



Functional Textiles – Trends and Analysis of Scientific Knowledge

A Bibliometric Assessment

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FP 7: 2BFunTex Project Number: 290500

Boosting collaboration between research centres and industry to enhance rapid industrial uptake of Innovative Functional Textile Structures and Textile related Materials in a Mondial Market

Introduction

Before starting with new scientific work and for establishing networks in the future scanning and assessing a research field with scientometric and bibliometric methods is an important step. In 2BFUNTEX, a collaborative EU project, scientific literature and patents regarding “Functional Textiles and Fibers” were analysed and clustered in order to identify

- **core and emerging topics and technologies,**
- **their dynamics,**
- as well as the most important **organizations,** researchers and the connections between them.

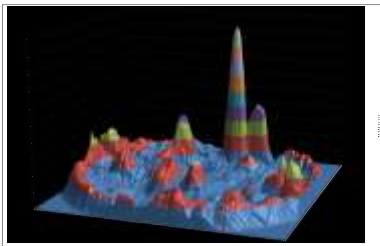
Therefore networks of scientific literature and patents were created. The extracted information serves as basis for further discussions and support for multidisciplinary teams for identification of relevant players in their research field.

Basic Idea and Research Questions

The basic idea is to get an **overview** of issues of “Functional Textiles” in **scientific literature and patent data**.

- Which **research topics** can be detected in “Functional Textiles”?
 - Which of the topics show an increased research activity over the past years and are therefore emerging?
 - In which **parts of the world** are there activities?
 - Which **organizations** are the most active/visible ones in those emerging topics?
 - Which other themes are closely connected to the identified topics?

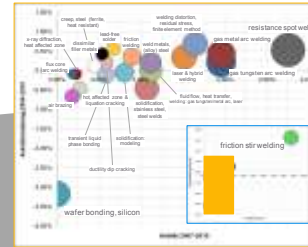
Monitoring of research and technology using BibTechMon™



Research Fronts



World map of Publication Activity



Research portfolios (Emerging topics)

Results

Strategic Position, Scenarios, Roadmaps, Emerging Technologies



Knowledge Bases

Methods

Relational Bibliometrics using BibTechMon™, Science Mapping, Network Analysis, Research Portfolios



Networks



Data

Databases from Literature or Patents

WEB OF KNOWLEDGE™



Data - Search Strategy

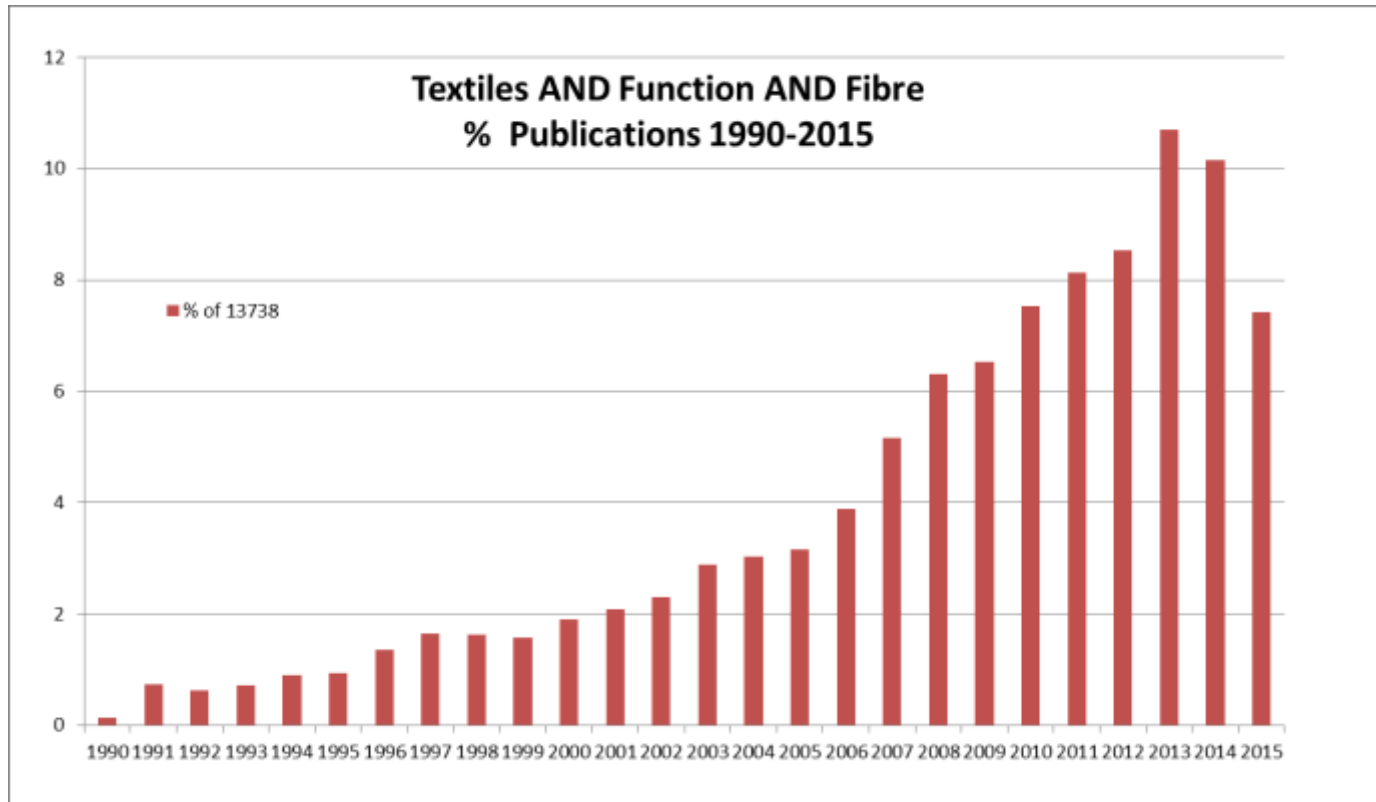
Search Strategy in Web of Science

- 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)
-
- First search: 1989 until 23.July 2012;
number of recorded articles: **8,931**
 - **Update 09.October 2015;**
number of recorded articles: **13,738**

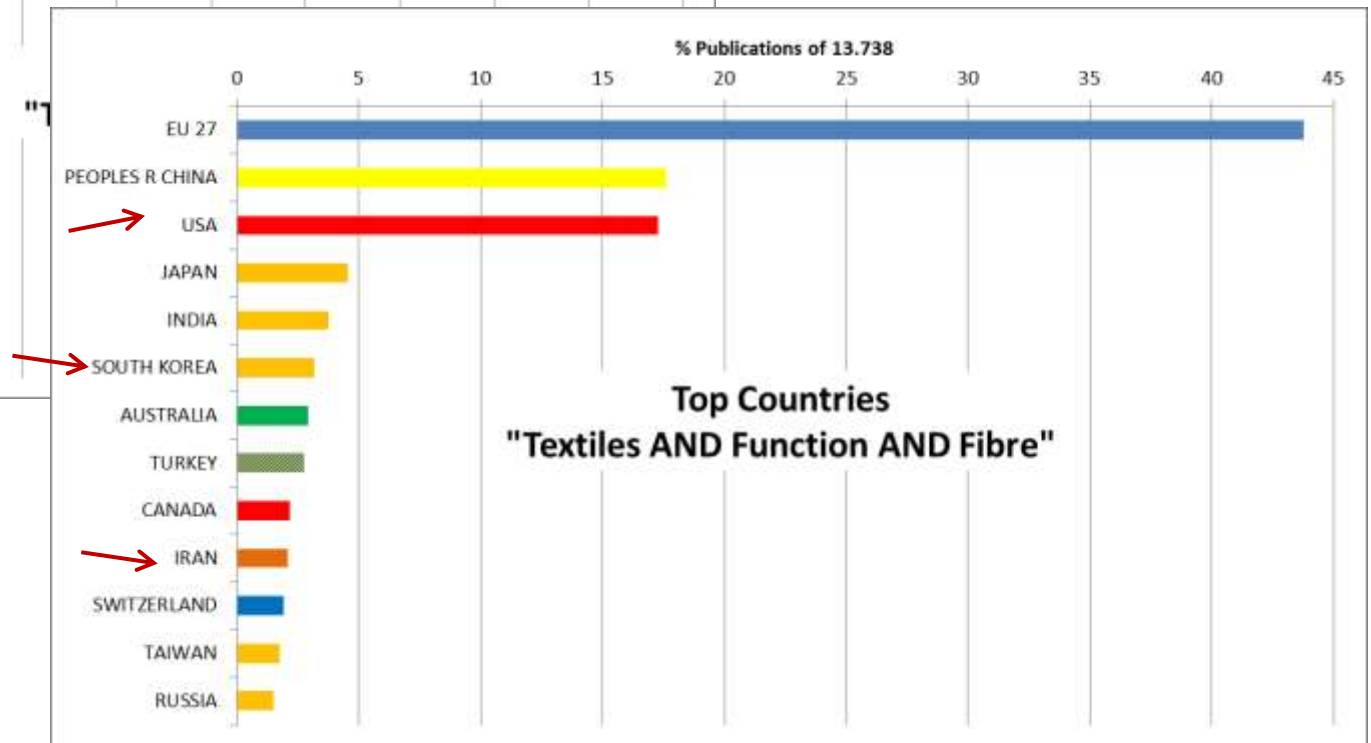
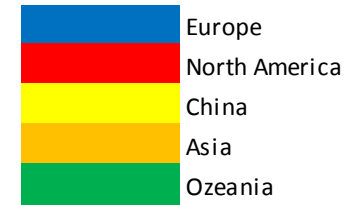
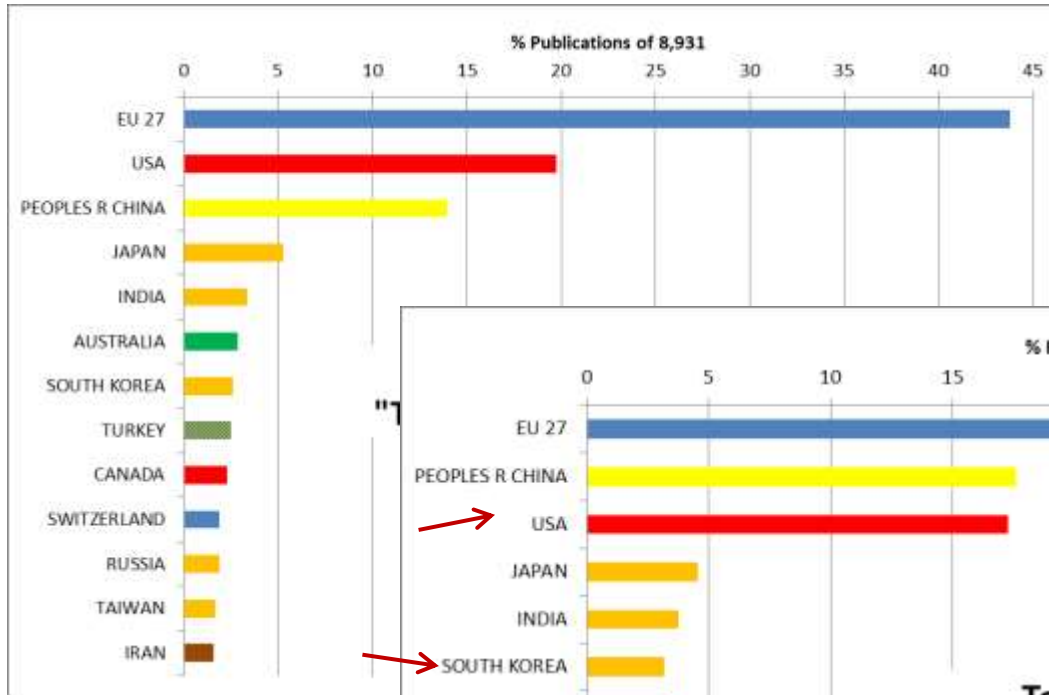
Statistic Results 2015

Publication Years

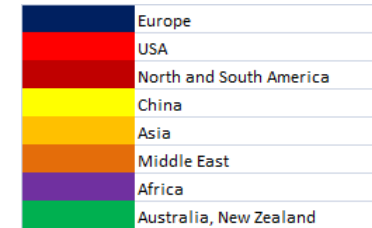
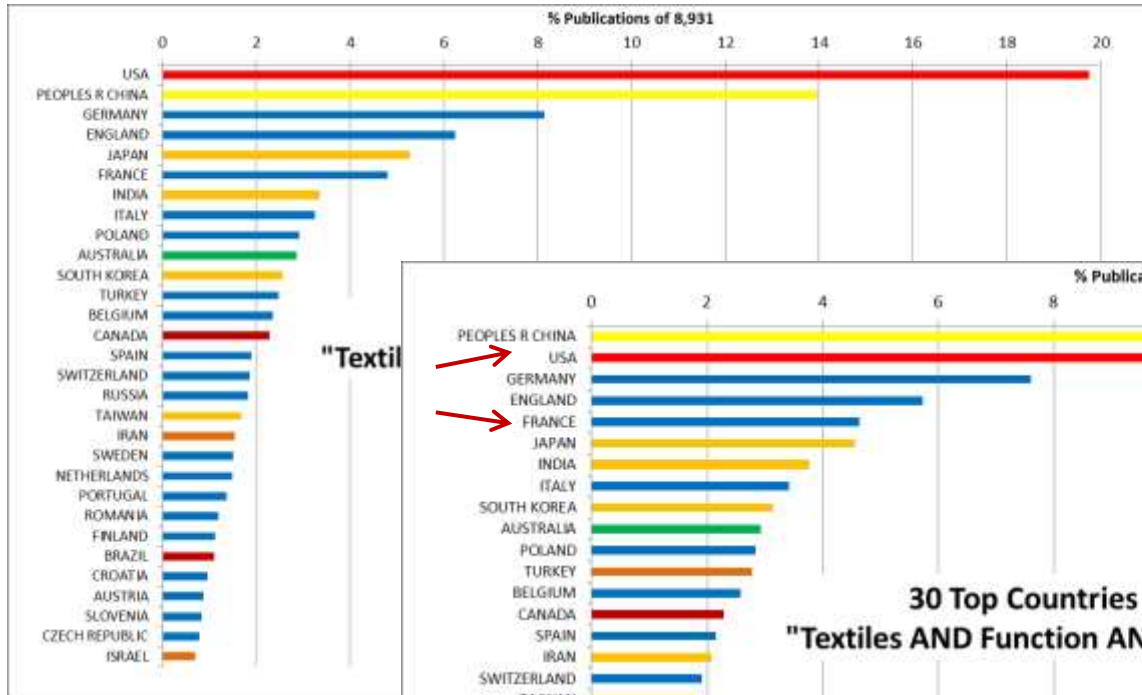
Development of publications from 1990 to 2015



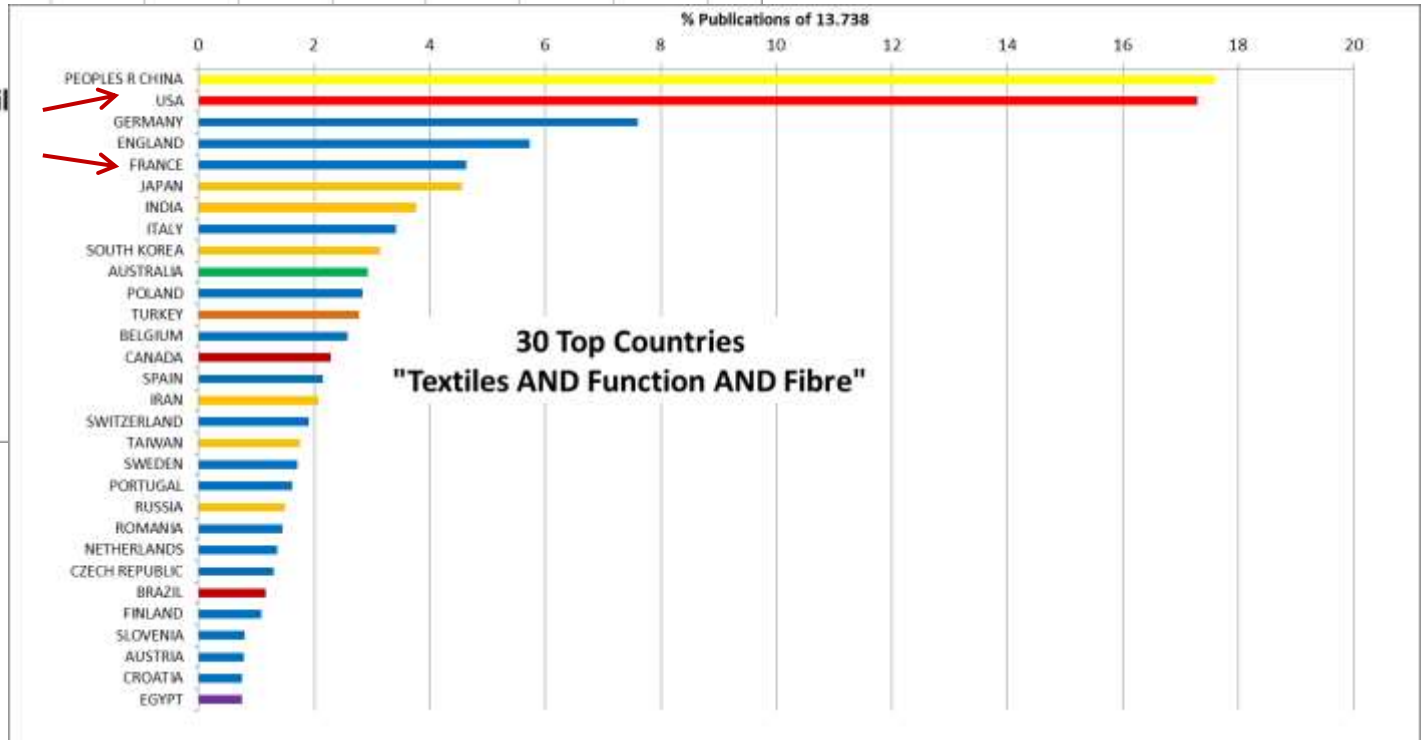
Countries with most Publications - Development from 2012



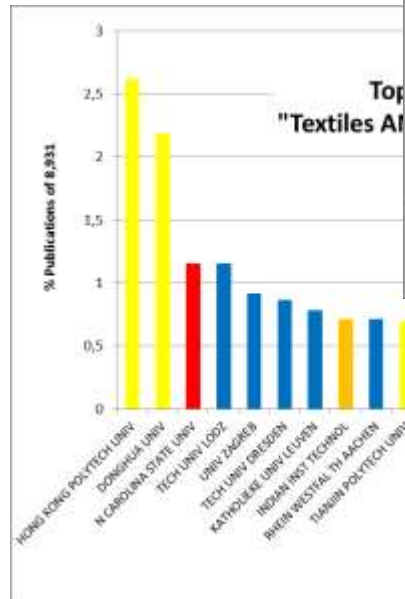
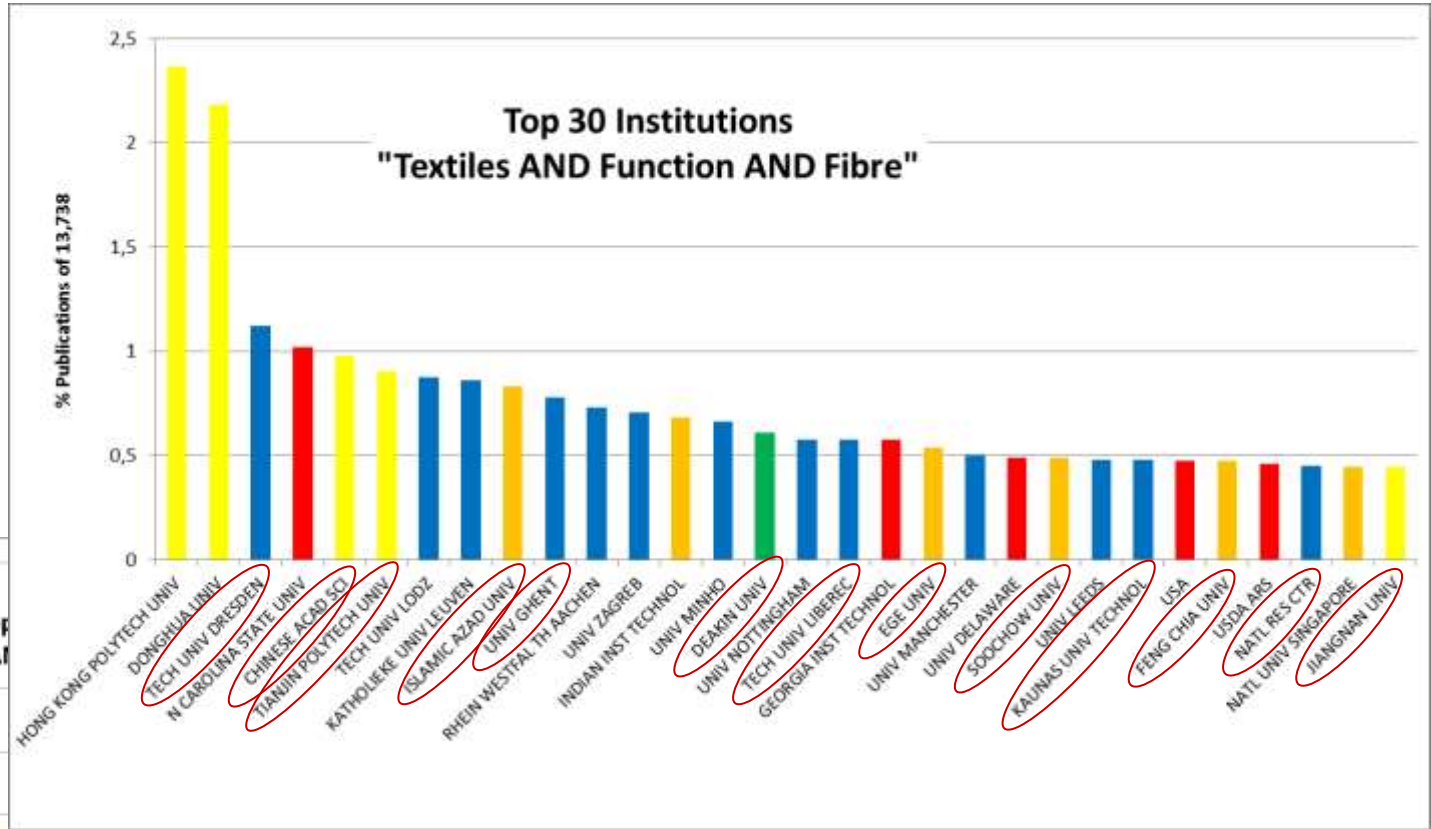
Countries with most Publications – Development from 2012



"Textil



Most Visible Organisations - Development from 2012



Europe
USA
North and South America
China
Asia
Middle East
Africa
Australia, New Zealand

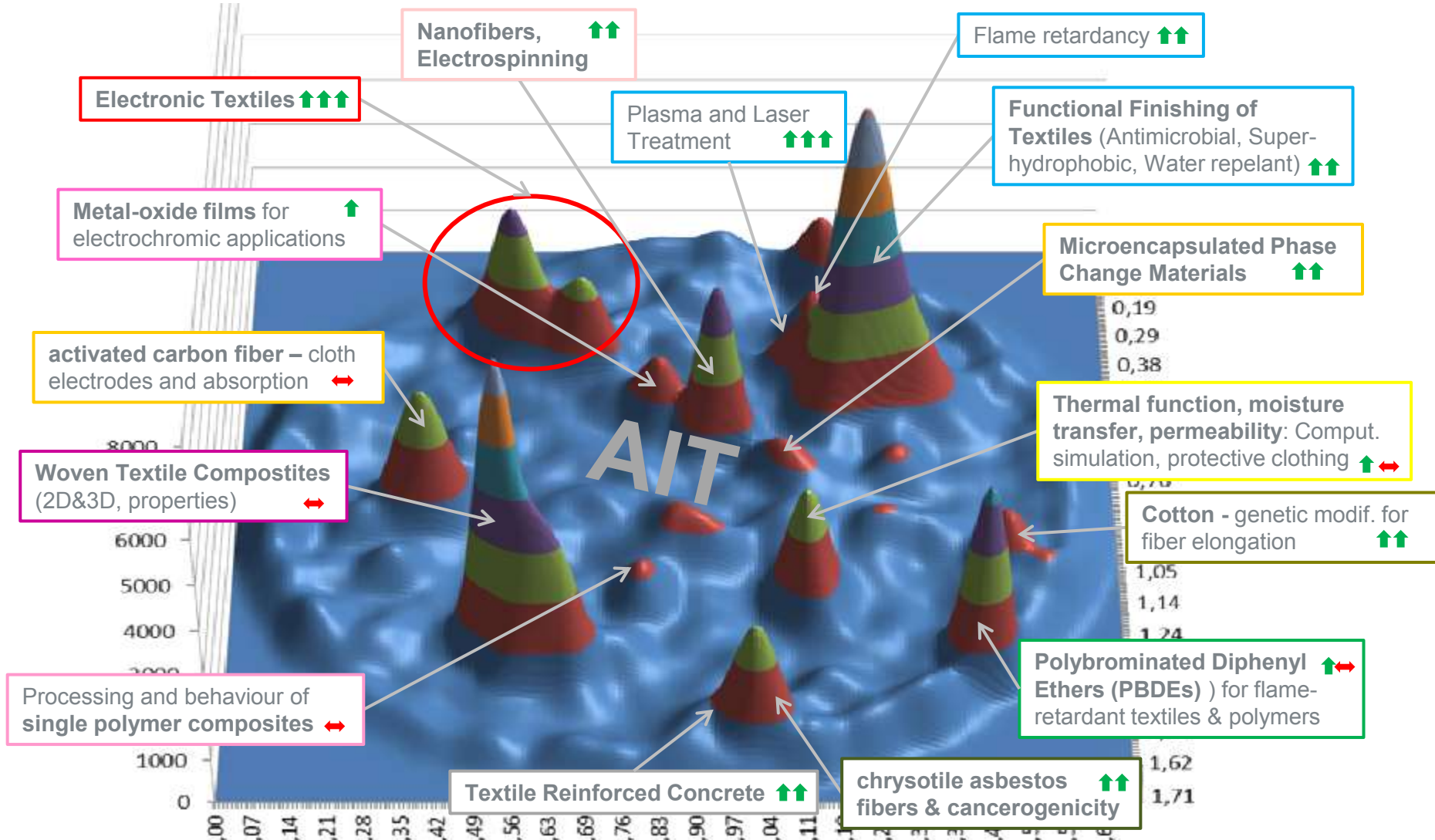
Changes in Publication Activity of Organisations

- | | |
|-----------------------------------|---------------------------------|
| 1. HONG KONG POLYTECH UNIV | 20.UNIV MANCHESTER |
| 2. DONGHUA UNIV | 21.UNIV DELAWARE |
| 3. TECH UNIV DRESDEN (was 6) | 22.SOOCHOW UNIV (was 86) |
| 4. N CAROLINA STATE UNIV | 23.UNIV LEEDS (was 14) |
| 5. CHINESE ACAD SCI (was 23) | 24.KAUNAS UNIV TECHNOL (was 34) |
| 6. TIANJIN POLYTECH UNIV (was 10) | 25.USA (was 11) |
| 7. TECH UNIV LODZ (was 4) | 26.FENG CHIA UNIV (was 37) |
| 8. KATHOLIEKE UNIV LEUVEN | 27.USDA ARS (was 12) |
| 9. ISLAMIC AZAD UNIV (was 32) | 28.NATL RES CTR (was 47) |
| 10.UNIV GHENT (was 15) | 29.NATL UNIV SINGAPORE (was 17) |
| 11.RHEIN WESTFAL TH AACHEN | 30.JIANGNAN UNIV (was 49) |
| 12.UNIV ZAGREB (was 5) | 31.UNIV LJUBLJANA (was 28) |
| 13.INDIAN INST TECHNOL (was 8) | 32.CORNELL UNIV (was 27) |
| 14.UNIV MINHO | 33.UNIV GEORGIA |
| 15.DEAKIN UNIV (was 20) | 34.ZHEJIANG SCI TECH UNIV |
| 16.UNIV NOTTINGHAM | 35.ZHEJIANG UNIV |
| 17.TECH UNIV LIBEREC (was 49) | 36.XIAN POLYTECH UNIV |
| 18.GEORGIA INST TECHNOL | 37.KYOTO INST TECHNOL (was 22) |
| 19.EGE UNIV (was 24) | 38.CSIC (was 26) |

Red: increase in publication activity / Blue: decrease / grey: not much change

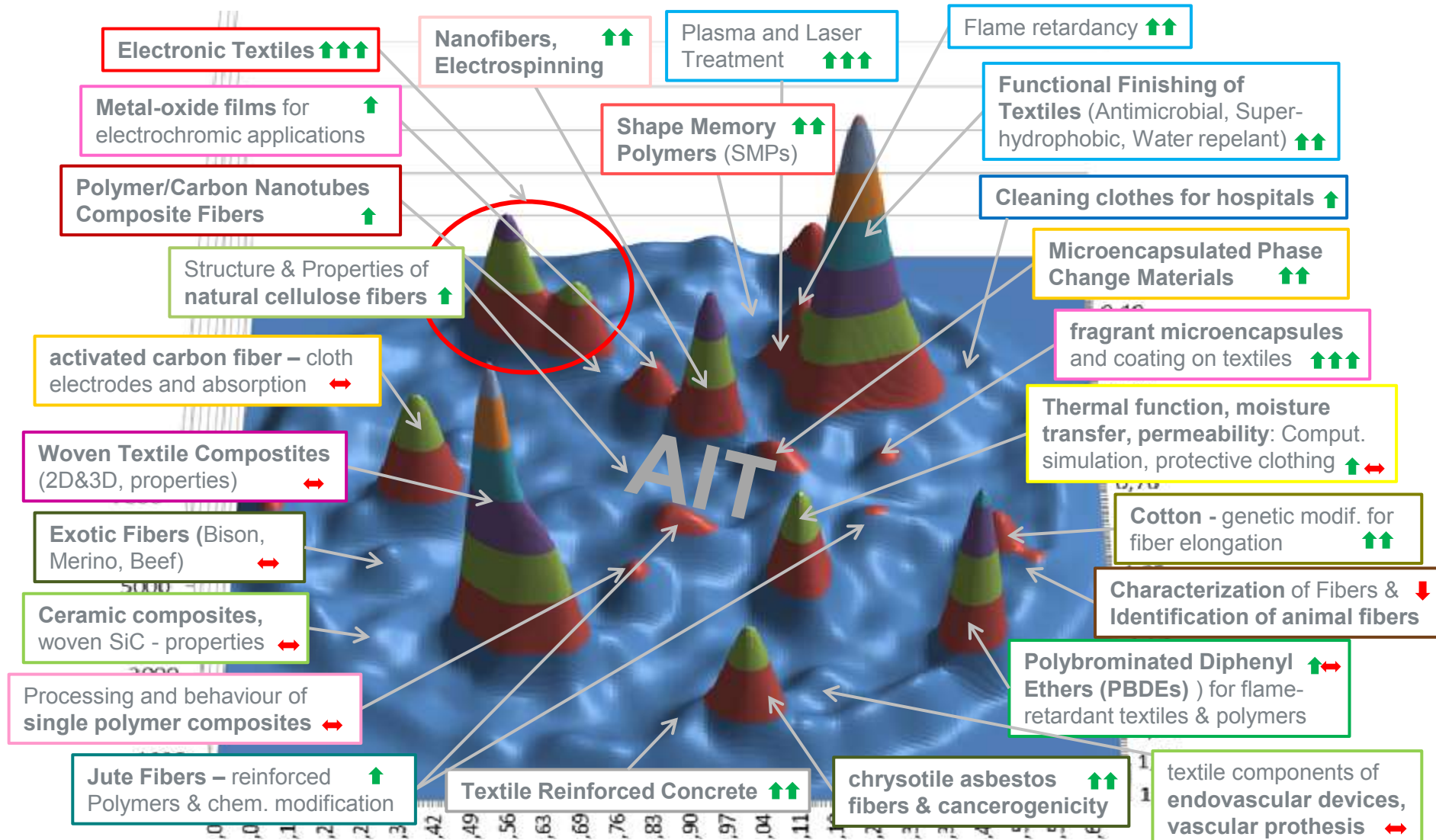
Bibliometric Results Generated with BibTechMon™

Research Fronts of Functional Textiles and Fibers in Publications until 2012



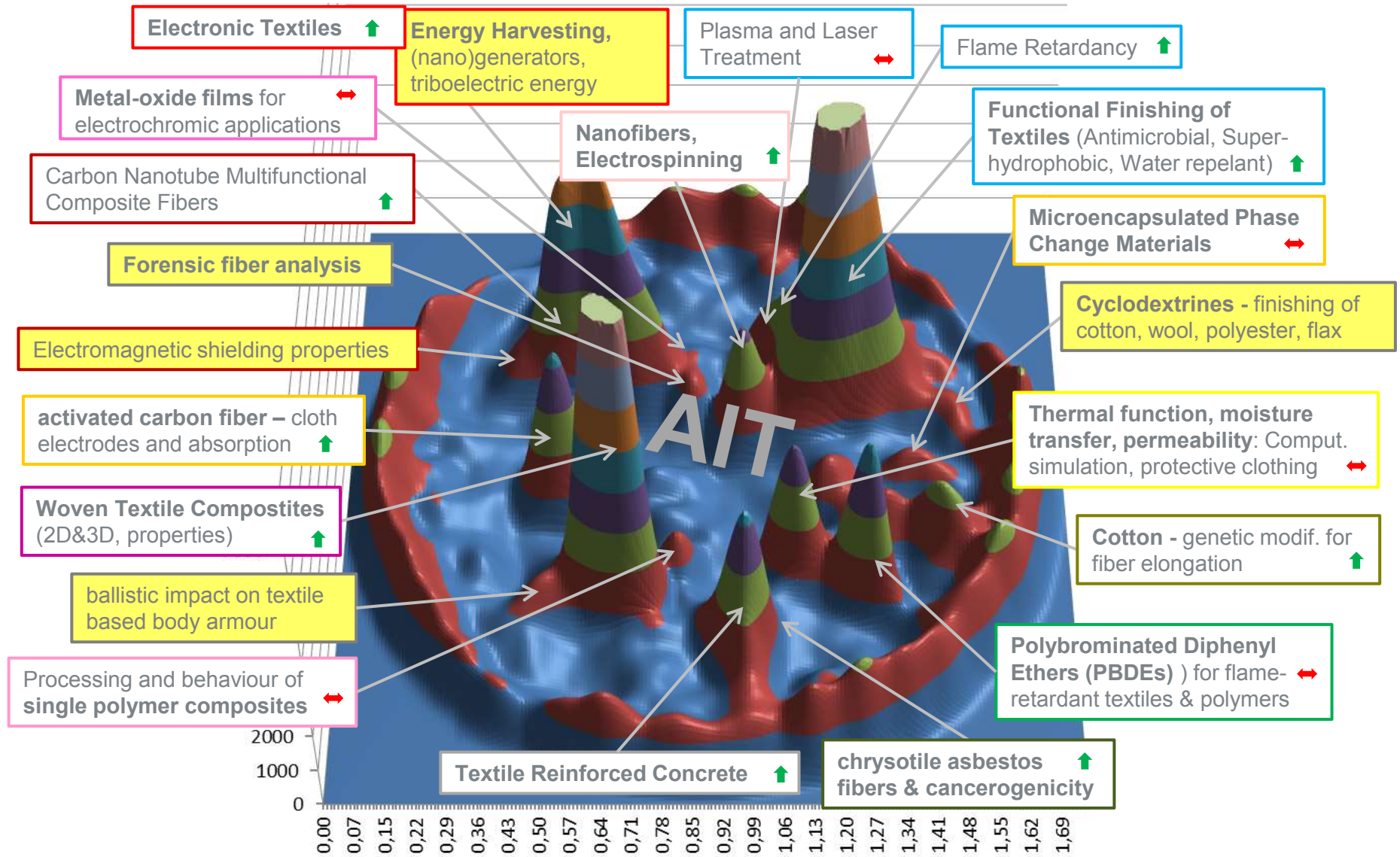
Arrows indicate if a topic shows increasing ↑, steady ↔ or decreasing ↓ research activity over the last 10 years

Research Fronts in Publications until 2012 - Details

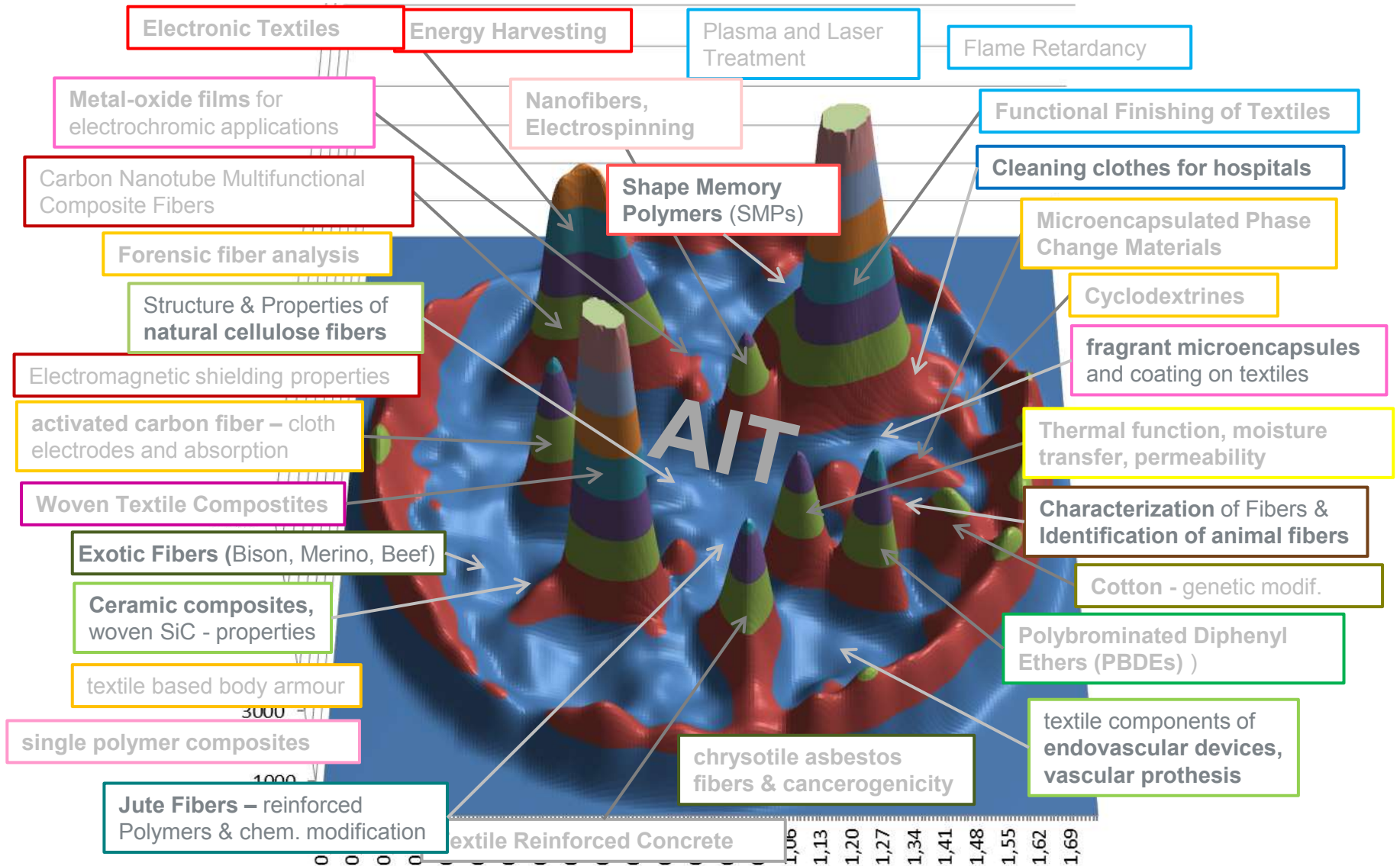


Arrows indicate if a topic shows increasing ↑, steady ↔ or decreasing ↓ research activity over the last 10 years

Research Fronts of Functional Textiles and Fibers in Publications updated to 2015



Research Fronts updated to 2015 - Details



Changes in Research Fronts – *new or with strong increase in research activities*

- **Electronic Textiles**
 - *Supercapacitors* – carbon nanotube multifunctional fibers (superconductors & stretchable)
 - Graphene
 - *Wearable Antenna*: medical applications & firefighters
 - *Triboelectric Energy* – Energy Harvesting
 - *Electromagnetic shielding* properties
- **Functional textiles**
 - *Cyclodextrine* Finishing
 - Increase in *antimicrobial* & *superhydrophobic* research
- Ballistic impact on *body armour*
- Research on *cotton genome* increased
- Activated *carbon fiber cloth electrodes* research increased

Cyclodextrines

Top Keywords „Cyclodextrines“

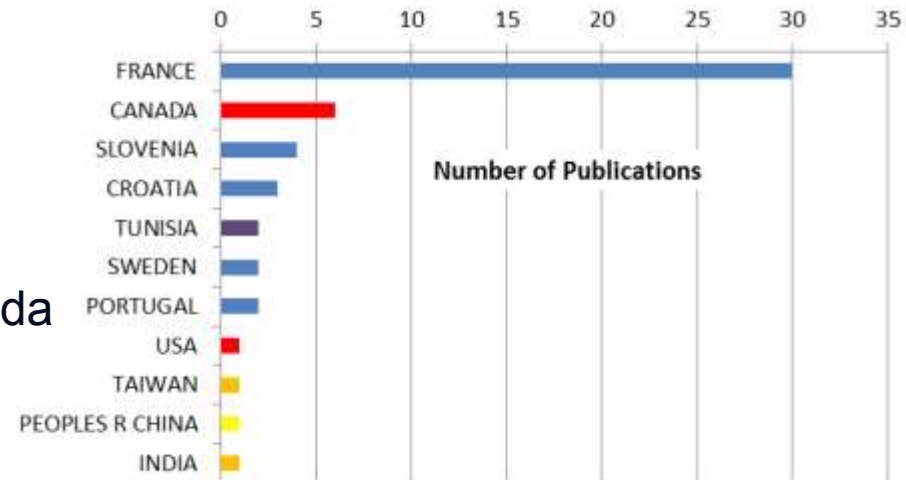
- (beta-)cyclodextrin
- polycarboxylic acids
- Cotton
- citric acid
- cross-linking agents
- Fabrics/Fibers
- Parameters
- textile finishing
- polyester
- In-vitro
- Formaldehyde
- polycarboxylic acid
- polyacrylic acid
- Cellulose
- Pharmaceutical applications
- Pet prostheses
- grafting
- Manufacture
- flax fibers
- Drug release
- Ciprofloxacin
- Biological evaluation
- Water
- catalysts
- Antibiotics
- surface modification
- Polypropylene nonwoven fabrics
- Reactive filters
- Dissolution
- Drug carrier systems
- Delivery
- Durable press reagent

Most Recent Publications „Cyclodextrines“

- 2015: Finishing of polypropylene fibers with cyclodextrins and polyacrylic acid as a crosslinking agent
- 2014: Axillary odour build-up in knit fabrics following multiple use cycles
- 2013: Cyclodextrin-grafted cellulose: Physico-chemical characterization
- 2012
 - Comparative study of vascular prostheses coated with polycyclodextrins for controlled ciprofloxacin release
 - Inclusion of antibacterial agent thymol on beta-cyclodextrin-grafted organic cotton
 - Safety, Healing, and Efficacy of Vascular Prostheses Coated with Hydroxypropyl-beta-cyclodextrin Polymer: Experimental In Vitro and Animal Studies
- 2011
 - Cyclodextrin and maltodextrin finishing of a polypropylene abdominal wall implant for the prolonged delivery of ciprofloxacin
 - Methyl-beta-cyclodextrin modified vascular prosthesis: Influence of the modification level on the drug delivery properties in different media
 - Morphology and Properties of PET Fabric Finished by beta-Cyclodextrin and Citric Acid

Top Research Organisations „Cyclodextrines“

- Univ Lille 2, Lille, France
- Univ Lille 1, Villeneuve Dascq, France
- Univ Lille Nord France, F-59000 Lille, France
- Univ Maribor, SLO-2000 Maribor, Slovenia
- Univ Sci & Technol Lille, Villeneuve Dascq, France
- Univ Zagreb, Zagreb, Croatia
- Univ Alberta, Edmonton, Canada
- Ecole Natl Super Arts & Ind Text, F-59056 Roubaix, France
- CHRU Lille, F-59037 Lille, France
- CHU Nice, Nice, France
- Chalmers Univ Technol,
41296 Gothenburg, Sweden
- Text Technol Ctr, PQ J2S 1H9, Canada



Triboelectricity –Energy Harvesting

Top Keywords „Triboelectricity –Energy Harvesting“

- (Piezoelectric) nanogenerators
- Arrays
- Energy
- Driven
- Devices
- (Flexible) electronics
- Generator
- Sensor
- Composites
- Energy harvesting/ Energy harvester
- Nanorods
- Electrospinning
- Triboelectric nanogenerator
- Output
- Growth
- Fabrication
- Nanofibers
- Conversion
- Vibration
- System
- Thin-film
- Nanowire (arrays)
- Films
- Generation
- Biomechanical energy

Most Recent Publications in „Triboelectricity –Energy Harvesting“ 2014

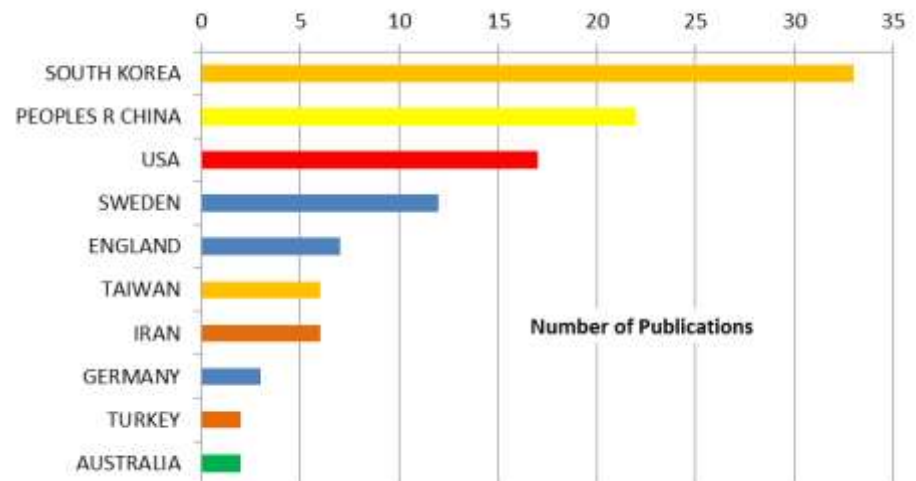
- 3D Fiber-Based Hybrid Nanogenerator for Energy Harvesting and as a Self-Powered Pressure Sensor
- A Flexible Sandwich Nanogenerator for Harvesting Piezoelectric Potential from Single Crystalline Zinc Oxide Nanowires
- A novel investigation on carbon nanotube/ZnO, Ag/ZnO and Ag/carbon nanotube/ZnO nanowires junctions for harvesting piezoelectric potential on textile
- Analysis of junction properties of gold-zinc oxide nanorods-based Schottky diode by means of frequency dependent electrical characterization on textile
- Constructing flexible cellulose-Cu nanocomposite film through in situ coating with highly single-side conductive performance
- Direct-write PVDF nonwoven fiber fabric energy harvesters via the hollow cylindrical near-field electrospinning process
- Electrical power generation from piezoelectric electrospun nanofibers membranes: electrospinning parameters optimization and effect of membranes thickness on output electrical voltage
- Fabrication of zinc oxide nanoneedles on conductive textile for harvesting piezoelectric potential
- Flexible piezoelectric nanogenerators based on a fiber/ZnO nanowires/paper hybrid structure for energy harvesting
- Flexible thermocells for utilization of body heat
- Integration of ZnO/ZnS nanostructured materials into a cotton fabric platform
- "Novel ""3-D spacer"" all fibre piezoelectric textiles for energy harvesting applications"
- Piezoelectric electrospun nanofibrous materials for self-powering wearable electronic textiles applications
- Stitchable organic photovoltaic cells with textile electrodes
- Wearable thermoelectric generator for harvesting human body heat energy

Most Recent Publications in „Triboelectricity –Energy Harvesting“ 2015

- A hybrid fibers based wearable fabric piezoelectric nanogenerator for energy harvesting application
- Analysis of direct and converse piezoelectric responses from zinc oxide nanowires grown on a conductive fabric
- Cloth-Based Power Shirt for Wearable Energy Harvesting and Clothes Ornamentation
- Direct Writing of Half-Meter Long CNT Based Fiber for Flexible Electronics
- Flexible Two-ply Piezoelectric Yarn Energy Harvester
- Highly Stretchable 2D Fabrics for Wearable Triboelectric Nanogenerator under Harsh Environments
- Nanopatterned Textile-Based Wearable Triboelectric Nanogenerator
- Powerful curved piezoelectric generator for wearable applications
- Single BaTiO₃ nanowires-polymer fiber based nanogenerator
- Triboelectric energy harvester based on wearable textile platforms employing various surface morphologies
- Triboelectric Generators and Sensors for Self-Powered Wearable Electronics

Top Research Organisations in „Triboelectricity –Energy Harvesting“

- Georgia Inst Technol, Atlanta, GA 30332 USA
- Linkoping Univ, Norrkoping, Sweden
- Hanyang Univ, Seoul 133791, South Korea
- Iowa State Univ, Ames, IA 50011 USA
- Sungkyunkwan Univ, Suwon 440746, South Korea
- Univ Michigan, Ann Arbor, MI 48109 USA
- Amirkabir Univ Technol, Tehran, Iran
- Univ Sci & Technol Beijing, Beijing 100083, Peoples R China
- Univ Ulm, D-89081 Ulm, Germany
- Lanzhou Univ, Lanzhou 730000, Peoples R China
- Xiamen Univ, Xiamen 361005, Peoples R China
- Univ Oxford, Oxford, England
- Korea Univ, KU KIST Grad Sch Converging Sci & Technol, Seoul 136701, South Korea
- Huazhong Univ Sci & Technol, Wuhan 430074, Peoples R China
- HSG IMIT Inst Micromachining & Informat Technol, D-78052 Villingen Schwenningen, Germany
- Ind Technol Res Inst, Elect & Optoelect Res Labs, Hsinchu 310, Taiwan
- Korea Inst Sci & Technol, Seoul 136791, South Korea
- Kwangwook Univ, Seoul 139701, South Korea
- Kyung Hee Univ, Yongin 446701, South Korea
- Chinese Acad Sci, Beijing 100864, Peoples R China



Download:

Bibliometric Analysis of Scientific Publications and Patents of
Functional Textiles and Fibers : Overview (published 2014)

<http://www.2bfuntex.eu/>

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