



Innovation Momentum 2022: The Global Top 100

Intellectual Property Report

Foreword



“The Innovation Momentum in the development of patent portfolios over time reveals true innovative strength.”

Marco Richter
Global Head of Product
& Customer Success,
LexisNexis®
Intellectual Property
Solutions

The drive to innovate is at the core of the human spirit. And as this innate desire to move forward—to have momentum—applies to our modern, technological world, we see patents as the official record of the spirit of innovation. As we seek to understand who is best harnessing that spirit and actively innovating, we often rely on rankings. Many innovation rankings measure patent portfolio sizes combined with other selection criteria, like patent filing rates, to uncover the front runners in patent development. Yet, these approaches often omit small start-ups with early disruptive innovation and over-rank on mature technology fields dominated by multinationals.

This limitation, which obstructed truly inclusive analyses, led to the Patent Asset Index™. This metric results from many years of scientific research and validation studies; it has been published in an academic journal for review (Ernst and Omland, 2011) and has evolved to an industry standard. It is used by corporations, top consultancies, investors, and governmental institutions (e.g., patent offices and the European Commission) to better understand innovation spaces, market forces, and to uncover what their competitors are hatching long before they come to market.

The Patent Asset Index was the first metric enabling objective assessment of patent portfolios with respect to portfolio strength. We now have over a decade of experience applying the Patent Asset Index, distilling insights, and deriving actions together with our customers. Now, we want to distill these learnings into a single number representing the Innovation Momentum to show the latest, most recent development of patent portfolios, and thus show innovation that is outperforming expectations. We leverage this unique approach to spotlight true technological contemporaries across all industries.

This report introduces the newly established Innovation Momentum by explaining its formula and providing context to the innovative companies included in its inaugural Top 100 list.

Whether advancing quick, responsive action to save millions of lives with a vaccine or representing years of proactively building and improving more accessible user interfaces across all types of devices, the patents behind the Top 100 on this list underscore the ingenuity of creators, with each endeavor demonstrating the will of the human spirit to progress, solve and share.

Executive Summary

“Innovation Momentum 2022: The Global Top 100” uncovers forward-looking technological developments and spotlights true innovative contemporaries across all industries. The new, unique methodology captures the Innovation Momentum over the last two years. It recognizes companies with exceptional Technology Relevance for the future and those outperforming their peers. The Innovation Momentum rewards technology companies with well-maintained portfolios while recognizing highly specialized technology drivers with exceptional relevance in their focus areas.

This inaugural 2022 report includes a peer group deep dive with analyses for the three selected industries on the list: pharmaceuticals, electronics, and semiconductors. These analyses illustrate the true innovative strength of the patent holders with the highest Innovation Momentum over the past two years.

The report uncovers themes around today's most pressing global challenges, such as the COVID-19 pandemic with an emphasis on our world's continued digital transformation. Geographical and academic analyses also reveal the regions and universities leading in the Innovation Momentum.



The Innovation Momentum effectively identifies innovators that outperform their peers without being dominated by portfolio size.

→ Page 1



Pharmaceuticals is the largest industry sector with a total of 17 innovators, mostly from the Americas, none from Asia and four from CEMEA.

→ Page 9



The majority of innovators are based in the Americas, followed by Asia, and then Central and Eastern Europe, the Middle East and Africa (CEMEA) with the fewest.

→ Page 8



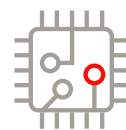
Human-machine interface technology is one of the major drivers in the field of increasingly differentiated electronic devices.

→ Page 11



Distribution of technologies observed across the globe is uneven, with certain geographical areas focusing on certain technological domains.

→ Page 8



Strong focus on semiconductor device manufacturing, is observed, as opposed to design in the semiconductor space.

→ Page 13



Companies that have worked on COVID-19 vaccines are highly represented in the Global Top 100 list.

→ Page 9



Among the 16 academics and public research entities, all except one are from the U.S. or China, and a very high technological differentiation is evident from region to region.

→ Page 15

Contents

Foreword	II
Executive Summary	III
How to Measure Innovation Momentum	1
The 2022 Global Top 100	2-6
The 2022 Industry Sector Distribution of Top 100 Companies	7
Innovation in the World's Regions	8
Focus Technologies 2022	9
Pharmaceuticals	9
Electronics	11
Semiconductors	13
Academics and Public Research	15
Closing Summary	17
About the PatentSight Patent Asset Index™	18
About the Authors	19
About LexisNexis® Intellectual Property Solutions	20
About LexisNexis® PatentSight®	20

How to Measure Innovation Momentum

The **Innovation Momentum** methodology follows the **Patent Asset Index**, an industry-trusted, scientifically developed index created to assess patents based not only on size but also taking into account the individual quality of all patent families belonging to a patent portfolio. The quality of a patent family, the **Competitive Impact**, is measured by the product of its **Technology Relevance** and **Market Coverage**. Therefore, the strength of an entire patent portfolio, the Patent Asset Index, is determined by the sum of each patent family's Competitive Impact.¹⁾

The Innovation Momentum was developed to provide an unbiased methodology to identify innovators who outperformed their peers over the period of the previous two years. In that context, outperforming the peer group means that the Technology Relevance of a patent portfolio has significantly increased for small portfolios or has been maintained or even increased in the case of large portfolios. In addition, portfolio size development and the global filing strategy, known as Market Coverage, are included in the Innovation Momentum.

The only condition a patent owner must fulfill to be considered as a Top 100 Innovation Momentum innovator is a portfolio size of at least 10 patent families. Other than that, there are no limitations, and thus about 11 million active patent families are taken into account in determining the Top 100 innovators.

To demonstrate their Innovation Momentum, the patent portfolios have to increase their Technology Relevance over a two-year period. As this is easier to achieve for small portfolios than it is for the large portfolios, the Technology Relevance increase for small portfolios has to be significantly higher than for larger portfolios; and for large and growing portfolios, maintaining Technology Relevance can be sufficient. On top of that, a change in Technology Relevance has to outperform all other patent families in the same technology field.

Thus, the Innovation Momentum reflects the dynamics of technology development, and this year's contenders have to work to maintain their Top 100 status.



Figure 1: Example of changes in the innovative strength of patent owners in the last two years.

The Innovation Momentum approach is unique because it:

- Recognizes patent owners with relatively small but high-quality portfolios
- Rewards patent owners with well-maintained portfolios
- Reflects the dynamics of thriving technologies
- Takes into account the differences of developments in all technology fields
- Considers the innovators' target markets

¹ Source: Ernst H., Omland N., "The Patent Asset Index—A new approach to benchmark patent portfolios." World Patent Information (2011)

The 2022 Global Top 100

Below you will see the Top 100 companies in alphabetical order, the headquarter locations, and industry sectors.

Patent Owner	HQ	Industry
10x Genomics	US	Biotechnologies
4Catalyzer	US	Medical Technologies
AAC Technologies	CN	Electronics
Acuitas Therapeutics	CA	Pharmaceuticals
Align Technology	US	Medical Technologies
Alphabet	US	Information Technologies
Altria Group	US	Consumer Goods
Amazon	US	Information Technologies
Amgen	US	Pharmaceuticals
Ant Group	CN	Information Technologies
Apple	US	Electronics
ARAMCO	SA	Chemicals and Materials
Araxes Pharma	US	Pharmaceuticals
ArcelorMittal	LU	Chemicals and Materials
Arvinas	US	Pharmaceuticals
ASM International	NL	Semiconductors
ASML	NL	Semiconductors
AT&T	US	Information Technologies
AU Optronics	TW	Electronics
BOE	CN	Electronics

CA: Canada, CN: China, LU: Luxembourg, NL: The Netherlands, SA: Saudi Arabia, TW: Taiwan, US: United States of America

Below is brief information on selected companies from the Top 100.

10x Genomics

is a biotech company that designs and manufactures gene sequencing technology. Its innovations center around processing and analysis of polynucleotides. The company actively retails single-cell sequencing technology, as opposed to the traditional multi-cell methods.

Ant Group

traces its roots back to Alipay, established in 2004 and became an open internet platform. Through technologies including blockchain, privacy computing, and green computing, the company supports partners to provide inclusive digital life and digital financial services to users.

ArcelorMittal

is one of the largest steel producers in the world. The company resulted from the merger of Arcelor and Mittal.

BOE

is a major manufacturer of display screens that supplies numerous manufacturers of consumer electronics, such as Apple. Its technology includes advancement in

The 2022 Global Top 100

organic light-emitting diode (OLED) display such as folding and through- screen biometric authentication.

CATL

is a battery manufacturer specializing in lithium-ion batteries for electric vehicles and energy storage.

Corning

is a manufacturer of glass and optics, best known for Gorilla Glass, which sits atop a large number of mobile devices. Corning also actively leverages advancements in the glass technology for fiber optics and even vials designed to withstand low temperatures of some of the COVID-19 vaccines.

Deere & Co,

well-known by its brand John Deere, manufactures a wide array of agricultural machinery. This continues to leverage advanced technologies such as self-driving, unmanned aerial vehicles for task assessment and multi-factor assessment of crop performance.

Endress+Hauser

is a supplier of the industrial process automation for various laboratory instrumentation and industries.

Patent Owner	HQ	Industry
Boeing	US	Engineering
Bosch	DE	Automotive
Bristol-Myers Squibb	US	Pharmaceuticals
British American Tobacco	GB	Consumer Goods
CATL	CN	Chemicals and Materials
CJ Corporation	KR	Consumer Goods
Comcast	US	Information Technologies
Corning	US	Chemicals and Materials
CPT Technology (Group)	CN	Electronics
CureVac	NL	Pharmaceuticals
Deere & Co	US	Engineering
DJI Innovations	CN	Electronics
Edwards Lifesciences	US	Medical Technologies
Endress+Hauser	CH	Engineering
Firmenich	CH	Chemicals and Materials
Ford	US	Automotive
Gilead Sciences	US	Pharmaceuticals
Global Graphene	US	Chemicals and Materials
GoerTek	CN	Electronics
Goodix	CN	Electronics

CH: Switzerland, CN: China , DE: Germany, GB: Great Britain, KR: South Korea, NL: The Netherlands, US: United States of America

The 2022 Global Top 100

Patent Owner	HQ	Industry
Huawei	CN	Information Technologies
Hyundai Motor	KR	Automotive
Illumina	US	Biotechnologies
Incyte	US	Pharmaceuticals
Infineon	DE	Semiconductors
Intel	US	Semiconductors
InterDigital	US	Technology R&D
Intuitive Surgical	US	Medical Technologies
Johnson & Johnson	US	Pharmaceuticals
Juul Labs	US	Consumer Goods
KLA	US	Semiconductors
Lam Research	US	Semiconductors
Largan Precision	TW	Engineering
LG Chem	KR	Chemicals and Materials
LG Electronics	KR	Electronics
Macronix	TW	Semiconductors
Magic Leap	US	Electronics
Masimo Corp	US	Medical Technologies
MediaTek	TW	Semiconductors
Medtronic	IE	Medical Technologies

CN: China, DE: Germany, IE: Ireland, KR: South Korea, TW: Taiwan, US: United States of America

GoerTek

is an acoustic component company that is supplying to consumer product companies like Apple and Samsung.

InterDigital

is a research and development company primarily focused on modern telecommunications. It actively contributes to the development of standards such as 5G, with the majority of its revenue resulting from licensing.

Juul Labs

is a tobacco company focused on electronic alternatives to traditional cigarettes. Significant development in recent years has been a major reason for several similar companies to be included in the Top 100.

LG Chem

is Korea's largest chemical company, having different product segments, including its well-known lithium-ion batteries, which are used in electric vehicles and mobile devices.

Magic Leap

is an augmented reality device manufacturer. Its technology covers a wide number of areas required for immersive augmented reality, from optics to sensors to systems.

The 2022 Global Top 100

Meta

is the latest name for the company that owns Facebook. It covers a wide array of data processing technologies but has the strongest innovations in virtual reality after acquiring Oculus in 2014.

Nitto Denko

is a producer of tapes and films primarily for optronics, converting optical input to electrical output. A number of their top innovations are centered around pressure-sensitive films for display and input devices.

Ofinno Technologies

is a technology research and development company that develops mobile networks and internet of things (IoT) technologies.

OMV Group

effectively owes all of its portfolio strength to Borealis, one of its subsidiaries, of which the Group became 75% owner in 2020. Borealis is one of the largest manufacturers of polyolefins.

Regeneron

is a biotechnology company among the front-runners in their attempt to bring mRNA-based vaccines and drugs to the market.

Patent Owner	HQ	Industry
Merck & Co	US	Pharmaceuticals
Merck KGaA	DE	Chemicals and Materials
Meta	US	Information Technologies
Moderna Therapeutics	US	Pharmaceuticals
nChain	CH	Information Technologies
Nestle	CH	Consumer Goods
NetEase	CN	Information Technologies
Nike	US	Consumer Goods
Nitto Denko	JP	Chemicals and Materials
Novartis	CH	Pharmaceuticals
Nvidia	US	Semiconductors
Ofinno Technologies	US	Technology R&D
OMV Group	AT	Chemicals and Materials
OneTrust	US	Information Technologies
Pfizer	US	Pharmaceuticals
Philip Morris	US	Consumer Goods
Qualcomm	US	Semiconductors
Raytheon Technologies	US	Engineering
Regeneron	US	Pharmaceuticals
ResMed	US	Medical Technologies

AT: Austria, CH: Switzerland, CN: China, DE: Germany, JP: Japan, US: United States of America

The 2022 Global Top 100

Patent Owner	HQ	Industry
Revolution Medicines	US	Pharmaceuticals
Roche	CH	Pharmaceuticals
ROFS Microsystem	CN	Semiconductors
Rolls-Royce	GB	Engineering
Samsung	KR	Electronics
Samsung SDI	KR	Chemicals and Materials
Sanofi	FR	Pharmaceuticals
Sinochem Holdings	CN	Chemicals and Materials
Stryker	US	Medical Technologies
Sunny Optical Tech.	CN	Engineering
Tencent	CN	Information Technologies
Thomas H. Lee Partners	US	Engineering
Thyssenkrupp	DE	Engineering
Tianma Microelectronics	CN	Electronics
Trumpf Gruppe	DE	Engineering
TSMC	TW	Semiconductors
Visionox	CN	Electronics
vivo	CN	Information Technologies
VW Group	DE	Automotive
WeBank	CN	Information Technologies

Rolls-Royce

is an aerospace and defense company and should not be confused with the car manufacturer with a similar name.

Samsung SDI

produces lithium-ion batteries for automotive applications and mobile devices. It also produces materials for the electronics industry.

Stryker

is a manufacturer of medical equipment. It has made a number of innovations in the area of advanced and robotic surgery.

Trumpf Gruppe

is a manufacturing equipment company. Its top innovations are centered around advanced manufacturing, such as laser cutting and associated optical systems.

TSMC

is the largest semiconductor foundry in the world and offers the most advanced manufacturing processes. It is a manufacturer of integrated circuits for companies like Apple, Intel, Nvidia, AMD, and Qualcomm.

CH: Switzerland, CN: China, DE: Germany, FR: France, GB: Great Britain, KR: South Korea, TW: Taiwan, US: United States of America

The 2022 Industry Sector Distribution of Top 100 Companies

With the methodology behind Innovation Momentum and its emphasis on high-performing patent development as a defining characteristic of innovation, we developed a unique breakdown of the Top 100 most innovative technology companies of 2022.

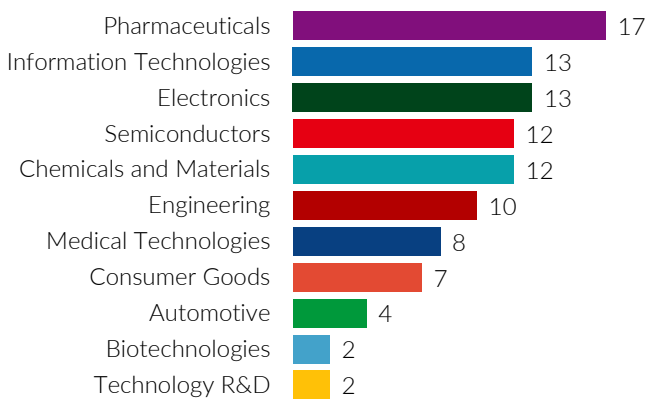


Figure 2: The number of Top 100 innovators per industry sector.

Our chief observation about the inaugural Innovation Momentum list of innovators is that the industry sectors most represented in the Top 100 are nearly a direct reflection of the most pressing global topics. Economic pressures like the global COVID-19 pandemic and the subsequent supply chain challenges are key themes driving developments in this year’s list.

As we reach the second year of the global pandemic, pharmaceuticals are at the top of the most innovative industries list, with continued vaccine development from companies like **Johnson & Johnson**, **Moderna Therapeutics**, and others. There are also various smaller players innovating in this space, with gene editing based on clustered regularly interspaced short palindromic repeats-associated protein 9 (CRISPR/Cas9) opening venues for the development of new therapeutics and **10x Genomics**, **Arvinas** and **Incyte** making great strides in the field of onco-immunology.

Information technologies are another well-represented industry, highlighting the continued digital transformation

of nearly every aspect of daily life. This includes financial services companies like **Ant Group** and **WeBank**, as well as internet giants like **Alphabet**, **Amazon**, and **Tencent**.

Further, many of the categories included highlight the technology and materials that are necessary to provision the most influential industries. For example, hardware from semiconductor manufacturers like **TSMC** and electronics companies like **Goodix** are vital to supporting the world’s continued digital transformation. The demand for rechargeable batteries for items such as mobile devices and electric vehicles gives context to the chemical and materials category with innovators like **Contemporary Amperex Technology (CATL)**, **LG Chem**, and **Samsung SDI** on the list.

We also see industries innovating as a response to the changing environments and policies. For example, the tobacco industry shows some representation in the consumer goods category as it continues to transform alongside shifting policies and reforms. We see patents in the automotive industry reflecting action on climate change challenges.

With all these observations, Innovation Momentum demonstrates the versatility of the innovators as well as the relevance of their innovations in our everyday lives.

Starting on page 9, you will see detailed analyses of the landscapes and developments pertaining to the patent portfolios of technology owners from selected sectors.

The industry sectors most represented in the Top 100 are nearly a direct reflection of the most pressing global topics.

Innovation in the World’s Regions

In a global economy with worldwide intertwined supply chains, it is worthwhile to convey a broader view of the Top 100 patent owners.

The Americas, namely the U.S., contributes almost half of the Top 100 companies. These are concentrated in the pharmaceuticals, medical technologies, and information technologies industry sectors. The Americas have the most diverse set of industry sectors, as opposed to Asia and Central and Eastern Europe, the Middle East and Africa (CEMEA) which have noticeable gaps.

About a third of the Top 100 innovators are located in the Asian region, which focuses on the industry sectors of electronics, chemicals and materials, and information technologies.

The remaining fifth comes from the CEMEA region with all but one innovator being located in Central Europe. Regarding the European patent owners on the list, it appears that they cannot claim a dominant share in any specific industry sector.

Uneven distribution across the globe also applies to industry sectors. Top contenders in the pharmaceuticals industry, for example are concentrated in the U.S., while the innovators in the electronics industry are mostly located in the Asian region.

In Europe, the most populated sectors are the chemicals and materials industry along with engineering. However, in both cases, the number of innovators is tied with Asia and the Americas, respectively.

Industry Sector	Americas	Asia	CEMEA	Total
Pharmaceuticals	13		4	17
Information Technologies	6	6	1	13
Electronics	2	11		13
Semiconductors	5	4	3	12
Chemicals and Materials	2	5	5	12
Engineering	4	2	4	10
Medical Technologies	7		1	8
Consumer Goods	4	1	2	7
Automotive	1	1	2	4
Biotechnologies	2			2
Technology R&D	2			2
Total	48	30	22	100

Table 1: The breakdown of the number of innovators by industry sector and region.

Focus Technologies 2022

In the following three sections, you will see brief overviews of the innovators in three selected industry sectors. This will put each owner into the context of its 2022 peer group and provide insights into the portfolio evolution over the last two years.



Pharmaceuticals

- Acuitas Therapeutics
- Amgen
- Araxes Pharma
- Arvinas
- Bristol-Myers Squibb
- CureVac
- Gilead Sciences
- Incyte
- Johnson & Johnson
- Merck & Co
- Moderna Therapeutics
- Novartis
- Pfizer
- Regeneron
- Revolution Medicines
- Roche
- Sanofi

The pharmaceuticals group is by far the largest sub-technology among the Top 100 and strongly highlights a theme of focus across all industries in this year's Top 100: the COVID-19 pandemic.

Johnson & Johnson and **Roche** both have the strongest portfolios in this sub-technology. These two have the largest portfolios in the technology group and, like the others, have a Competitive Impact above the database average of about one. They have increased their patent portfolio strength, as measured by the Patent Asset Index over recent years, further improving the quality of their patents.

For some time now, **Amgen** has been active in the field of cancer immunotherapy and has invented path-breaking potential treatments against different types of cancers, the most recent being lung cancer. **Incyte** and **Arvinas** are also active in this field. **Merck & Co** holds a strong position in the field of cancer therapy with its patented cancer drugs. **Novartis** has been inventing treatments for diseases like psoriasis, muscular atrophy, and cancer. It has also ventured into the field of precision treatment, as indicated by its patent portfolio.

Revolution Medicines is an emerging key player in the field of cancer therapy concentrating on potential new targets for cancer treatments. Especially those caused due to mutations in the Ras genes that are associated with Noonan syndrome and hence juvenile myelomonocytic leukemia and pediatric leukemia.

Along with well-known innovators in pharmaceuticals, a number of smaller players have also ranked in the Top 100, and many of them have technologies that influence the way we diagnose and treat COVID-19. Thus, these companies are part of the innovation movement that enabled humankind to swiftly react to the COVID-19 pandemic and save many lives. By now the world is familiar with **Moderna Therapeutics**, as its COVID-19 vaccine has now been widely administered. **CureVac** has also seen some recognition working on mRNA-based therapies in a similar way to **Moderna's** vaccine.

So, while we hope that the COVID-19 pandemic will be over soon, the newly developed innovative methods for combating COVID-19 remain and are likely to provide new opportunities for therapeutics to address a wider range of diseases.

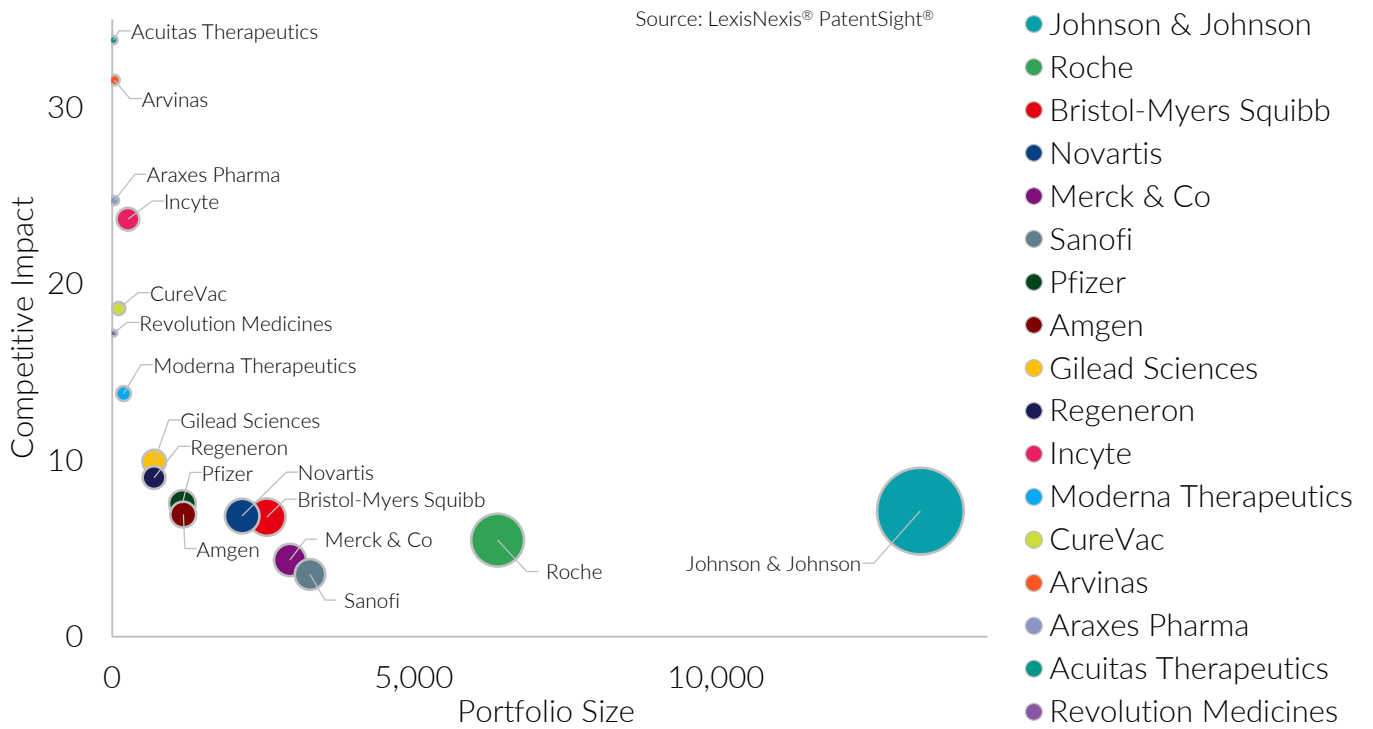


Figure 3: Average patent quality (Competitive Impact) versus Portfolio Size for pharmaceuticals industry sector patent owners. The bubble size for the patent owners scales with portfolio strength (Patent Asset Index™).

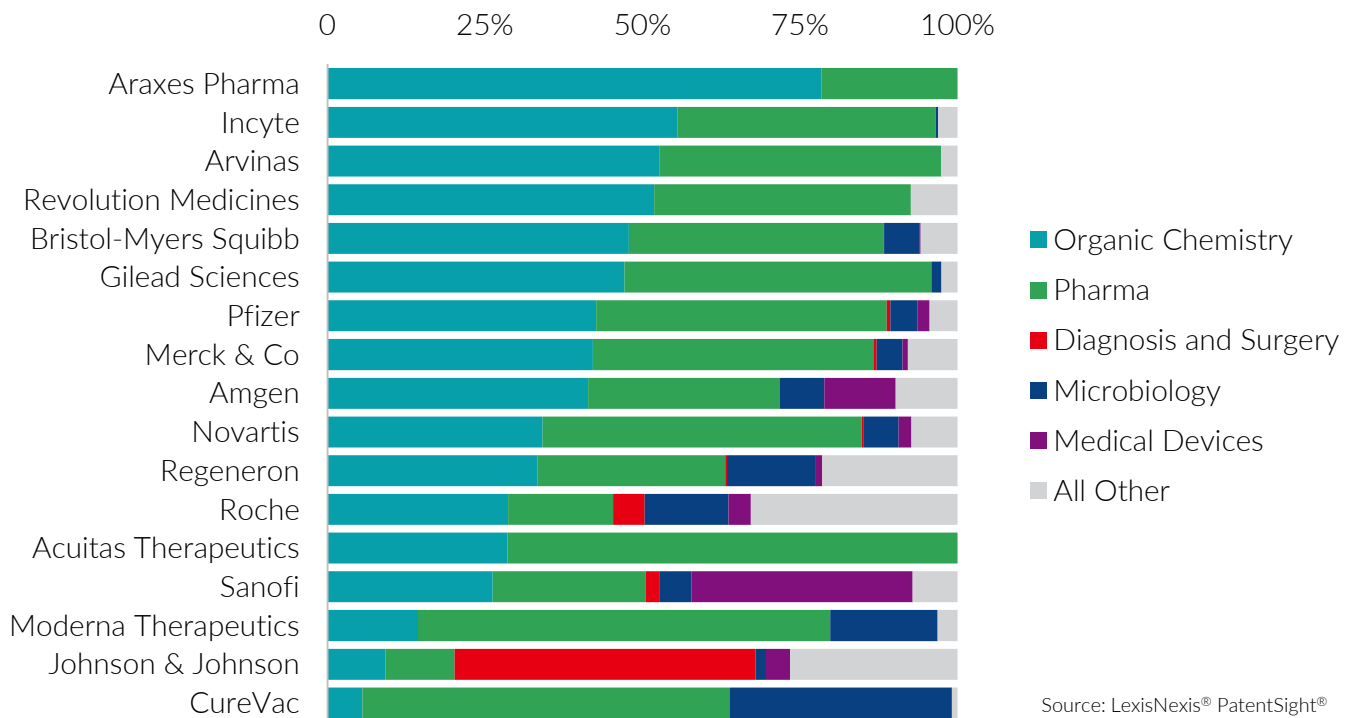


Figure 4: Major technology fields covered by the innovators in the pharmaceuticals industry sector as share of the patent owners' portfolio.



Electronics

- AAC Technologies
- Apple
- AU Optronics
- BOE
- CPT Technology (Group)
- DJI Innovations
- GoerTek
- Goodix
- LG Electronics
- Magic Leap
- Samsung
- Tianma Microelectronics
- Visionox

The top innovators in electronics emphasize the influence of human interfaces and the continued evolution of human interaction with digital devices—from sight to sound to touch.

Display technology is prominent among the top electronics innovators, with **Samsung**, **BOE**, and **CPT Technology** being major display manufacturers along with **AU Optronics** supplying technology for touch screens. This should not be a surprise because displays are the preferred machine/user interface for any electronic or communication device in an ever more digitized world.

For most of the time, innovation in display technology was centered around good old cathode ray tube (CRT) technology, which celebrates its 125th anniversary this year. Even though liquid crystals were discovered prior to the invention of the CRT, MOSFET thin-film transistors were required to build liquid crystal displays (LCDs), which became popular in the late 1980s. At the same time, the success story of OLEDs started enabling colorful, high-contrast displays. And today, displays in which the display pixels consist of individual light-emitting diodes (LEDs) are available.

But there are alternative ways to interact with electronic devices using senses other than sight. As the computational power of virtual assistant systems increases, speech and hearing are being used for human/machine interaction.

This is similar to interaction with a display using a hands-free way of interacting with devices. However, it is an alternative interaction for situations when the device is out of sight or when sight is needed to focus on other tasks without distraction—for example, when driving a car. **AAC Technologies**, **GoerTek**, and **Goodix** are among the electronics innovators offering technologies in this area. Complementing sight and hearing, the touch sensor is used for haptic interaction. Here, the same innovators again represent a different way to interact with electronic devices, such as providing a feedback signal when real and virtual buttons are pressed.

Beyond specific device interaction, virtual and augmented reality have become mainstream. To provide a truly seamless experience, computing performance, high quality, and refreshed displays, along with sensors and user inputs need to be expertly combined. These experiences quickly become strange or even physically uncomfortable when all these aspects do not function correctly. **Magic Leap** has and continues to make considerable strides in this area, which is a testament to the company itself and the broader technology base. Another interesting area of innovation has emerged with the manufacturing of unmanned aerial vehicles by **DJI Innovations**, often in combination with photographic devices. Progress of this technology can be seen in the production of television shows and movies that capture agile aerial footage in narrow spaces that were not accessible via helicopters in the past.

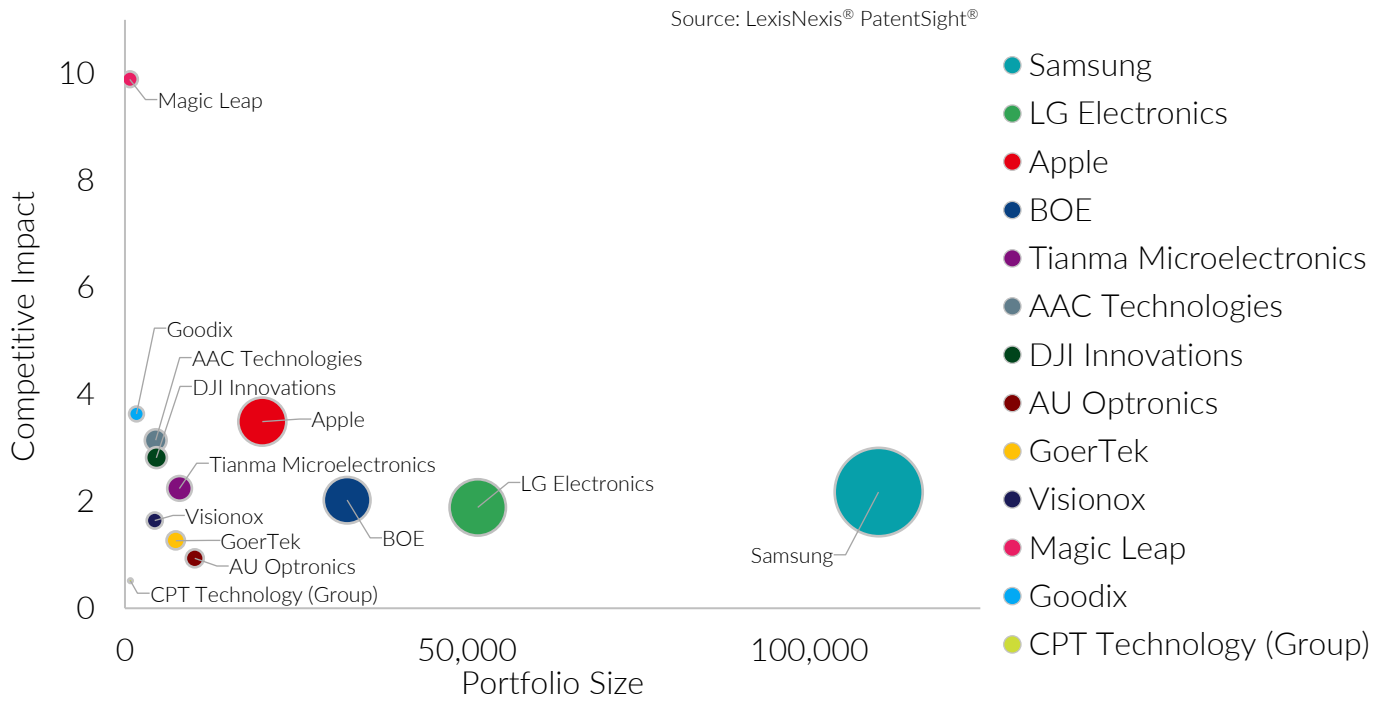


Figure 5: Average patent quality (Competitive Impact) versus Portfolio Size for electronics industry sector patent owners. The bubble size for the patent owners scales with portfolio strength (Patent Asset Index™).

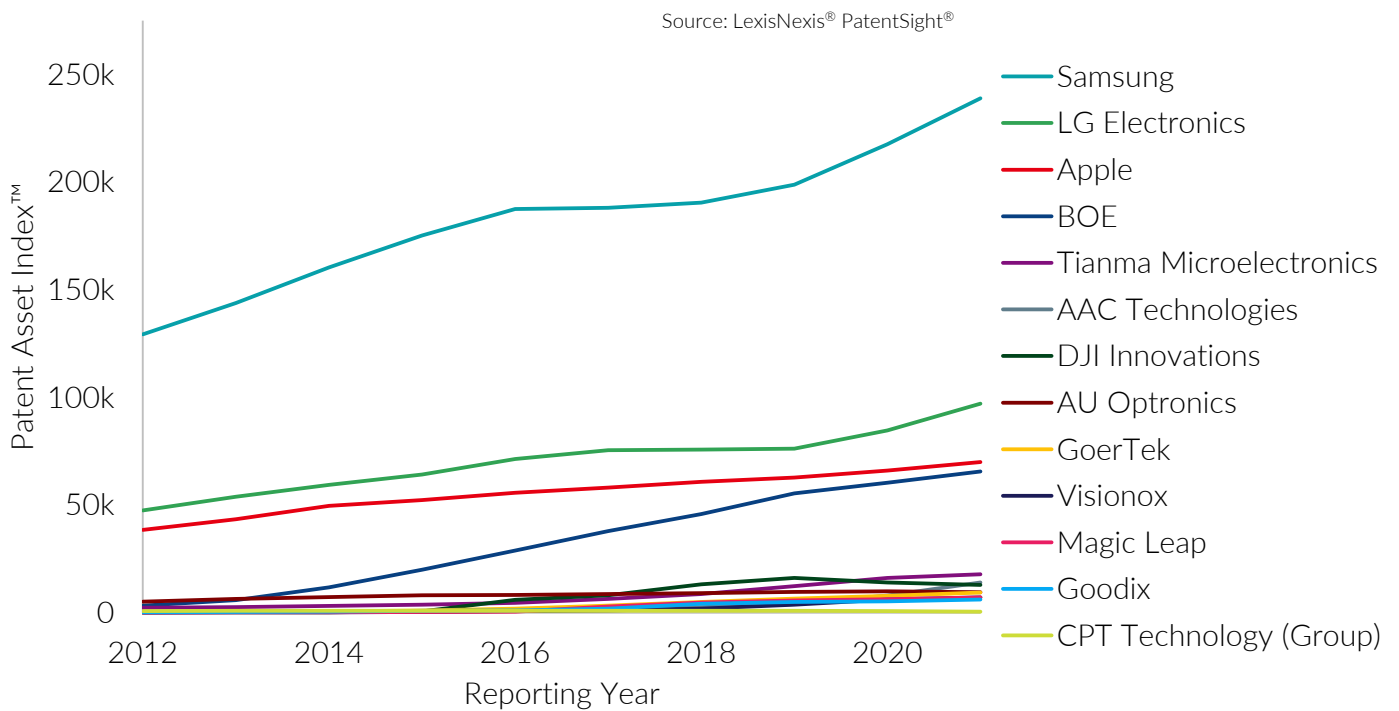
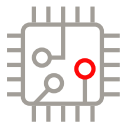


Figure 6: Patent Asset Index™ trends for electronics industry sector patent owners over the last 10 years.



Semiconductors

- ASM International
- ASML
- Infineon
- Intel
- KLA
- Lam Research
- Macronix
- MediaTek
- Nvidia
- Qualcomm
- ROFS Microsystem
- TSMC

The semiconductors category is yet another dominant sub-technology on this year's global Top 100 list. As with pharmaceuticals, highlights from this group reflect current challenges facing many businesses, most notably supply chain strains. We see these struggles overflowing into related industries, like automotive.

Overall, the semiconductors category comprises 12 companies this year. Data demonstrates that the Innovation Momentum in the semiconductors industry is currently focused on manufacturing.

Among the innovators in the semiconductors industry, the largest portfolios are owned by **Qualcomm**, **Intel**, and **Taiwan Semiconductor Manufacturing Company (TSMC)** with an above average Competitive Impact, followed by **Infineon Technologies**. **Intel** and **Infineon Technologies** are integrated device manufacturers (IDMs), which means that they design, manufacture, and sell their products.

In contrast, **Qualcomm** follows a so-called fabless model in which it designs its chips but does not manufacture them. Fabless semiconductor companies and IDMs, outsource the chip manufacturing to semiconductor contract manufacturers like **TSMC**, which are called "semiconductor foundries."

TSMC shows a constant increase in its portfolio strength over the last decade and is one of the largest strength gainers of the whole semiconductor innovation group. Further, the business model differences of **Qualcomm**, **Intel** and **TSMC** highlight an additional aspect of the evolution of patent portfolio strength in **TSMC**: As a pure play foundry, **TSMC** has intellectual property that

focuses on contract manufacturing of semiconductor devices. This is in clear contrast to the fabless **Qualcomm** and IDM **Intel**, with **Qualcomm's** intellectual property covering chip design and **Intel's** mostly covering chip design and products. Despite this difference, the gap in portfolio strength between **Intel** and **TSMC** continuously decreases. With **Intel's** foundry service initiative in mind, it will be interesting to observe the future portfolio strength development for both companies.

Manufacturing equipment suppliers are the largest sub-grouping in the semiconductors category, including **Lam Research**, **ASM International (ASMI)**, **ASML**, and **KLA Corporation (KLA)**.

Semiconductor equipment and semiconductor device manufacturers collaborate closely to ensure manufacturing equipment matches the needs of manufacturers to push semiconductor technologies further. Thus, it is no surprise to see semiconductor equipment manufacturers next to the top semiconductor device manufacturers. This also demonstrates how important it is for semiconductor manufacturing to turn increasingly powerful integrated circuits into actual, affordable products.

The semiconductor equipment manufacturers generally cluster with their respective portfolio sizes and average patent quality (Competitive Impact). **ASM International** is an exception with the smallest patent portfolio, but the best average patent quality (Competitive Impact) among its peers. Its exceptional position is likely due to **ASM International's** strong focus on the technology that is used in the process of manufacturing modern integrated circuits.

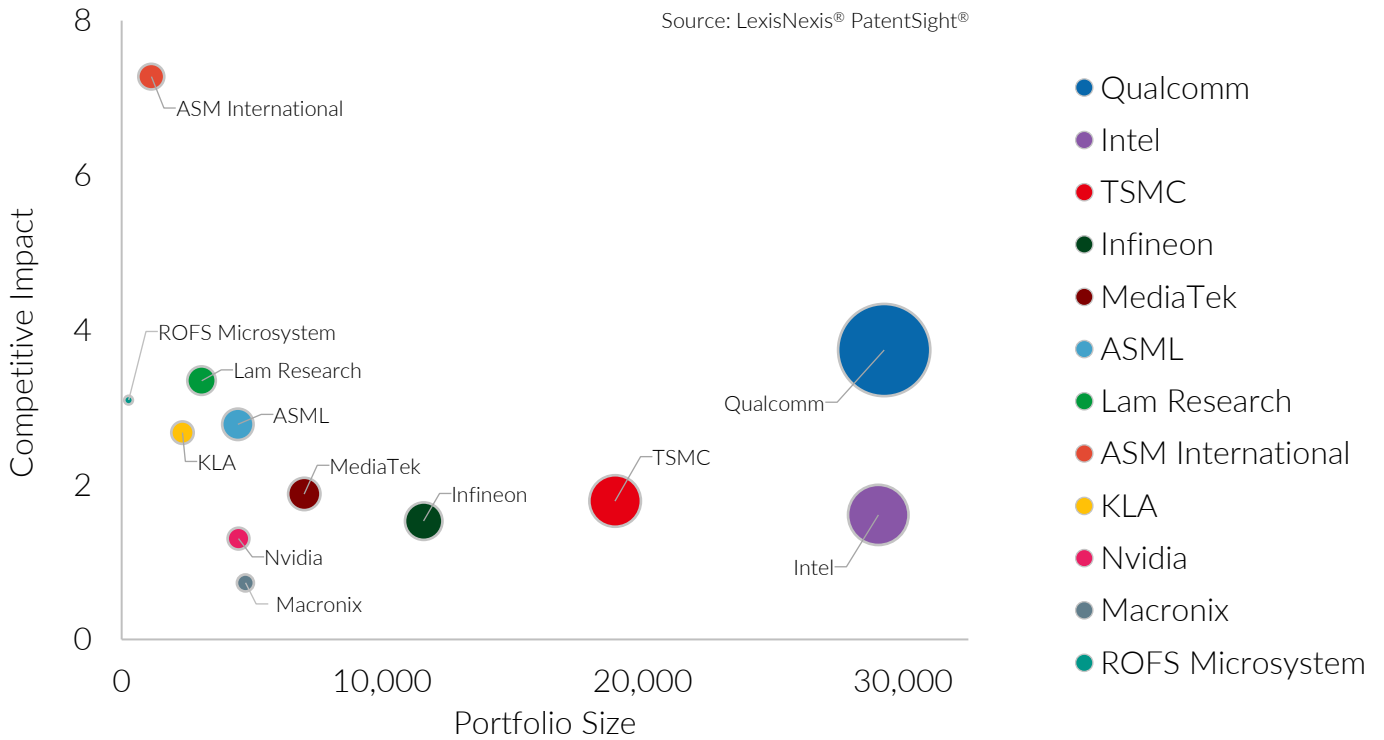


Figure 7: Average patent quality (Competitive Impact) versus Portfolio Size for the semiconductors industry sector patent owners. The bubble size for the patent owners scales with portfolio strength (Patent Asset Index™).

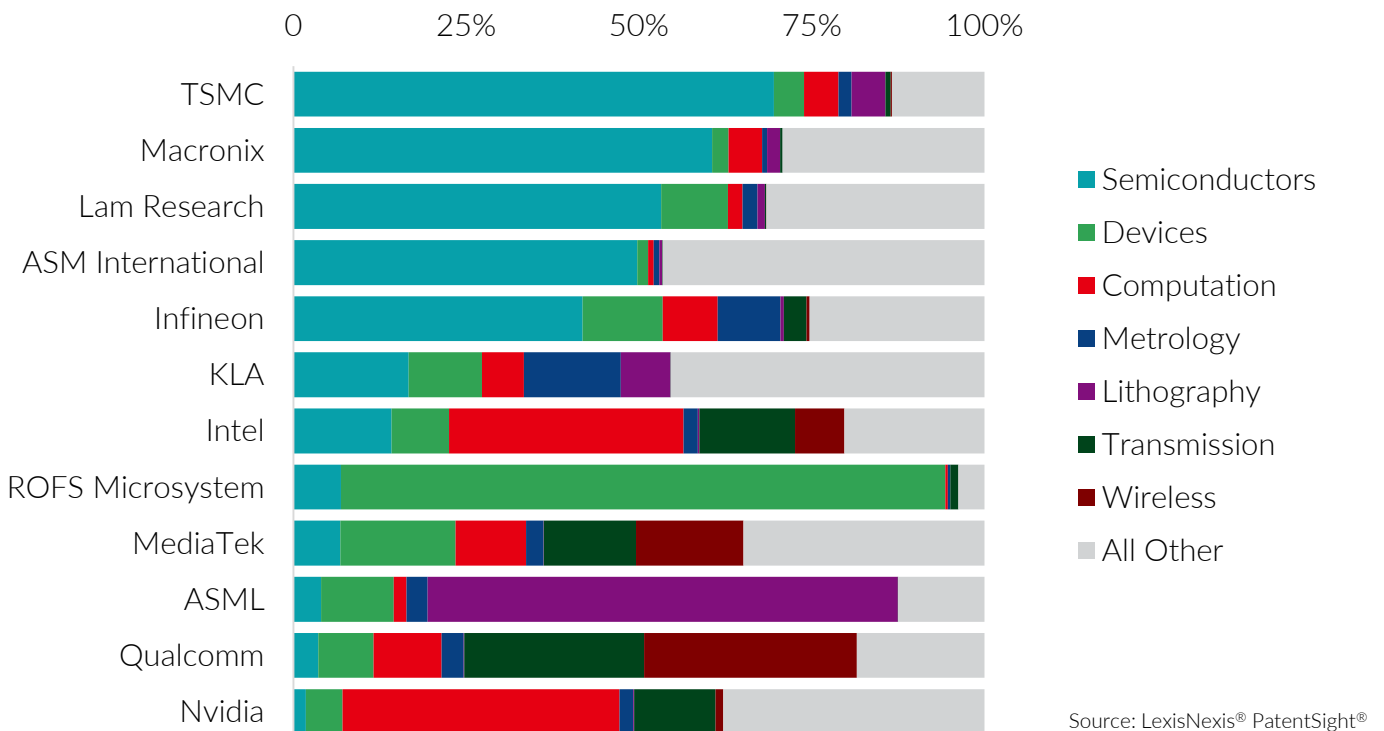


Figure 8: Major technology fields covered by innovators in the semiconductors industry sector as share of the patent owners' portfolio.



Academics and Public Research

The Top 100 includes only corporates; however, a number of academic and public research innovators met the same criteria of outstanding Innovation Momentum and we recognize them here.

- Broad Institute
- Central South University
- Dalian University of Technology
- Dana-Farber
- Fraunhofer
- Harvard
- Huazhong Univ. of Sci. & Tech.
- Mass General Brigham
- MIT
- Shandong University
- Sloan-Kettering
- Stanford University
- Tsinghua University (China)
- University of California
- University of Pennsylvania
- Xi'an Jiaotong University

All the academic and public research institutions included are located in the U.S. or China, except **Fraunhofer**, which is based in Germany. **Fraunhofer** is a research organization with a large number of institutes spread over Germany, focusing on different fields of applied science. It is the largest applied research and development services organization in Europe.

The Chinese players have a larger portfolio than those in other regions, likely as a result of the government incentive programs in place around patent filing. As such, these Chinese players have lower quality; this is not a given, but a typical outcome of a larger portfolio. To maintain a high level of quality, each additional patent needs to be equally strong, or stronger, than the previous ones. Their quality may be lower but is still above the global average and continues to be so even as these organizations have grown their portfolios, hence their inclusion.

Some innovators with much smaller portfolios, even 10% the size of the Chinese institutes, have a higher quality. **Broad Institute** has by far the highest. **Broad Institute** was set up as a joint venture for the CRISPR technology developed by **MIT** and **Harvard**. CRISPR

is an advanced gene editing technology and has been heralded as a game changer for a vast array of sectors from medical to crops to biofuel applications. This is the driver of **Broad's** strength; the key patents of this technology are also co-owned with **Harvard** and **MIT**, contributing significantly to their inclusion.

Not only is there a regional split in terms of size and quality, but also a split in technologies between the Chinese and U.S. players. The Chinese players mainly have innovations in information technology, whereas the U.S. players have their innovations primarily in the chemistry and healthcare sectors. Outside these two fields, there is a notable activity from the **University of California** and **Mass General Brigham** in the healthcare sector, **Tsinghua University** in telecommunications and **Fraunhofer** in telecommunications and physics.

Notably, Boston appears to be the powerhouse for innovation with **Broad**, **MIT**, **Harvard**, **Dana-Farber**, and **Mass General Brigham** all in the immediate area. Those we have not discussed already are the **Dana-Farber Cancer Institute** and **Mass General Brigham**, previously known as Partners HealthCare, a non-profit hospital and one of the largest biomedical research institutes.

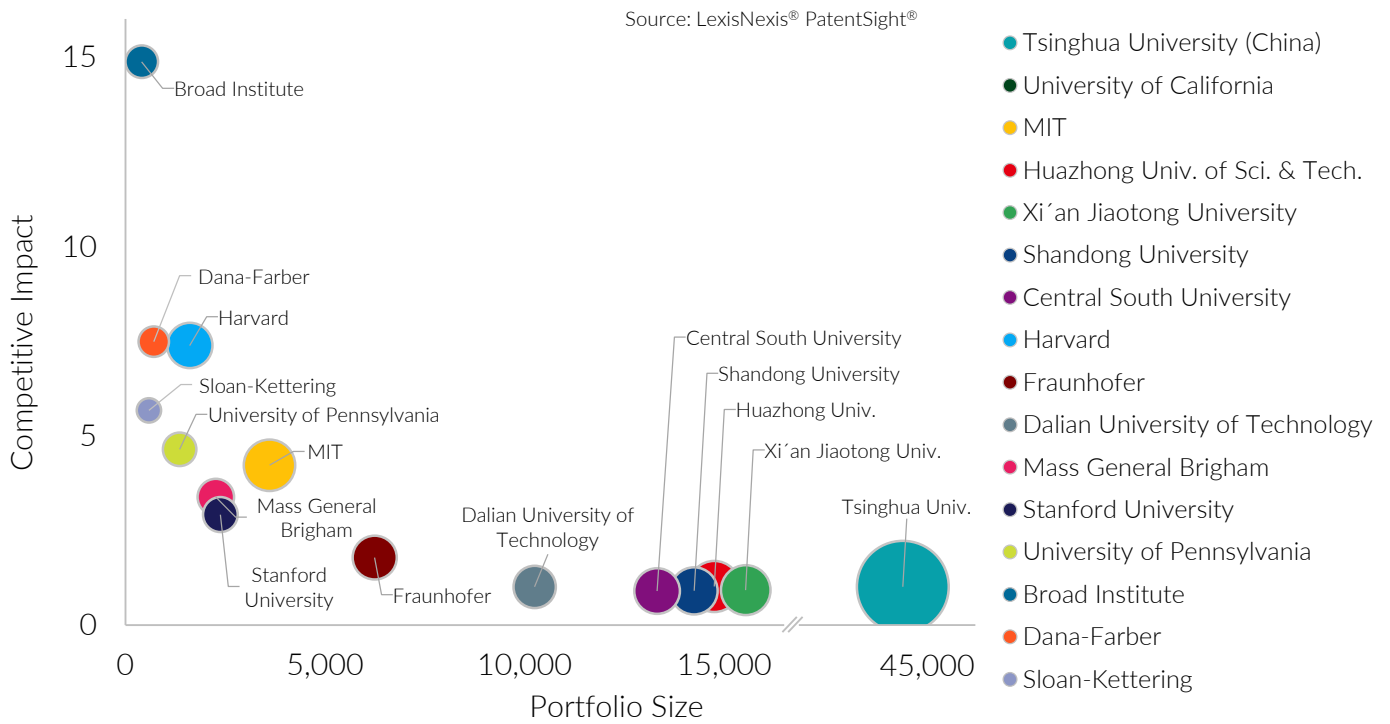


Figure 9: Average patent quality (Competitive Impact) versus Portfolio Size for academic and public research innovators. The bubble size for the patent owners scales with portfolio strength (Patent Asset Index™).

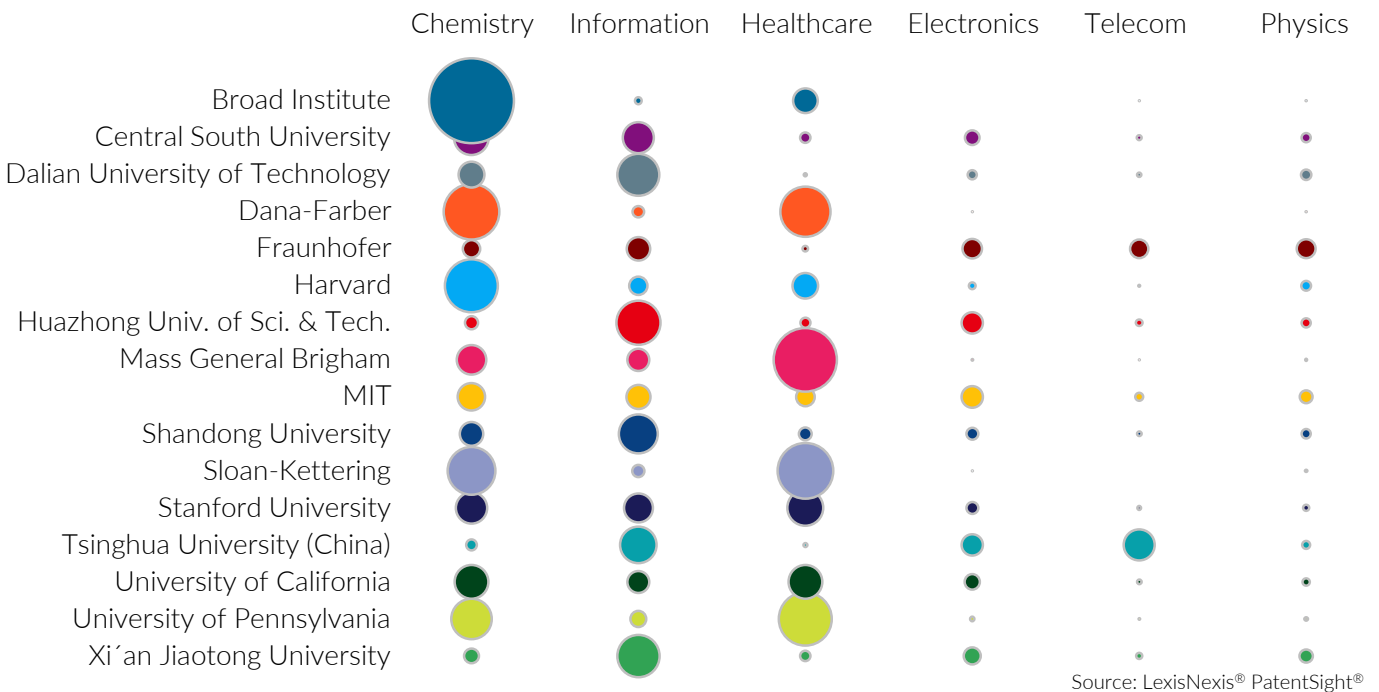


Figure 10: Major technology fields covered by academic and public research innovators. The bubble size scales with technology share in the academic and public research innovators' portfolio.

Closing Summary

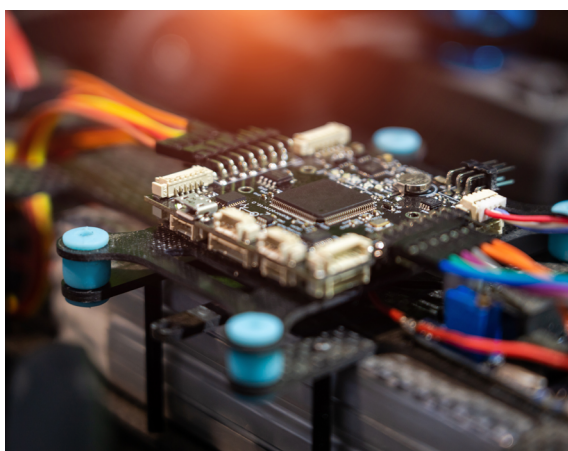
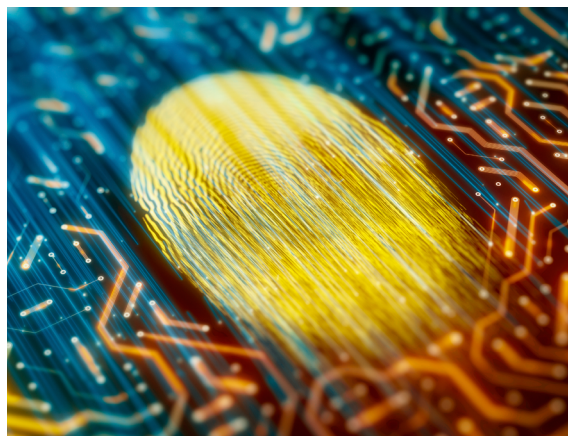
This is the first edition of the Intellectual Property Report “Innovation Momentum 2022: The Global Top 100.” We are grateful for all the organizations on the Top 100 list, as well as the academic innovators. They are making tremendous contributions to advancing technology and solving the challenges of our time.

Looking at the dynamics of innovation gives us a unique view of current and future developments and recognizes those who are making them a reality through their work. The new Innovation Momentum methodology provides insights into the global IP landscape of innovative patent owners and their technologies, helping to identify relevant trends and make the most of opportunities.

Collection of global patent data, enriched with significant information, such as the assignment of patent portfolios to their ultimate commercial owner, makes the processing of these large data sets possible. The Patent Asset Index and its underlying metrics highlight unique insights and allow us to understand the true strength of patent portfolios as measured by their Technology Relevance and scope of global protection.

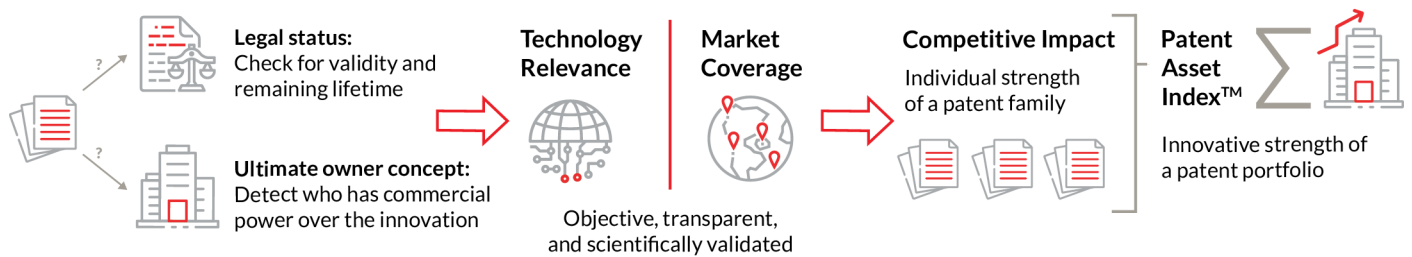
We have seen the strength and valuable influence of patent owners with small but very qualitative portfolios. We also recognize innovators with large portfolios, who are making enormous efforts to optimize their extensive and diversified patent portfolios and thus distinguish themselves from their peers. We observed the differences in developments in the technology fields and how developments differ in individual markets.

How will the momentum of technological developments continue? What innovations will find their way into our lives in the coming years? We look forward with curiosity and eagerness to follow these developments in the future.



About the PatentSight Patent Asset Index™

The Patent Asset Index represents a measure of the innovative strength of a patent portfolio. A patent family is more valuable when other innovations build on the technology protected by this patent family and by the scope of protection that the patent family holder considers appropriate.



PatentSight Technology Relevance is a measure of the importance of a patent family and the technological invention it protects. It is calculated based on the total number of worldwide citations that are received from other patent families and is adjusted for the facts that (1) older patents are cited more often, on average, than younger patents; (2) international patent offices follow different citation rules; (3) and different citation practices are prevalent in different technology fields.

PatentSight Market Coverage is measured as the size of the markets in which a patent family is protected, as benchmarked against the world’s largest economy—the United States. In this context, the gross national income (GNI) of a country is used as a proxy for the relative size of its national market. Market coverage is calculated based on granted and pending patents, adjusted for the patent family’s protected market size.

PatentSight Competitive Impact represents the individual strength of a patent family and is obtained by multiplying

the Technology Relevance and the Market Coverage of each patent family. It is stated relative to the other patent families in the same field. For example, a value of three means that the patent family is three times as important as the average patent family in the field. The value obtained by adding up all the Competitive Impact values of all patent families constituting the portfolio is defined as the Patent Asset Index, which measures the overall strength of a patent portfolio.

The Patent Asset Index methodology is based on many years of scientific research and was validated in peer-reviewed academic publications and studies. Our patent analytics platform LexisNexis® PatentSight®, featuring the Patent Asset Index, has been used for several years by leading companies in many industries, as well as governmental bodies and organizations, e.g., in antitrust consideration or merger clearances. Numerous corporations trust the Patent Asset Index to illustrate the strength of their patent portfolios in annual shareholder reports and other stakeholder communications.

About the Authors



Dr. Dirk Caspary
Senior Consultant
LexisNexis® Intellectual Property Solutions

Dr. Dirk Caspary is a senior consultant with excellent knowledge in the field of patent search, portfolio analysis and competitive intelligence. He has extensive experience in the analysis and evaluation of patents and patent portfolios, e.g., in the context of patent prosecution, licensing programs or defense against third-party patent assertions. He has broad technical knowledge, demonstrates rapid comprehension of complex technologies; and has comprehensive expertise in semiconductor technologies which he has acquired through many years of consulting work for leading global semiconductor manufacturers, reverse engineering, and his work in the semiconductor industry.



William Mansfield
Head of Consulting and Customer Success
LexisNexis® Intellectual Property Solutions

William Mansfield is the head of consulting and customer success in the Americas and CEMEA for LexisNexis® Intellectual Property Solutions. He is responsible for overseeing the negotiation, creation, and delivery of global consulting work, along with managing the Customer Success team. He works closely with numerous international and Fortune 500 companies and others to ensure effective deployment of patent analysis for business strategy, M&A due diligence, portfolio management, and other needs. Mansfield has an economics background and experience in market and R&D strategy in the semiconductor industry.

About LexisNexis® Intellectual Property Solutions

LexisNexis® Intellectual Property Solutions bring clarity to innovation for businesses worldwide. We enable innovators to accomplish more by helping them make informed decisions, be more productive, comply with regulations and ultimately achieve competitive advantage for their business. Our broad suite of workflow and analytics solutions (LexisNexis® IP DataDirect, LexisNexis PatentAdvisor®, LexisNexis PatentOptimizer®, LexisNexis® PatentSight®, and LexisNexis TotalPatent One®), enables companies to be more efficient and effective at bringing meaningful innovations to our world. We are proud to directly support and serve these innovators in their endeavors to better humankind.

About LexisNexis® PatentSight®

LexisNexis® PatentSight® is a powerful and easy-to-use analysis platform that makes quick answers accessible to both top management and intellectual property experts, as well as data experts in a wide array of application areas. The software and its underlying data enable the evaluation of companies and technologies, as well as deep, varied and practical analysis for strategic decision-making. It also enables searching and viewing of individual patents and important patent details.

PatentSight Business Intelligence is recognized for its intuitive usability, flexibility and powerful visualizations. PatentSight compiles bibliographic patent data from over 95 authorities worldwide utilizing the DOCDBN, the European Patent Office's master documentation database with worldwide coverage and has vast full-text patent data, with over 100 million patent documents in English, approximately 700 million drawings and illustrations of inventions, and nearly 100 million PDFs that are searchable (via OCR) and quickly downloadable.

LexisNexis® Intellectual Property Solutions.
Bringing clarity to innovation.

To learn more visit us at
[PatentSight.com](https://www.patentsight.com)