

PATENTS: AN INDICATOR OF NANOTECHNOLOGY INNOVATION

Statistical analysis of patent applications is a valuable and well-known indicator for the assessment of trends and developments in specific research areas.¹ Patenting is driven by commercial interests and thus mainly focuses on research outcomes that are assumed to have economic potential. Therefore patent applications largely originate from companies and private enterprises and can provide interesting information regarding the transfer from research to products and markets. Statistical analyses of nano-related patent activities are of rising interest for many researchers, and various methodologies and strategies have been applied^{2,3}; working groups within the OECD^{4,5,6} and different patent offices^{7,8} are extensively engaged in such activities. With the introduction of specific nanotechnology classification systems the United States Patent and Trademark Office (USPTO), the Japan Patent Office (JPO), and the European Patent Office (EPO) have created a fruitful basis for comprehensive analyses of inventive activities in the field.⁹

In the frame of "ObservatoryNANO", statistical analyses have been applied to ten specific application sectors as defined by the project¹⁰, as well as to individual countries and three different legal types of applying institutions. The aim is to depict Europe's situation in both international and internal comparison and to identify key players and application areas. "Europe" in this respect covers the EU-27 and associated states (approximately 40 countries). The evaluation has been performed on the basis of EPO's "Worldwide Patent Statistical database" (PATSTAT) and the online patent service "esp@cenet" making use of the specific preliminary classification code "Y01N", which has recently been transferred to the ordinary European patent class "B82Y". The search is based on a combined classification and keyword approach. Country assignments of individual patent applications are due

to countries of priority application and institutional applicants' countries.

Global Sectoral Evaluation

The global number of patent applications in nanotechnology has increased by a factor of 10 over the past two decades; PATSTAT counts a total of more than 130 000 applications with an annual growth of greater than 10 000 applications.

Figure 1 shows the temporal development of the worldwide applications in nanotechnology. The numbers of patent applications have been broken down to ten specific application sectors. Most of the sectors show a strong increase during the early 2000s followed by a saturation later in the decade, and are thus in agreement with the general behaviour in nanotechnology. However, the energy

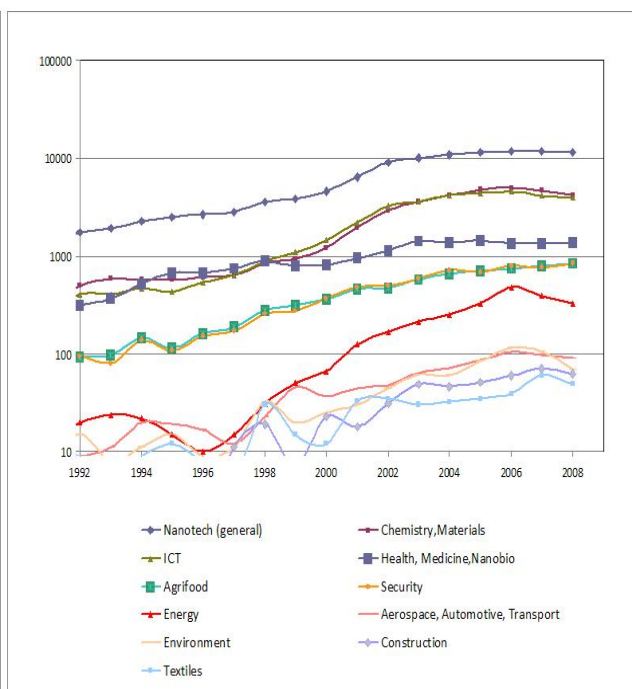
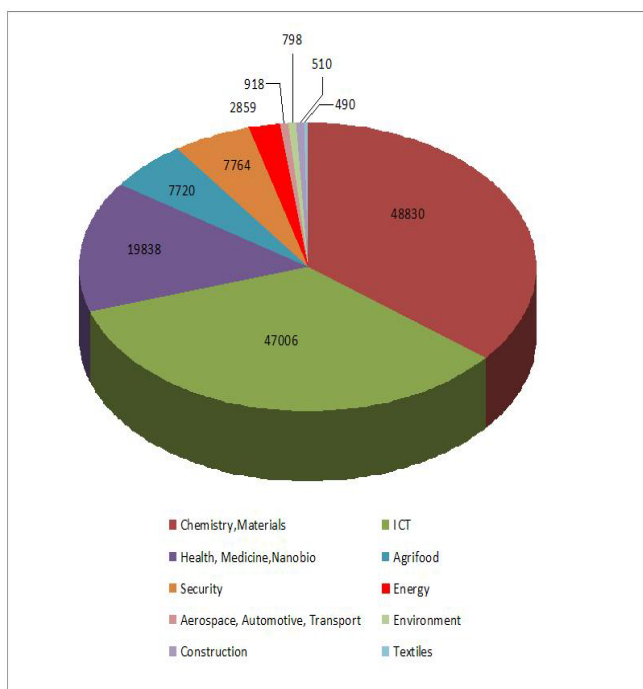


Figure 1: Comparison of worldwide nano-related patent applications in specific sectors and their temporal development (logarithmic scale for clearer comparability) between 1992 and 2008.

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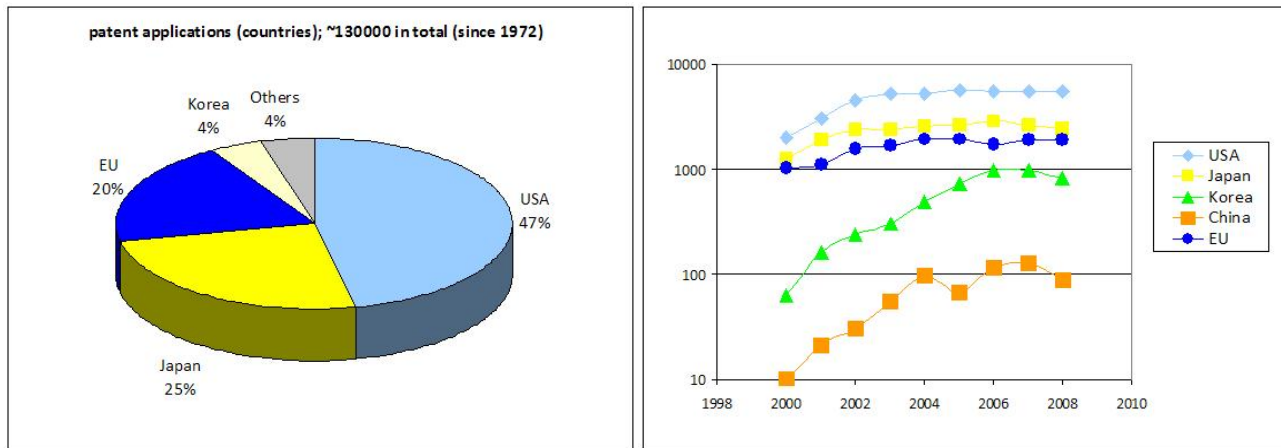


Figure 2: Country assignment of patent applications since 1972 (left) and temporal development (right) for selected countries between 2000 and 2008 (lower).

sector, in particular, has shown outstanding growth since the middle of the 1990s which has continued to increase strongly in recent years. The security sector, as well as agriculture and food, have shown a moderate but steady, close to exponential increase of annual application numbers.

Both “chemistry/materials” and “information and communication technologies (ICT)” contribute with the largest sectoral shares. This is obviously due to the overwhelming importance of IT and electronics as well as to the cross-sectoral characteristics of nanomaterials and nano-surface chemistry and their significance to numerous technical applications. Nano related bio-medical applications – including consumer products such as home detergents, cosmetics, and body care – represent a third sector continuously contributing with more than 1000 annual patent applications.

How the EU compares in a global comparison

Country assignments of patent applications allow for an indication of innovation strengths and developments. The corresponding allocation shows the United States and Japan in the leading positions with respective shares of 47 % and 25 % of the total applications. Germany follows as the main European contributor with 8 %, followed by France (4 %), and the UK (4 %). The European Union (EU-27) as a whole contributes a 20 % share.

To extend the quite static aspect of these figures, it is worthwhile to spend some time on the temporal dynamics of the activities and to particularly compare established developed states with some emerging countries.

Indeed the absolute contribution of emerging nations to nanotechnology patenting is still quite low, currently far below the level of the US, Japan or Europe; moreover, only a small number of emerging countries are contributing at all. However, a strong pattern, particularly for Korea and China,

can be determined; **Figure 2**, displayed on a log scale, shows a low but rapidly growing patenting activity in these countries over the past decade.

Europe; Institutions and Key Players

Focused on Europe and its internal situation the analysis resulted in a total of about 11 000 nano-related patent applications between January 2000 and June 2010 originating in European institutions. The vast majority of these applications were from the private sector.

In total, around 1700 European institutions applied for nano-related patents, around 1300 of which were companies and slightly above 400 universities and public or semi-public research institutions.

Although nano-patenting is predominantly originating in company activities, the Commissariat à l’Énergie Atomique (CEA) and the Centre National de la Recherche Scientifique (CNRS), two French public research institutions, are in leading positions intermediated only by Philips. However, in general mainly large companies are dominating the scene. Among these, further large electronics

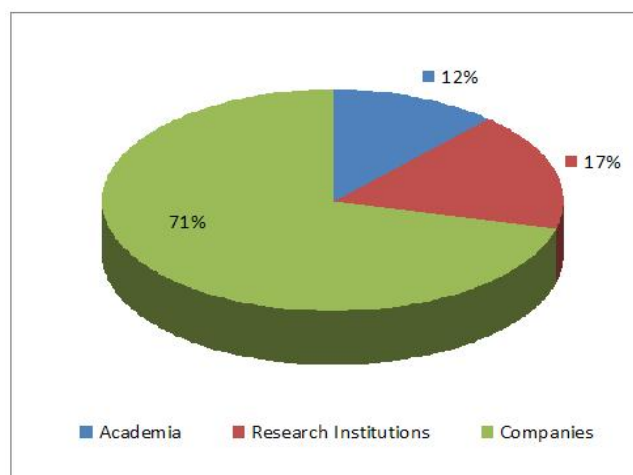


Figure 3: Breakdown of European patent applicants according to applicant institution category.

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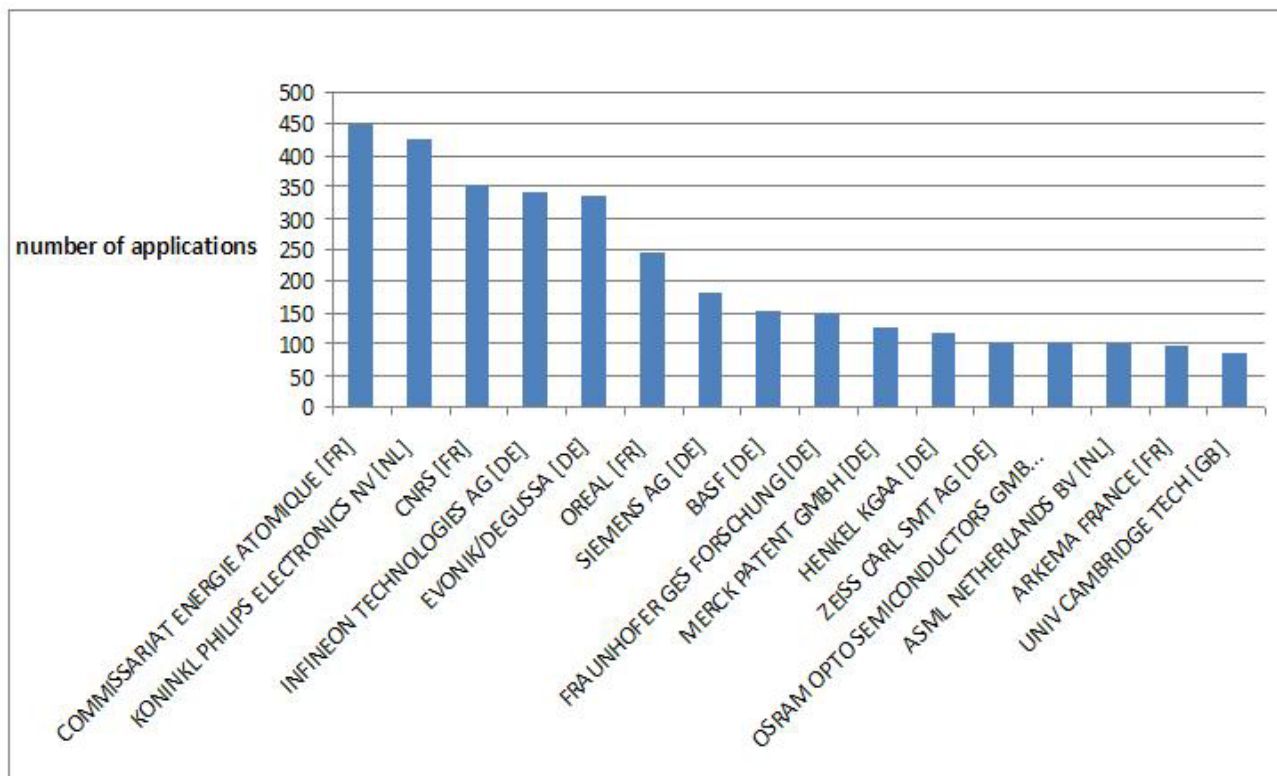


Figure 4: European organisations with the highest number of patent applications.

and ICT players such as Infineon or Siemens may be found as well as manufacturers of chemicals and consumer products such as Evonik/Degussa, L'Óreal, BASF, Arkema and others.

Among universities, the University of Cambridge is clearly leading with more than 80 applications, followed by the University of Glasgow, the Technical University of Dresden, and ETH in Zurich. However, the total contribution of all universities is only 12% of the total share.

Comparison within Europe

The European average fraction of nano-related applications by companies is around 70 % (**Figure 3**). However, this number varies considerably from

country to country, ranging from France with a company fraction of below 50% to countries like the Netherlands, Sweden or Finland with fractions at or above 90%. Moreover, it is dynamically developing rather than remaining constant. **Figure 5** provides the company fraction values for Europe as a whole and also a number of selected European countries.

The value of the Netherlands for example has remained at a consistently high level of around 90% over the whole decade. This is obviously due to large Dutch companies such as Philips and ASML belonging to the major European contributors and widely dominating the nanotechnology scene within their own country. In contrast, a clear decline of the company fraction can be seen in

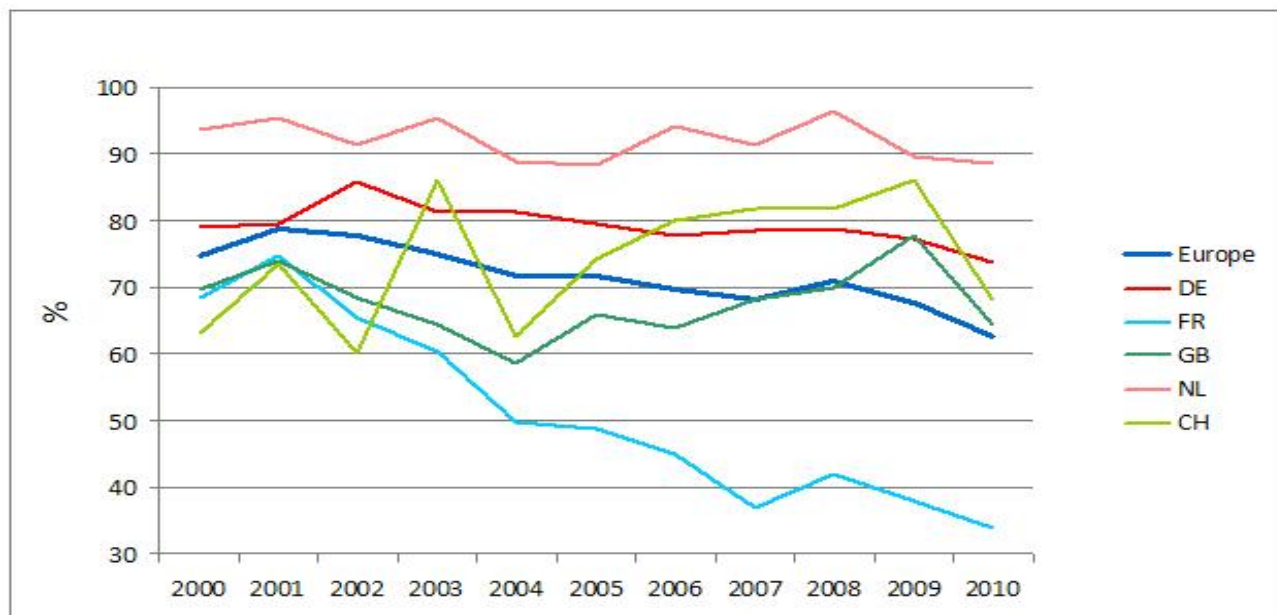


Figure 5: Fractions of company-originating patent applications for Europe and selected countries.

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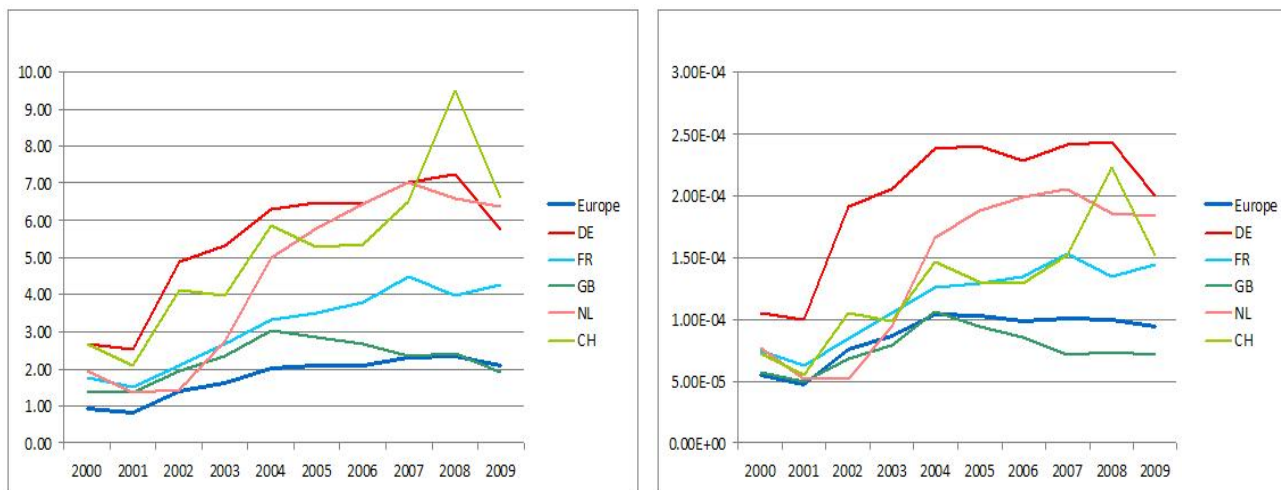


Figure 6: Patent applications of Europe and selected countries. **Left:** normalized to the population. **Right:** normalized to the GDP (per 1 million €)

France although the absolute number of French nano-related patent applications has increased over the same period. Moreover, even the number of pure company applications has increased from around 70 in 2000 to above 100 in 2009. However, it was the contribution of the large public research institutions CEA and CNRS in particular, which grew sharply from below 30 applications in 2000 to greater than 130 in 2009, representing a fourfold increase.

The total number of nano-related patent applications has been growing over the past decade; for Europe as a whole as well as for the majority of its individual states. The leading position of Germany, France, and Britain in absolute numbers is evident, as they represent the largest populations and economies within Europe. Normalizations to both the population size and the Gross Domestic Products (GDP) as a measure of the economic strengths allow for a better comparison (see **Figure 6**).

Both representations show Germany, Switzerland and the Netherlands in leading positions; however, they have become somewhat stagnant over recent years. France, in contrast, expressed a moderate but quite steady growth, whereas the UK suffered from a decline during the second half of the decade.

Summary

- Patent statistics allows for comparative analyses of variables such as countries, institutions, application sectors in specific research areas.
- Patent statistics represent a valuable indicator for the assessment of states, developments and trends in nanotechnology.
- Leading patent offices have introduced specific nanotechnology classification systems.
- Nano-related patent applications, as a whole, show a strong increase over the past two decades.

- Chemistry/Materials, ICT and Health/Bio-Medicine sectors account for the largest sectoral fractions.
- EU-27 accounts for only 20% of all nano-related patent applications; coming in third position behind the US and Japan.
- Around 1700 European institutions (among those around 1300 companies) applied for nano-related patents during the past decade.
- Between 2005 and 2010 one European nano-related patent application was “generated” by ~€10 billion of GDP or by 500 000 inhabitants.

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