Bio-chips: the future of medicine

Patent Landscape Analysis

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1. Introduction

1.1 Background on the subject

“Biochips” form the most exciting technology to emerge from the fields of Biotechnology, Electronics and Computers in recent years. Advances in the areas of proteomics, genomics and pharmaceuticals are empowering scientists with new methods for unraveling the complex biochemical processes occurring within cells, with the larger goal of understanding and treating human diseases. Almost simultaneously, the semiconductor industry has been steadily perfecting the science of micro-miniaturization. The merging of these two fields led to the development of Biochip that enabled Biotechnologists to begin packing their traditionally bulky sensing tools into smaller and slighter spaces.

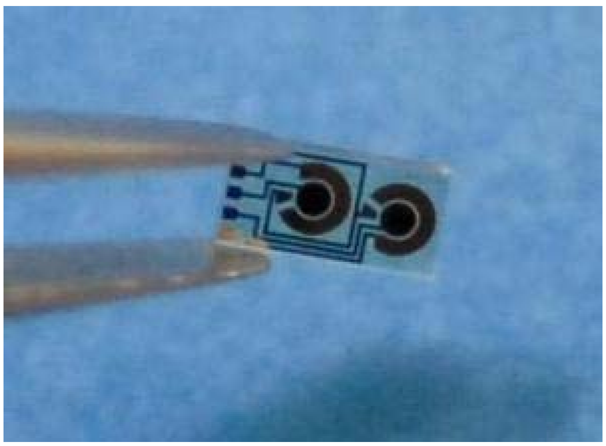


Figure 1: Biochip [SOURCE]

A biochip is the device that can contain anywhere from tens to tens of millions of individual sensor elements (or biosensors). The packaging of these sensor elements on a solid substrate over a microscopic slide helps in performing lengthy tasks in a short time with high throughput and pace. Unlike microchips, biochips are generally not electronic. Each biochip can be thought of as a “micro-reactor” that can sense a specific analyte. The analyte can be a DNA, protein, enzyme, antibody or any biological molecule. A biochip can perform thousands of biological reactions, such as decoding genes, in a few seconds.

1.2 The Biochip Technology

Biochip implant systems basically comprise of two components: a transponder and a reader (or scanner). The biochip system is radio frequency identification (RFID) based, using low-frequency radio signals to communicate between the biochip and reader. The reading range or activation range, between the reader and biochip is small, normally between 2 and 12 inches.

1.2.1 Size

The size of a biochip is as small as an uncooked rice grain size. It ranges from 2 inches to 12 inches.

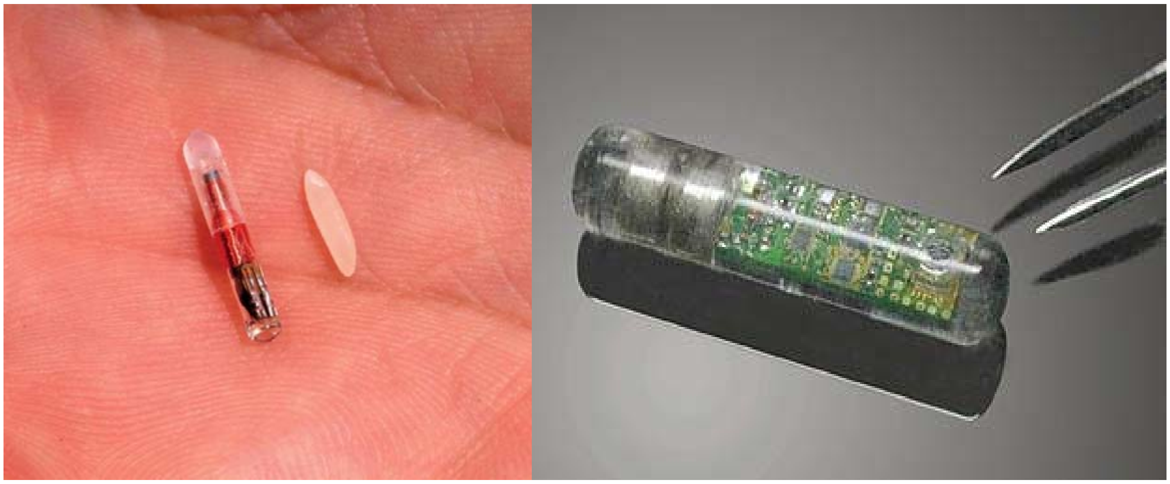


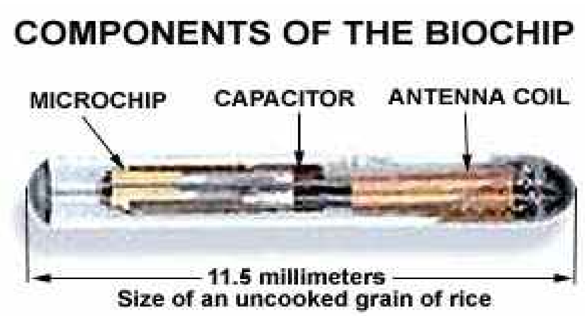
Figure 2: Size of Biochips [SOURCE]

1.2.2 Components of Biochips

The biochip implant system consists of mainly two components the transponder and reader.

1.2.2.1 The Transponder

The transponder is the actual biochip implant. It is a passive transponder, meaning it contains no battery or energy of its own. In comparison, an active transponder would provide its own energy source, normally a small battery. Being passive, it's inactive until the reader activates it by sending it a low-power electrical charge.



[SOURCE]

Figure 3: Transponder

1.2.2.2 The Reader

The reader consists of an "exciter" coil which creates an electromagnetic field that, via radio signals, provides the necessary energy (less than 1/1000 of a watt) to "excite" or "activate" the implanted biochip. The reader also carries a receiving coil that receives the transmitted code or ID number sent back from the "activated" implanted biochip.

Figure 4: Reader [SOURCE]

1.3 Future scope of Biochips

The biochip is continuing to evolve as a collection of assays that provide a technology platform. One interesting development in this regard is the recent effort to couple so-called representational difference analysis (RDA) with high-throughput DNA array analysis. The RDA technology allows the comparison of cDNA from two separate tissue samples simultaneously. One application is to compare tissue samples obtained from a metastatic form of cancer versus a non-metastatic one in successive rounds. A "subtracted cDNA library" is produced from this comparison which consists of the cDNA from one tissue minus that from the other. If, for example, one wants to see which genes are unique to the metastatic cancer cells, a high density DNA array can be built from this subtractive library to which fluorescently labeled probes are added to automate the detection process of the differentially expressed genes. One study using this method compared a localized versus a metastatic form of Ewing's sarcoma and demonstrated that 90% of the genes examined had expression levels that differed between the two cancers by more than twofold.

Another area of interest for future development is protein-based biochips. This biochip could be used to array protein substrates that could then be used for drug-lead screening or diagnostic tests. If a biosensor apparatus is built into this biochip a further application might be to measure the catalytic activity of various enzymes. The ability to apply proteins and peptides on a wide variety of chip substrates is currently an area of intense research. The goal is to be able to control the three-dimensional patterning of these proteins on the chips through either nano-patterning on single layers or protein self-assembly.

The future will also see novel practical extensions of biochip applications that enable significant advances to occur without major new technology engineering. For example, a recent study described a novel practical system that allows high-throughput genotyping of single nucleotide polymorphisms (SNPs) and detection of mutations by allele-specific extension on standard primer arrays. The assay is simple and robust enough to enable an increase in throughput of SNP typing in non-clinical as well as in clinical labs, with significant implications for areas such as pharmacogenomics.

Finally, another development in the field of protein biochips involves the use of powerful detection methodologies such as surface plasmon resonance (SPR). A recent study describes the use of SPR to detect the interaction between autoantibodies and β2-glycoprotein I (βa2GPI) immobilized on protein sensor chips, this interaction being correlated with lupus. SPR enabled the interaction to be detected at a very low density of protein immobilization on the chip, and this approach therefore has significant potential for the future.

2. Market analysis

2.1 Merck

[SOURCE]

2.1.1 Profile

Merck KGaA (d.b.a. EMD Millipore in the U.S. and Canada) is a German chemical and pharmaceutical company. Merck, also known as “German Merck” and “Merck Darmstadt”, was founded in Darmstadt, Germany, in 1668, making it the world's oldest operating chemical and pharmaceutical company. The company was privately owned until going public in 1995. However, the Merck family still controls a majority (≈70%) of the company's shares.

2.2 Samsung Group.

[SOURCE]

2.2.1 Profile

Samsung Group is a South Korean multinational conglomerate company headquartered in Samsung Town, Seoul. It comprises numerous subsidiaries and affiliated businesses; most of them united under the Samsung brand, and is the largest South Korean business conglomerate.

Samsung was founded by Lee Byung-chul in 1938 as a trading company. Over the next three decades the group diversified into areas including food processing, textiles, insurance, securities and retail. Samsung entered the electronics industry in the late 1960s and the construction and shipbuilding industries in the mid-1970s; these areas would drive its subsequent growth. Following Lee's death in 1987, Samsung was separated into four business groups – Samsung Group, Shinsegae Group, CJ Group and Hansol Group.

2.3 Rosetta Genomics

[SOURCE]

2.3.1 Profile

Rosetta Genomics, Ltd. (NASDAQ: ROSG) is a leading molecular diagnostics company advancing microRNA-based diagnostics discovered and developed through its proprietary microRNAs and platform technologies. Backed by a strong IP portfolio, Rosetta Genomics' scientists have developed proprietary platform technologies for the identification, extraction, quantification, and analysis of microRNAs from a wide range of sample types. These technologies enable the identification and advancement of multiple diagnostic projects addressing critical unmet needs in cancer, cardiovascular diseases and other indications. The Company's four commercial oncology tests have been launched in multiple countries worldwide via partners, and by a Company-led effort in the U.S. The Company is now working to develop additional tests in the cancer realm and in other fields.

Rosetta Genomics was founded by Isaac Bentwich in 2000 to pursue commercial applications of microRNA research. The company had its IPO on March 6, 2007 and is traded on the NASDAQ. Rosetta Genomics expects the funds raised to advance its microRNA-based diagnostic and therapeutic cancer products through initial clinical validation, defined as success in identifying the specific biomarker panels via blinded tests of samples supplied by medical institutions.

2.4 Other Assignees

Febit Holding, Protagen, Electronics and Telecommunication Research Institute, Johns Hopkins University, The First Affiliated Hospital of Third Military Medical University, Sony etc. are among the other major assignees in the field.

3. Global Overview of Biochip

The purpose of this study is to generate a landscape dossier primarily focused on biochip applications.

The present landscape was thus generated by analyzing numerous such patents which either imparts usage of biochip or discloses new application or in other words patents which acknowledges biochip appliance. Primarily patents were chosen to compose this study because patents form the core aspect for a company in a knowledge-driven economy.

The first step to the analysis was achieved by conducting a search for patents using an array of keywords constituting: biochip, microchip, and other possible combinations. The patents relating to a priority date on or after 2008 were searched with respect to jurisdictions in North America, Asia-pacific, Europe, and South-America. This methodology led to extraction of around 700 patents published in the span of 5 years. Out-of the 700 patents 410 were selected for further technological analysis as they contain the primary factors for our landscape as cited above.

3.1 Patenting Trend

Biochips form a crucial breakthrough in biotechnological innovation, and have sought patent protection from the very beginning of their inception in the technological market. The current data illustrates the patent protection biochip has witnessed in the stretch of 5 years i.e. since 2008 to 2012.

Initially technology witness a downfall in filing trend which may be the outcome of an economic recession the world economy suffered in year 2007 to 2009. Gradually, the patent filing gained momentum and recorded an increase in the filing trend as companies eventually identified the vast potential in this medical engineering marvel. Although the global recession did slow down the growth of biochips, the end of global recession marked the rebirth of biochip technology and R&D picked up to ultimately peak in the year 2011 – which is the year most patents mark as their priority dates.

(The trend seems to decline after the year 2011, but this may be because the patent set extracted contains published and granted applications after 2008 and there may be a possibility of some unpublished patents/applications which take priority after 2011. One thing is clear – research of this technology will only rise in the future.)

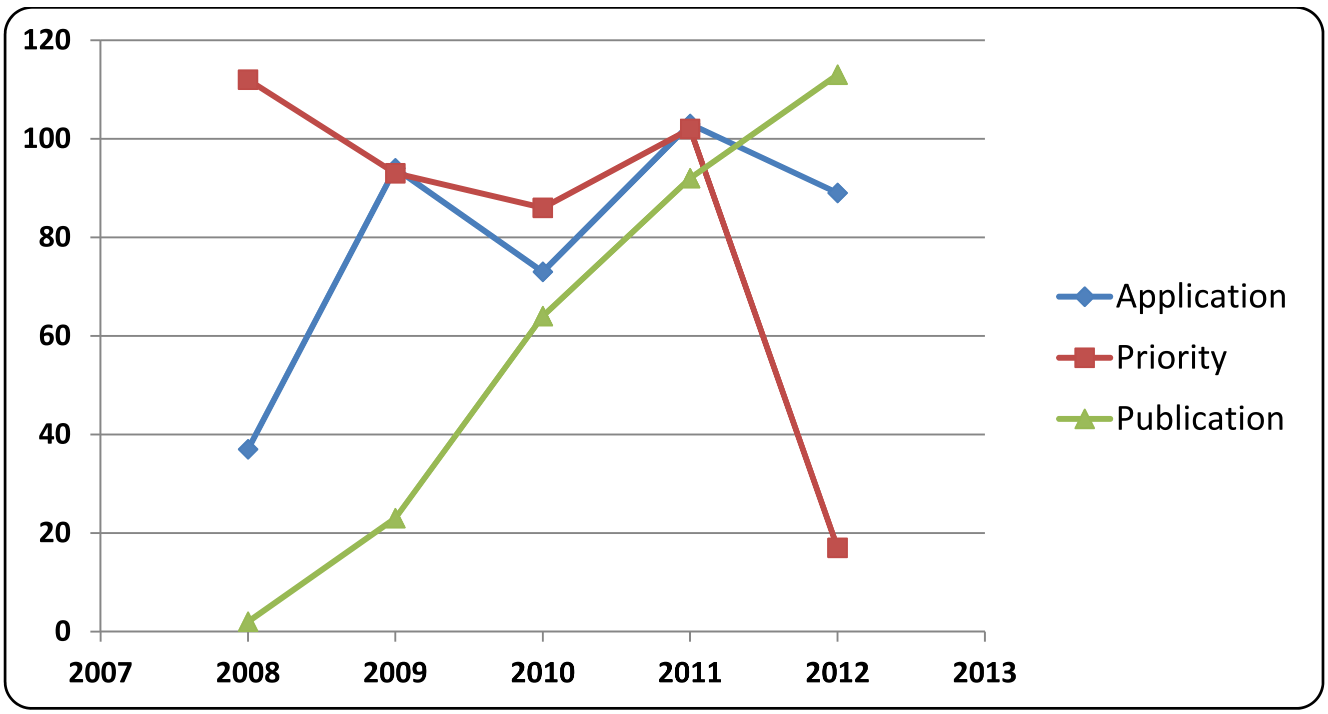


Figure 5: Patenting trend in Biochip

3.2 Priority Country Distribution

Biochip technology arises from various developing and developed economies around the globe. The graph below illustrates the global outreach of patents being filed in different jurisdictions.

Among the applicants, USA emerged out to be the dominant country. Nevertheless, two striking facts can be seen i.e. China too boasts of impressive numbers and forms second major nation developing biochip technology. WIPO publications, on a positive note, suggest that the technology is being driven to all parts of the globe.

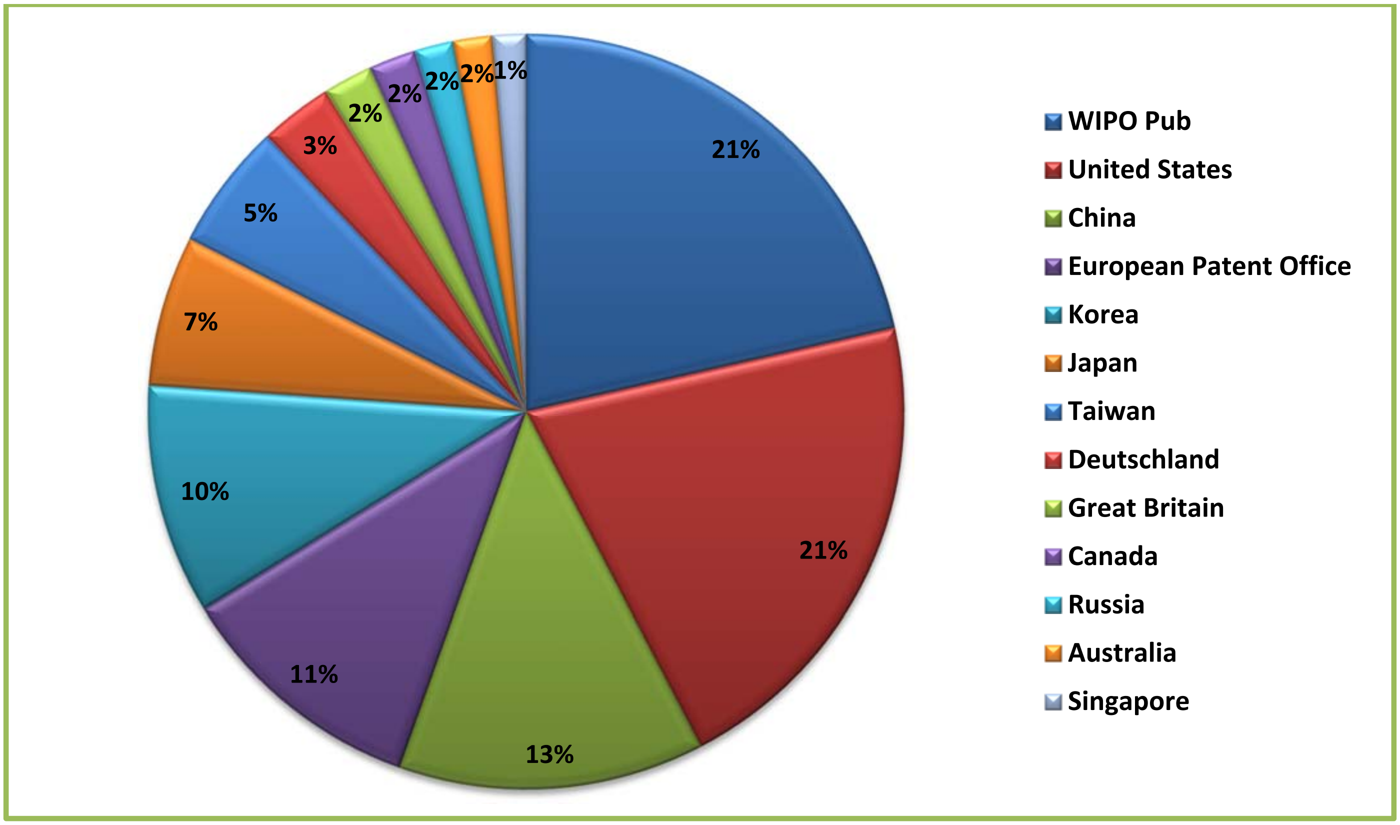


Figure 6: Worldwide Patent Distribution

3.3 Segmentation of patents by IPC code

We have highlighted the IPC codes that are the most represented in the patent applications filed since 2008. This segmentation is given in the **Figure 7**.

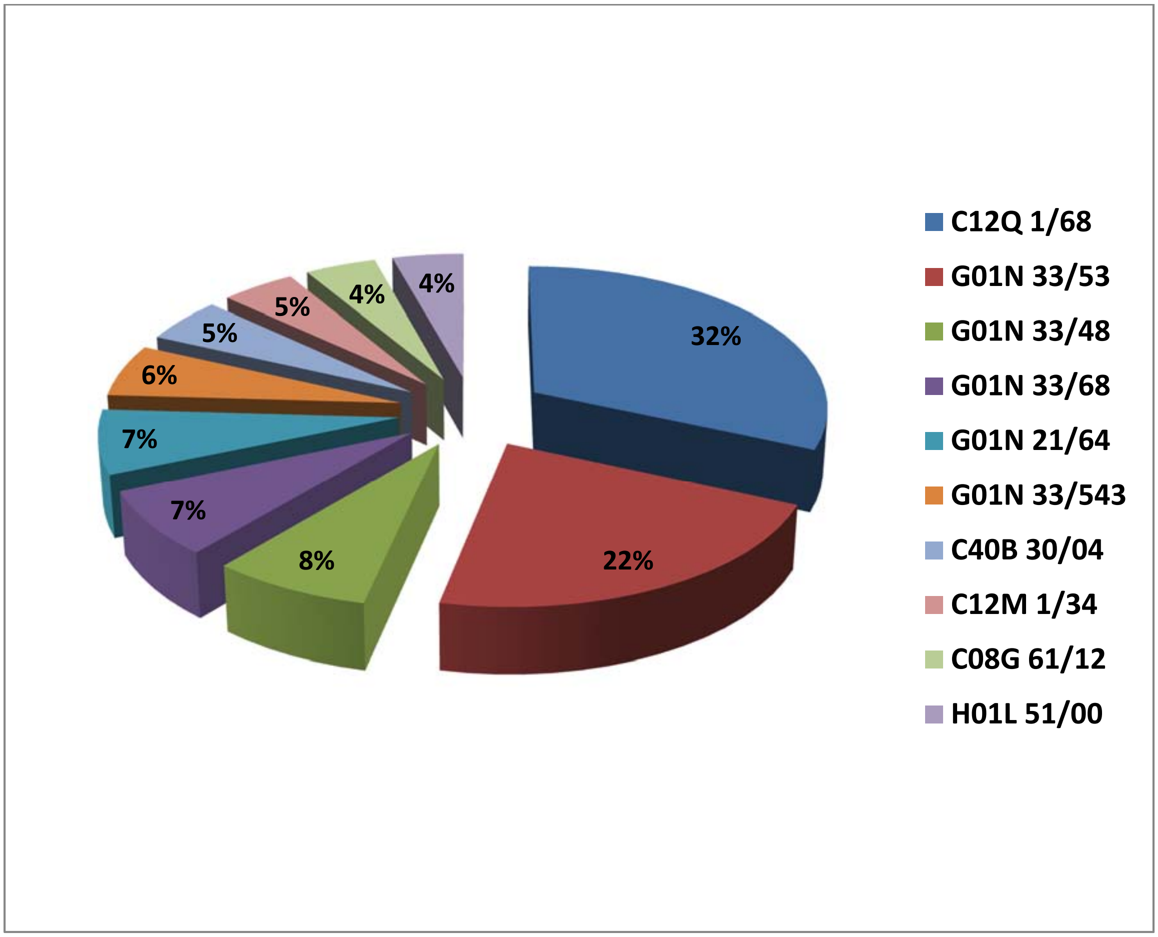


Figure 7: Key International patent classes that have maximum patent filings in this portfolio

3.3.1 Main IPC Classes and their Definitions

The main IPC codes are stable over time and are particularly representative of this sector.

IPC Classes		
S. No.	**IPC Class**	**Definition**
1.	**C12Q 1/68**	Chemistry; metallurgy; Biochemistry; beer; spirits; wine; vinegar; microbiology; enzymology; mutation or genetic engineering; Measuring or testing processes involving enzymes or micro-organisms; compositions or test papers therefor; processes of preparing such compositions; condition-responsive control in microbiological or enzymological processes; Measuring or testing processes involving enzymes or micro-or Compositions therefor; Processes of preparing such compositions: involving nucleic acids
2.	**G01N 33/48**	Physics; Measuring; testing; Investigating or analysing materials by determining their chemical or physical properties; Investigating or analysing materials by specific methods not covered by groups; Biological material, e.g. blood, urine; Haemocytometers
3.	**G01N 33/53**	Physics; Measuring; testing; Investigating or analysing materials by determining their chemical or physical properties; Investigating or analysing materials by specific methods not covered by groups; Biological material, e.g. blood, urine; Haemocytometers: Chemical analysis of biological material, e.g. blood, urine; Testing involving biospecific ligand binding methods; Immunological testing: Immunoassay; Biospecific binding assay; Materials therefor
4.	**G01N 33/543**	Physics; Measuring; testing; Investigating or analysing materials by determining their chemical or physical properties; Investigating or analysing materials by specific methods not covered by groups; Biological material, e.g. blood, urine;

		Haemocytometers: Chemical analysis of biological material, e.g. blood, urine; Testing involving biospecific ligand binding methods; Immunological testing: Immunoassay; Biospecific binding assay; Materials therefor : with an insoluble carrier for immobilising immunochemicals
5.	**G01N 21/64**	Physics; Measuring; testing; Investigating or analysing materials by determining their chemical or physical properties : Investigating or analysing materials by the use of optical means, i.e. using infra-red, visible, or ultra-violet light: Systems in which the material investigated is excited whereby it emits light or causes a change in wavelength of the incident light: optically excited: Fluorescence; Phosphorescence
6.	**G01N 33/68**	Physics; Measuring; testing; Investigating or analysing materials by determining their chemical or physical properties; Investigating or analysing materials by specific methods not covered by groups: Biological material, e.g. blood, urine; Haemocytometers: Chemical analysis of biological material, e.g. blood, urine; Testing involving biospecific ligand binding methods; Immunological testing: involving proteins, peptides or amino acids
7.	**C40B 30/04**	Chemistry; metallurgy; Combinatorial technology; Combinatorial chemistry; libraries; Libraries per se, e.g. arrays, mixtures.
8.	**C12M 1/34**	Chemistry; metallurgy; Biochemistry; beer; spirits; wine; vinegar; microbiology; enzymology; mutation or genetic engineering; Apparatus for enzymology or microbiology ; Apparatus for enzymology or microbiology: Measuring or testing with condition measuring or sensing means
9.	**C08G 61/12**	Chemistry; metallurgy; Organic macromolecular compounds; their preparation or chemical working-up; compositions based

		thereon; Macromolecular compounds obtained otherwise than by reactions only involving carbon-to-carbon unsaturated bonds; Macromolecular compounds obtained by reactions forming a carbon-to-carbon link in the main chain of the macromolecule: Macromolecular compounds containing atoms other than carbon in the main chain of the macromolecule
10.	**H01L 51/00**	Electricity; Basic electric elements; Semiconductor devices; electric solid state devices not otherwise provided for; Solid state devices using organic materials as the active part, or using a combination of organic materials with other materials as the active part; Processes or apparatus specially adapted for the manufacture or treatment of such devices, or of parts thereof

4. Key Assignees in Biochip patent portfolio

4.1 Major Assignees

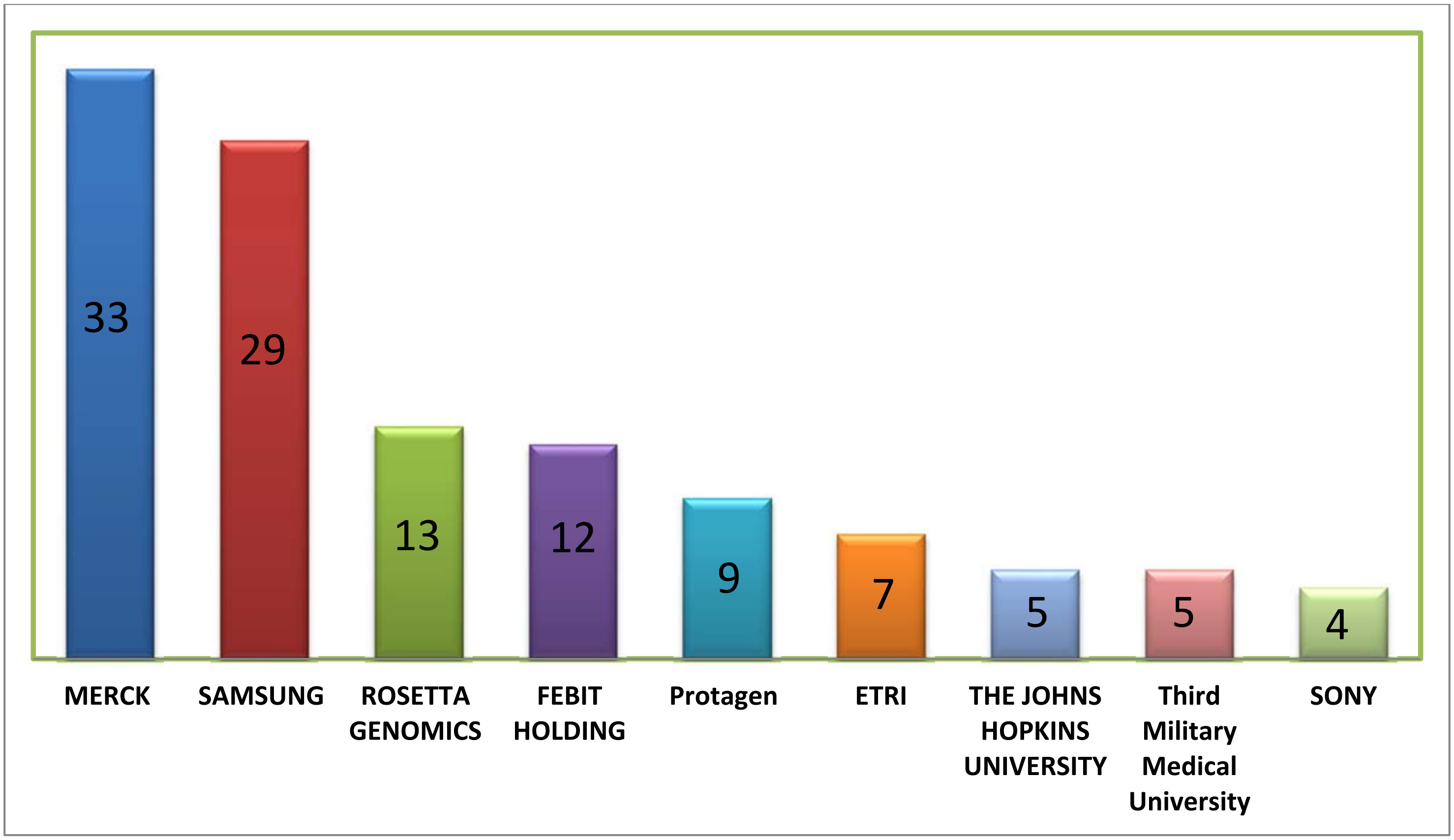


Figure 8: Major assignees in the field of biochips

The above chart depicts the top 9 assignees of our patent portfolio used for the preparation of the present landscape dossier.

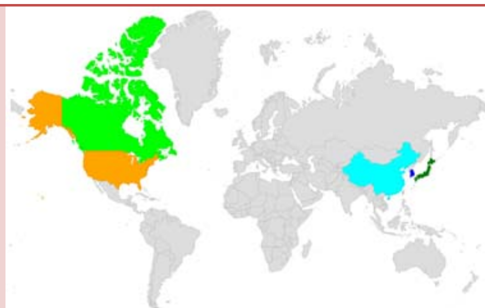
Merck GmbH, a unit of Merck KGaA, is a German giant in the field of chemical and pharmaceutical industry. Merck dominates the portfolio constituting the maximum numbers of patents (33). The patents under Merck's umbrella have their priority in the year 2008 and therefore display an active participation of the company in the growth of this technology. The complete portfolio of Merck analyzed in this dossier relates to the usage of biochip for the purpose of organic semiconductors only.

Samsung is also not too far behind, making their presence count in the market and holds a portfolio of descent number (29) of patents. Although, Samsung is not the leader in the maximum number of patents but it is the most prolific assignee by driving its patent portfolio in number of varied applications.

Apart, from the multinational giants leaping in this technology, our analysis displays academic institutions are also trying to make a mark in this technology such as The Electronics & Telecommunications

Research Institute (in the graph referred as ETRI), Korea, and The John Hopkins University, United States.

4.2 Geographical analysis of Major Applicants

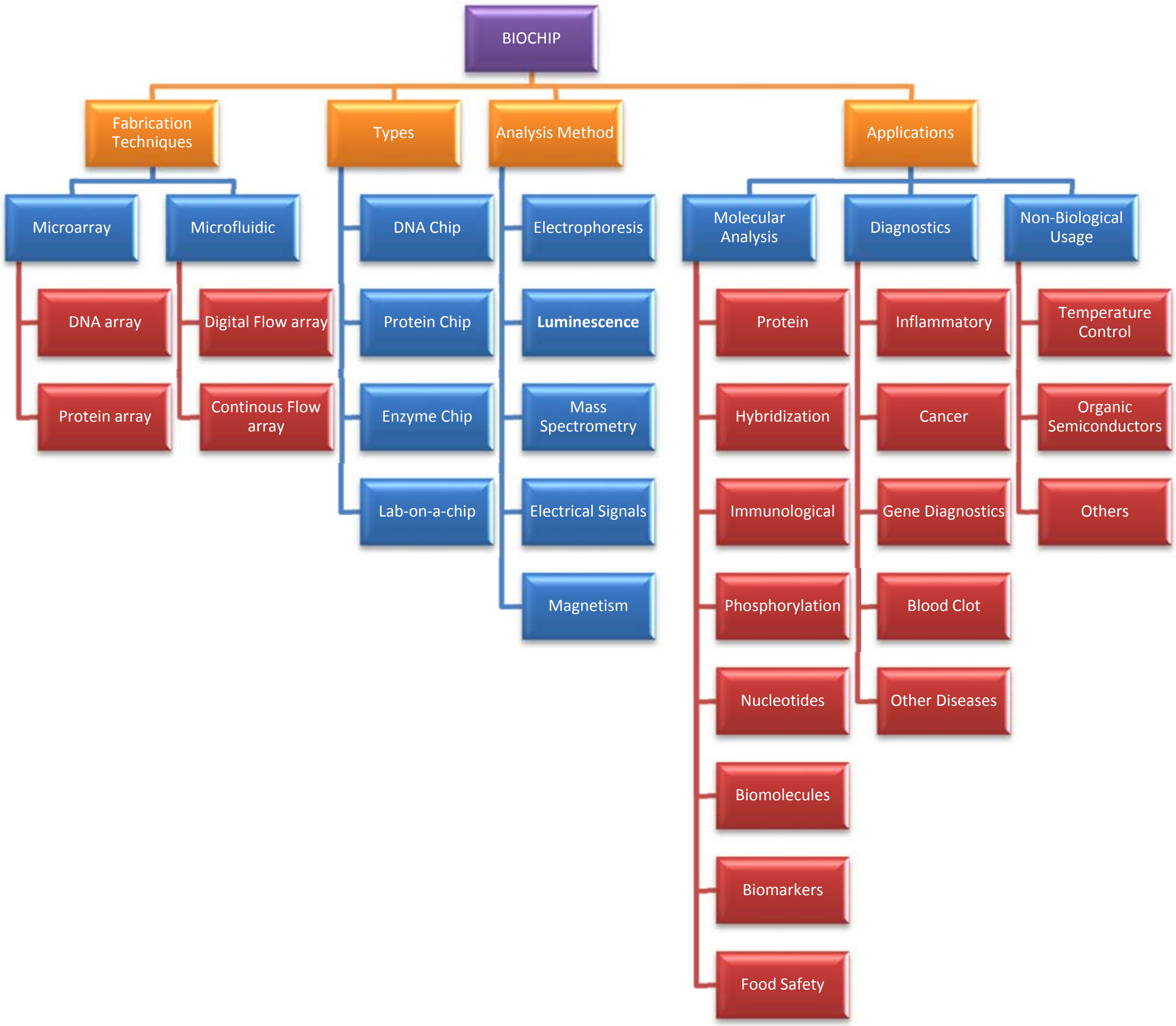
S No.	Assignee	Geographical Location	US	EP	CN	TW	KR	JP	CA	WO
1	Merck		16	18	16	30	8	9	2	41
2	Samsung		25	8	8	0	42	4	0	4
3	Rosetta Genomics		5	2	0	0	0	1	1	19
4	Febit Holding		8	11	0	0	0	0	0	19

5	Protagen		7	11	0	0	0	0	1	17
6	Electronics and Telecommunications Research Institute		4	0	0	0	0	1	0	0
7	The Johns Hopkins University		2	2	0	0	0	0	1	8
8	Third Military Medical University		0	0	7	0	0	0	0	0
9	Sony Corporation		3	0	3	0	0	4	0	0

Table 1: Geographical analysis of Major applicants

5. Technology Segmentation

5.1 Taxonomy



5.2 Technical Analysis:

A biochip is miniaturized laboratory that can perform hundreds or thousands of simultaneous biochemical reactions. It comprises of a 2D array of sensors arranged on a solid substrate in order to achieve high throughput and speed. These are basically microprocessor chips that can be used in Biology.

5.2.1Fabrication Techniques

Biochips are fabricated in two ways – Microarrays and Microfluidics. A microarray is a 2D array on a solid substrate (usually a glass slide or silicon thin-film cell) that assays large amounts of biological material using high-throughput screening methods whereas microfluidics deals with the behavior, precise control and manipulation of fluids that are geometrically constrained to a small, typically sub-millimeter, scale. Active microfluidics refers to the defined manipulation of the working fluid by active (micro) components as micro pumps or micro valves.

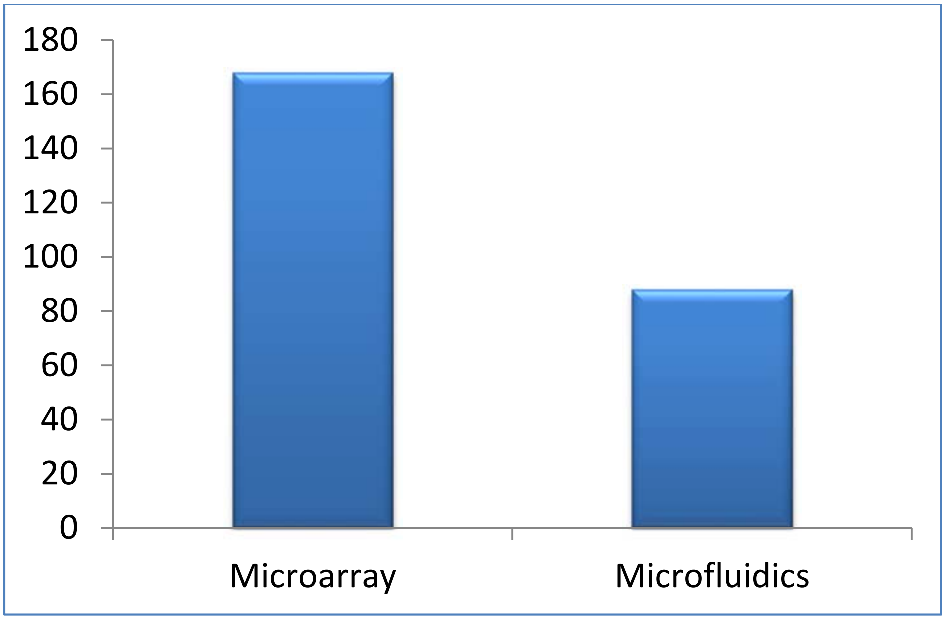


Figure 9: Fabrication Techniques

Figure 1 depicts the patent distribution trends according to different types of Fabrication Techniques used. As seen from the graph, microarray based biochips are the most prevalent as they are easy to access and don't require the use of pumps. For example, EP Patent EP2291661A2 talks about the use of microarrays in identification of ligand-binding molecules.

Microarrays are further categorized into DNA microarrays and Protein microarrays. A DNA microarray is a collection of microscopic DNA spots attached to a solid surface. These are used to measure the expression levels of large numbers of genes simultaneously or to genotype multiple regions of a genome. A protein microarray is a high-throughput method used to track the interactions and activities of proteins and to determine their function and determining function on a large scale.

Similarly, Microfluidics are sub-divided into Continuous Flow Array and Digital Flow Array. Continuous flow technologies are based on the manipulation of continuous liquid flow through micro fabricated channels. Actuation of liquid flow is implemented either by external pressure sources, external mechanical pumps, integrated mechanical micro pumps, or by combinations of capillary forces and electro kinetic mechanisms. Digital flow arrays use discrete and independently controllable droplets that are manipulated on a substrate using electro wetting. By using discrete unit-volume droplets, a microfluidic function can be reduced to a set of repeated basic operations, i.e., moving one unit of fluid over one unit of distance. This "digitization" method facilitates the use of a hierarchical and cell-based approach for microfluidic biochip design.

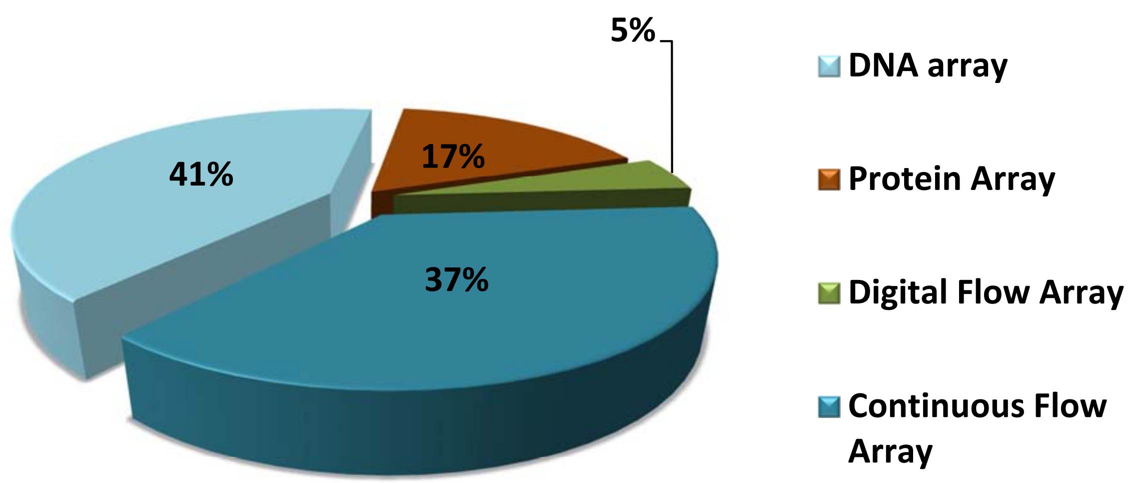


Figure 10: Types of fabrication

Figure 2 depicts that DNA microarrays are more widely used. This is because DNA molecules are relatively homogenous and possess high affinity and high specificity binding partners. For example US patent US20110266362 talks about an acrylic adhesive for assembling elements of DNA microarray.

5.2.2 Types of Biochip

On the basis of the target molecules in the sample, biochips are classified as DNA chips, Protein chips, Enzyme chips and Lab-on-a-chips. A Lab-on-a-chip (LOC) is a device that integrates one or several laboratory functions on a single chip of only millimeters to a few square centimeters in size. LOCs deal with the handling of extremely small fluid volumes down to less than pico liters. This kind of a multipurpose device is the future of biochips.

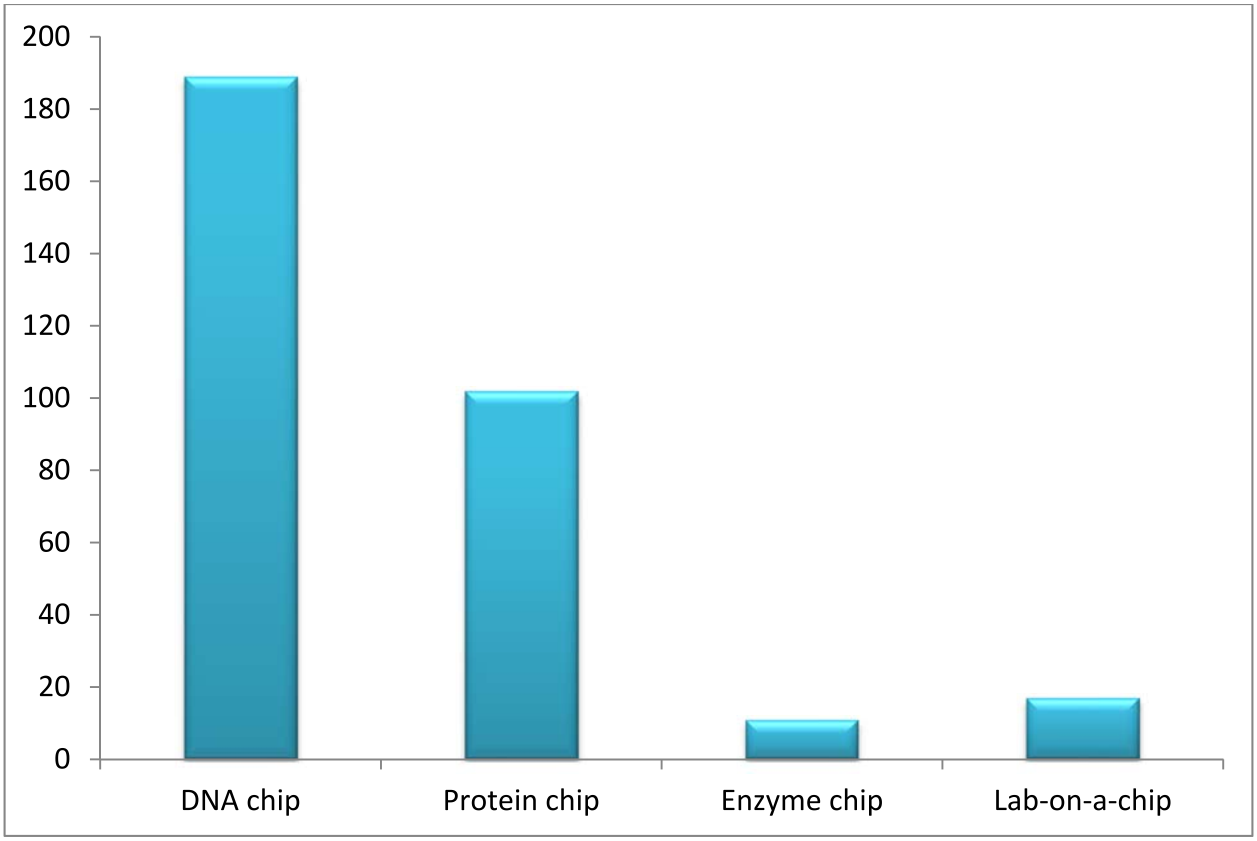


Figure 11: Types of Biochips

Figure 3 represents patent distribution trends with the types of biochips. DNA chip is most commonly used among all. This can be attributed to its ability to detect genetic mutations and related diseases henceforth. For example Korean patent KR1184566, uses DNA chip for the amplification of biomaterial.

5.2.3 Analysis Methods

The methods used for analysis of the sample include Electrophoresis, Mass Spectrometry, Luminescence, Electrical Signals and Magnetism.

Electrophoresis is the motion of dispersed particles relative to a fluid under the influence of a spatially uniform electric field.

Mass spectrometry (MS) is an analytical technique that produces spectra (singular spectrum) of the masses of the molecules comprising a sample of material. The spectra are used to determine the elemental composition of a sample, the masses of particles and of molecules, and to elucidate the chemical structures of molecules, such as peptides and other chemical compounds.

Luminescence is emission of light by a substance not resulting from heat. It includes fluorescence and phosphorescence.

Electrical Signals generated due to various reactions in the biochip are detected and analyzed.

Magnetism is used with biomolecules or biomarkers with magnetic properties for qualitative and quantitative analysis.

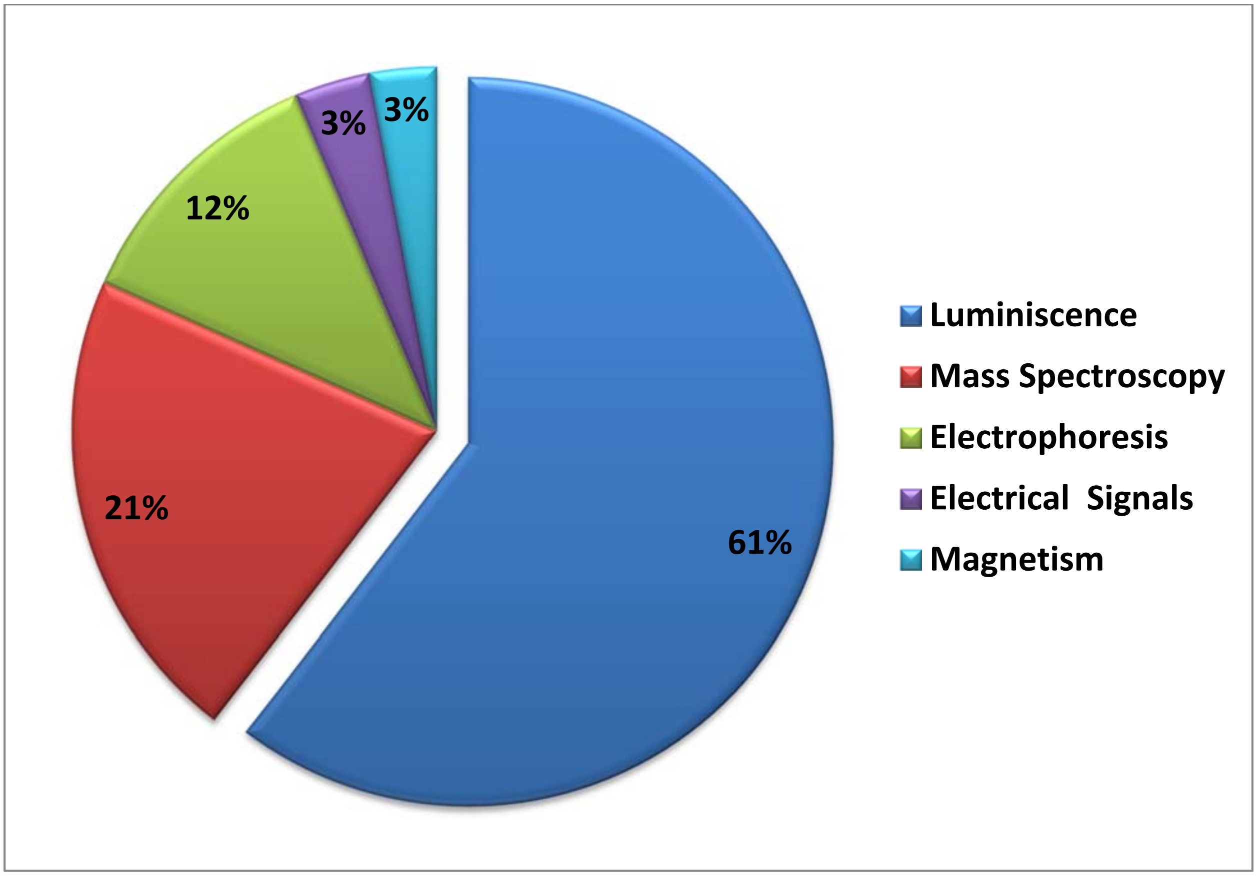


Figure 12: Methods of Analysis

Figure 4 illustrates the patent distribution for methods of analysis of a sample. As can be concluded from the figure, luminescence is the most employed technique for the detection and analysis of biomolecules in the sample as it is the easiest technique in which electrons are excited to the higher energy level with the help of some external light source and while returning back to the original ground state level, they emit visible range radiations.

5.2.4 Applications of Biochips

Biochips can be categorized into three broad categories based on applications, namely Molecular Analysis, Diagnostics and Non-Biological Usage.

Molecular Analysis includes detailed study of different types of molecules such as proteins, DNAs, RNAs, antibodies, antigens, enzymes and pathogens such as bacteria, fungi and viruses. It also includes hybridization of nucleic acids.

Diagnostics basically include the use of biochips in medical purposes such as prognosis, treatment and diagnosis of wounds, blood clots and diseases (mainly cancer).

Non-biological Usage includes the use of biochips in non-medical fields as organic semiconductors and temperature controllers.

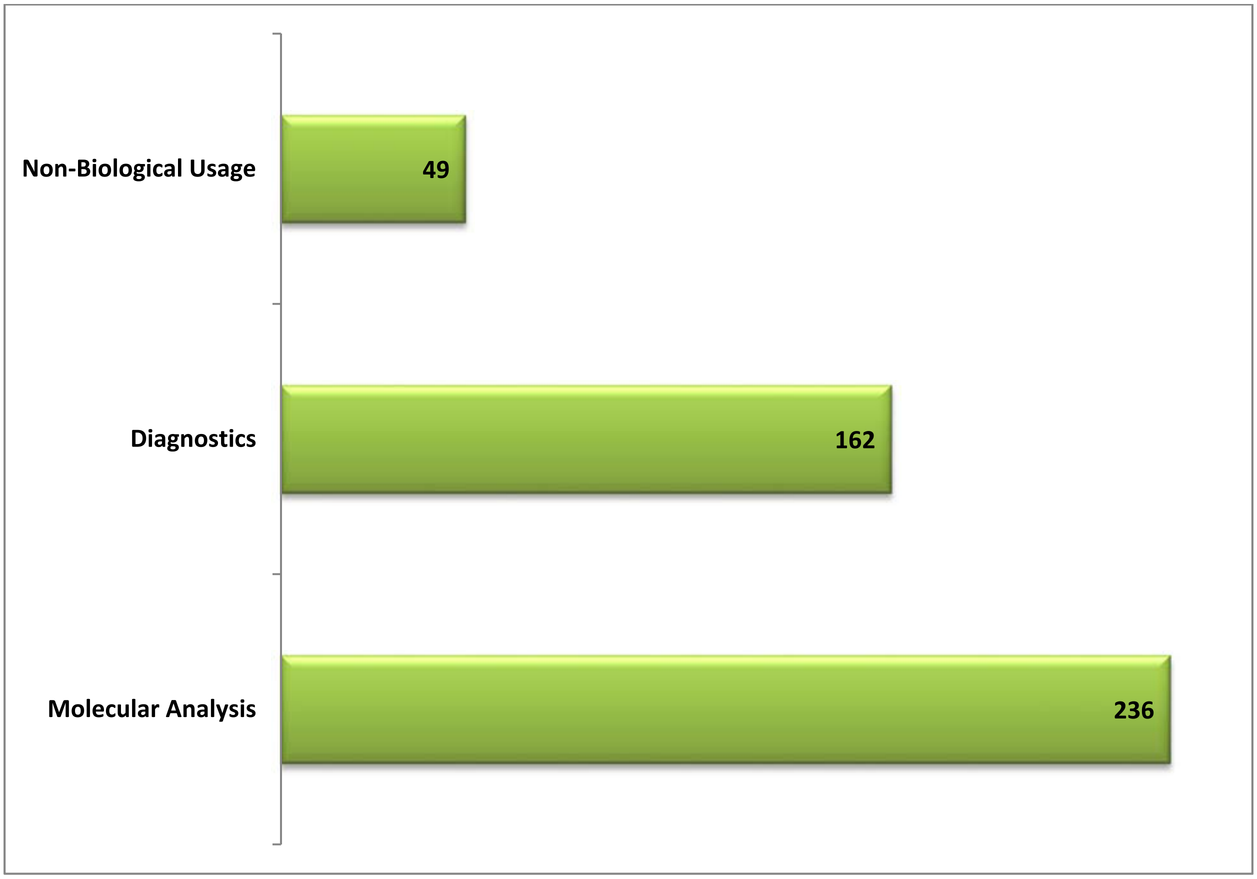


Figure 13: Applications of Biochips

Figure 5 relates to patent distribution trend of the applications of biochips. Molecular analysis is the most explored application of biochips. For example WIPO patent WO2012164136, deals with use of TGF-β as a marker for the identification of a-Synucleinopathies.

6. Applicant v/s Fabrication Technique

6.1 Applicant v/s Fabrication Technique

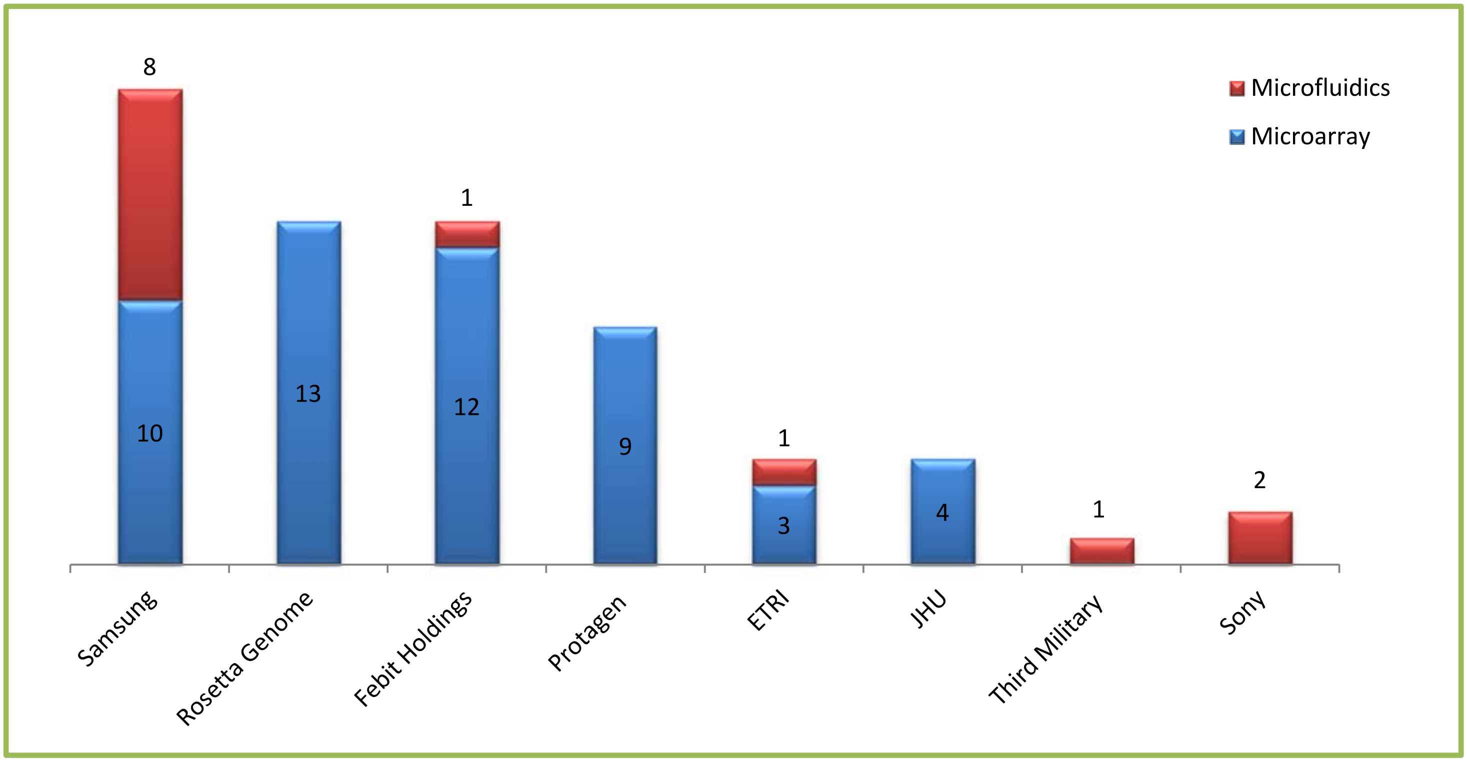


Figure 14: Fabrication Technique wise patents filed by top assignees

These numbers represent number of patents filed by an assignee disclosing the type of fabrication technique employed on the biochip. The two types of fabrication techniques are Microfluidics and Microarray.

From the above graph it can be observed that Rosetta genomics utilizes microarray fabrication technique in their biochips. Other than the corporate giants the category also includes few academic institutes such as The John Hopkins University (in the graph as JHU) has their research driven towards biochips developed through microarray technique.

Samsung once again earns the title of prolific assignee in the field of microfluidics and microarray fabricated biochips. Febit too focused their biochip technology applications using microarray technology and interestingly show their presence in microfluidics usage.

Ironically Merck is missing from this analysis graph as patents under Merck bucket do not disclose any fabrication techniques.

6.2 Applicant v/s Type of Chip

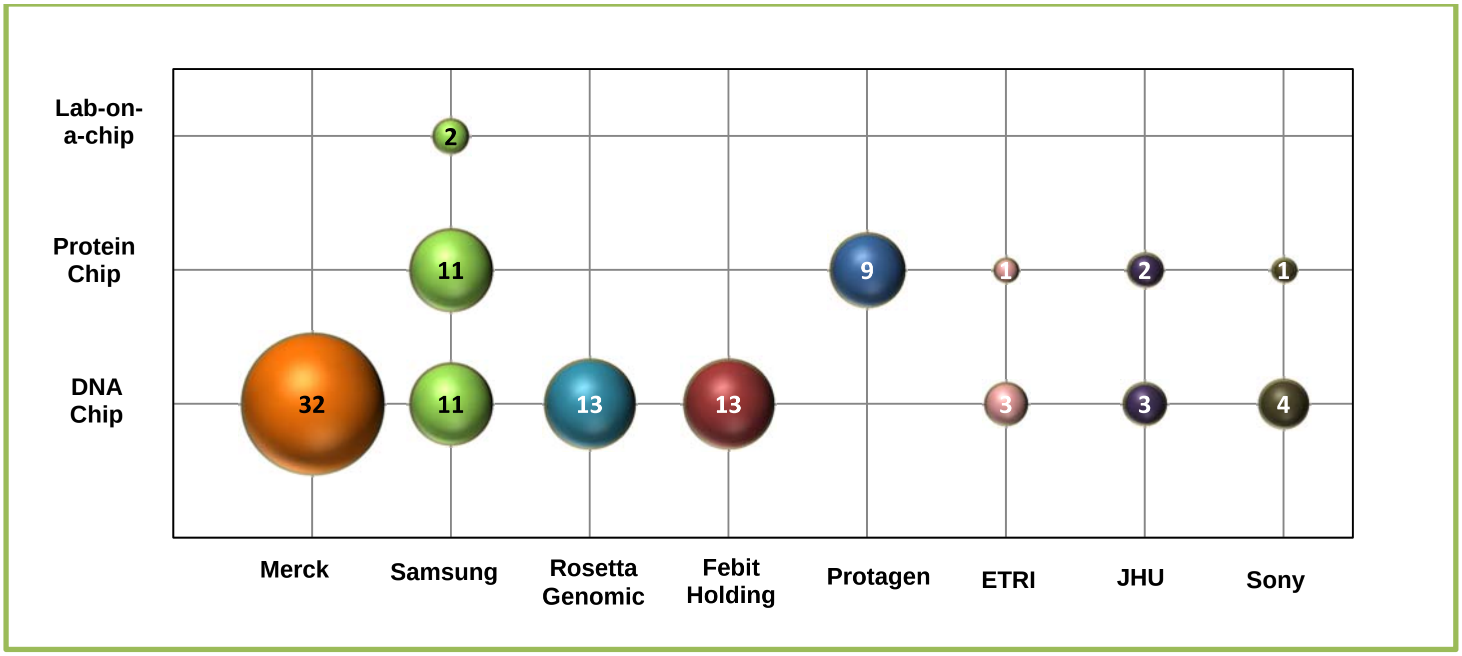


Figure 15: Patent distribution of type of biochips and top assignees

The graph illustrates usage of different types of chips by the top assignees of our patent portfolio.

Merck GmbH discloses usage of only DNA chip in its patents. On the other hand, Samsung deploys its R&D facility to work in DNA chips, Protein Chips as well as Lab-on-a-chip.

Like Merck, Rosetta and Febit too are focused on working with DNA chips and relate their patents to DNA chips only.

Unlike these three companies, Protagen's patent portfolio relates to use of protein chip only.

6.3 Applicant v/s Application

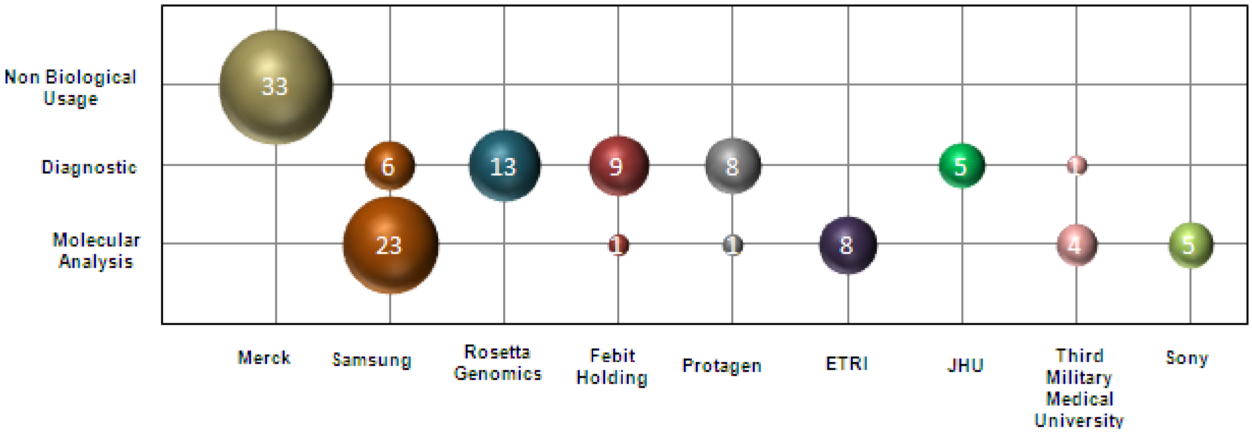


Figure 16: Patent distribution of assignees in various application fields

The graph interprets application focus of our top assignees.

As mentioned above, the application of biochips can vary, and our analysis has segmented the application of biochips in 3 broad categories. Figure 16 shows activity of the top assignees in the segmented applications.

Merck, holder of the most number of patents in our analysis divulges its patent portfolio in the application area of non-biological usage.

Unlike Merck, Samsung's foothold is in diagnosis and molecular analysis applications. Rosetta, Febit and Protagen also disclose applications of diagnosis in their patent portfolio.

Research institutes seem to be focusing on working with applications in the area of diagnostics and molecular analysis. Besides Merck, none of the assignees contributed towards non-biological applications of biochips. Therefore, one may infer that the non-biological usage of biochips could be explored more extensively.

6.4 Applicant v/s Application

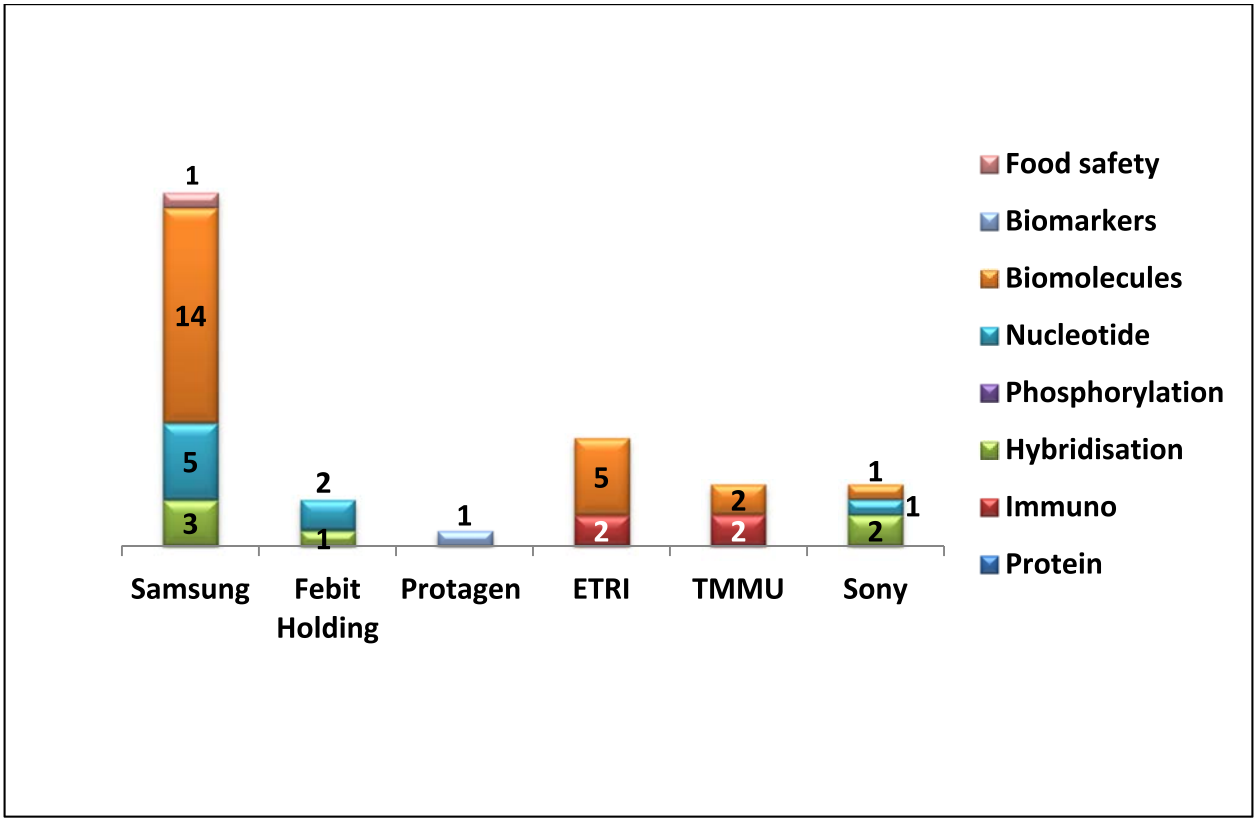


Figure 17: Graph illustrates assignees activity in different molecular analysis

Figure 17 depicts the number of patents each assignee holds with regard to different molecular analysis techniques.

Samsung's biochip patent portfolio in our analysis reveals application of biochips pertaining to biomolecules and protein analysis. Academic institutes such as The Electronics and Telecommunication Institute (referred in the graph as ETRI) and The Third Medical Military University (referred in the graph as TMMU) are also impelling in the biomolecules application.

Samsung's patent portfolio also shows focus towards food safety applications which may be a very fruitful and to-be-explored area of application as none other assignees are working towards this field.

6.5 Applicant v/s Application (Diagnostics)

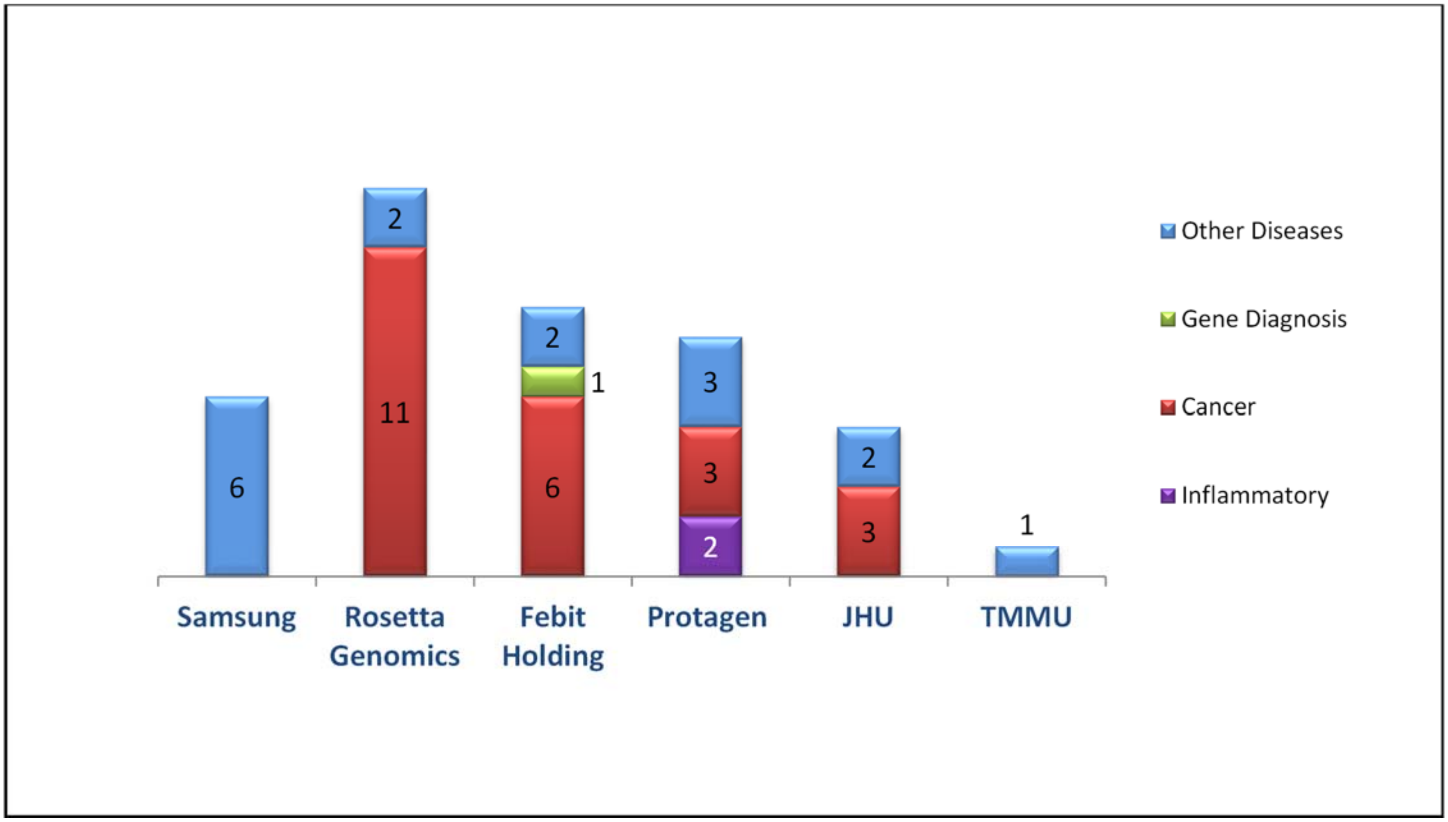


Figure 18: Graph illustrates assignees activity in different diagnostic applications

The graph is the subject matter to represent an assignee contribution in different applications pertaining to the diagnostic usage of biochips.

Rosetta, Febit, and Protagen are exploring cancer diagnosis techniques and thereby leave little space for other companies to explor biochip utilization for cancer diagnosis. Biochip utilization for diagnosis of gene and inflammatory disorders are still unexplored and observe very few patent filings.

Samsung patents disclose utilization of biochip in order to diagnose various diseases. Other diseases category includes diseases such as multiple sclerosis, Parkinson's, syphilis, dermatitis and some respiratory diseases.

7. Application v/s Countries

APPLICATION FIELD	SUB-APPLICATION	Unites States of America	European Patent Office	China	Taiwan	Korea	Canada	Australia	Japan	Great Britain	Deutschland
	Protein	10	3	4	4	5	0	1	1	1	0
	Immunological	15	10	11	2	6	1	2	3	0	3
	Hybridization	6	0	6	0	7	0	0	5	0	0
MOLECULAR ANALYSIS	Phosphorylation	4	0	0	0	4	0	0	0	0	0
	Nucleotide	23	8	13	1	10	1	6	8	6	2
	Biomolecules	65	40	39	6	50	8	1	16	4	6
	Food Safety	6	0	4	1	3	1	1	0	0	0
	Biomarkers	4	2	3	2	1	0	0	0	0	2
	Inflammatory	9	7	0	0	5	0	0	2	0	3
	Cancer	33	17	12	0	7	6	2	4	1	1
DIAGNOSTICS	Gene Diagnostics	6	2	4	1	0	2	1	3	1	2
	Blood Clot	3	3	2	0	2	0	0	0	0	2
	Oher Disease	29	24	22	5	12	3	3	0	2	1
	Temperature Control	1	1	0	0	0	0	0	1	0	2
NON-BIOLOGICAL USE	Organic Semiconductor	17	18	17	30	10	0	1	12	19	8
	Other	4	1	1	0	0	0	0	0	0	1

Table 2: Epitomize application segment along with the further sub-categories of application and their country-wise distribution

The mentioned table is a tool to identify gaps or areas of application least exploited and most exploited in different jurisdictions. The number corresponding to every jurisdiction represents the count of patents in that particular jurisdiction conjugated with a particular application. Therefore, the areas in table with color code red or value 0 represents possible gaps or white spaces and provide a possible chance to explore the corresponding application in that particular country.

8. Conclusion

This dossier depicts biochip technology and its various applications, along with various other key features. Biochips can be employed for multiple applications in various spheres of technology such as diagnosis of cancer, blood clots, analysis of biomarkers, biomolecules, etc.

The analysis brings forth a scenario of different application focus in different countries. The analysis may be utilized as an informative tool in order to identify the active countries or the active markets with regard to the different applications of biochips.

Also, the landscape study provides various other insights regarding principal assignees and their focus areas. The analysis also reveals that USA and China are the leading countries for biochip development.

Merck GmbH and Samsung forms the two most active assignees in the patent portfolio analyzed. Samsung drives its patent portfolio in most diversified manner by employing different types of biochips (DNA chip/Protein chip/Lab-on-a-chip), working in numerous applications. Samsung seems to be the most prolific and dominant of all assignees.

The presence of such giants making big leaps in this technology is a clear indication that this industry has a bright future and it will mark a revolution in medicine.

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