibres** - sea weed, cornstalks, sorghum, soy bean
RF 10	**Cotton** - genetic modification for fibre elongation
RF 28	**Microbial fuel cells**, fibre brush anodes
RF 7	Chrysotile **asbestos fibres** & cancerogenicity
RF 33	Plant Fibre Formation and **chemical modification** of **jute fibres**

Figure 11: Detail of Portfolio analysis of topics in scientific literature

5.2 Analysed Topics in Patents

Carbon Fiber Electrode

- Carbon fibre electrode, fuel cells
- Carbon fibre, electrodes and batteries
- Carbon fibre, plated, other fibres for micro electrodes
- Carbon Nanofibers and hybrid fibres production
- Carbon fibre electrode

Electronic Textiles

- Electrochemical cells and fibres
- electrochemically surface treating carbon fibres
- Electroconductive fibres
- Electrode Composition and Electrode for Super Capacitor
- Electrolytic Treatment or electroplating of carbon fibre bundle
- Electromodulation by fibers- electrostrictive or electrooptic, electroconductive
- Electronic systems incorporated into textile threads or fibres
- Electrothermal fibre wire or tube from carbon fibre e.g. for heating in car seats
- Fibre structures, non-woven and textiles used in electrodes
- Glass and fibre glass for electrical applications
- glass fibre reinforced plastic electrolytic cell
- Graphitic nanofibers in electrochemical capacitors
- Textile based electrodes and catheter used for medical applications
- Textile electrode and accumulator containing such an electrode

Electrospinning

- electrospinning or spinning of textile fibres
- electrostatic fibre spinning

Functional Textiles

- Composite, functional textile fabric, multilayer warp, interwoven fibres for application as electronic textiles or home textiles
- Functional fibre - Antiviral fibres
- Functional fibre - Illuminated fibres
- Functional Textiles - Finishing of of textile fibres, tissues, and fabrics - Synthetic fibre, polymers, coating of textiles
- Functional textile structures - elastic
- Functional Textiles - Electromagnetic shield textile
- Functional Textiles - Finishing of textile fibre materials - anti-bacterial, flame retardant, antisoiling...
- Functional Textiles - Finishing of textiles - antibacterial et al.
- Functional Textiles - Finishing of Textiles - thermal, water, bleach resistance, flame retardancy, self cleaning

- Functional Textiles - Flame retardant textile products
- Functional Textiles - Textile skin cleaning device
- Functional textiles - various functions - flame retardant, heat resistant, electrostatic
- Functional Textiles (D06M 11/00: treatment with inorganic substances)
- Functionalised fibres - microencapsuled or cross-binding
- Improvements in the treatment of textile fibres
- Nanofibers and fibres with special properties - Warming and health-care photoelectronic fibres , antibacterial
- Textile material for protective working clothes - abrasion, temperature resistant, electromagnetic shield
- Textile plasma finishing equipment

Textile Machines

- Combing machine for textile fibres
- Processing fibres - Needling, interlacing or braiding fibres, multi-layers, web-structures, methods
- Textile Machines - Apparatus for the fibre-sorting or fibre-selection esp. for combing
- Textile Machines - Apparatus for the fibre-sorting or fibre-selection of a fibre bundle comprising textile fibres
- Textile Machines - Carding machines - improvements
- Textile Machines - Cleaning devices
- Textile Machines - Cleaning, cardening, opening Textile Fibres
- Textile Machines - combing machines for textile fibres
- Textile Machines - Crimping textile fibres
- Textile Machines - detecting undesirable particles in textile fibre material, moisture, impurities, thickness...
- Textile Machines - Devices for sliver, rovings, Improvements relating to machines for spinning textile fibres
- Textile Machines - improvements for drafting and spinning
- Textile Machines - Recycling, recovering textile fibre, improvements to machines
- Textile Machines - spinning or twisting textile fibres - process and apparatus
- Textile Machines - Textile fibre drafting, spinning, carding - improvements in machinery
- Textile Machines - Textile fibre blending, mixing, opening... equipment
- Textile Machines - Transport of textiles or textile webs and other materials
- Textile Machines - various improvements e.g.: spindles, cleaning

Cleaning

- Cleaning and Treatment of textile fibres - sizing
- Cleaning Textile - Dry cleaning
- Cleaning Textiles - Cleaning agents, aerosols
- Cleaning Textiles - cleaning planar products e.g. carpets
- Cleaning Textiles - dry cleaning, cleaning floor textiles, wet cleaning, cleaning machines
- Cleaning Textiles - methods for cleaning clothes, waterproofing, chemical cleaning
- Cleaning Textiles - ultrasonic, water, foamed compositions

Optical Fibres

- Optic fibre displays
- Optical fibre
- Optical fibre- glass-fibre reinforced laminates

Various Topics

- Alkyl acrylate copolymer modified oriented polypropylene
- Artificial textile fibres - artificial silk, casein, skins of fish
- Electrostatic measurement-Textile and fibrous material electrostatic detector
- Fibre reinforced composites, 3D structures
- Geotextiles, electrically conductive textiles for earthing
- Hollow fibre assembly or membranes for in vivo plasma separation
- Materials for treating keratin fibres or used as textile finish
- Plasma treated textile fabric
- Printing and dyeing - Fixation and Finishing, camouflage
- Printing and dyeing - Process for printing and dyeing textile fibre materials
- Solar cells and photovoltaic
- Textile material for cleaning
- Treating plants in order to obtain therefrom textile fibres

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