MEAT & LIVESTOCK AUSTRALIA

final report

Project code: V.RDP.1003

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Date published: April 2016

PUBLISHED BY
Meat and Livestock Australia Limited
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NORTH SYDNEY NSW 2059

SMART PACKAGING

Meat & Livestock Australia acknowledges the matching funds provided by the Australian Government to support the research and development detailed in this publication.

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APRIL 2016

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CONTENTS

PROJECT BACKGROUND

The Rural R&D for Profit project, Market and Consumer Insights to Drive Food Value Chain Innovation and Growth Project is a collaborative project involving a number of agrifood sectors.

Food producers need a deep understanding of market and technology trends to be able to evaluate and prioritise new product and packaging technologies to open up new export markets. The domestic market alone will not generate the necessary type or quantity of innovations required for Asian markets in key areas like packaging, preservation, tamper evidence and provenance. In addition, the size and variety of international markets means that those technologies need to be viewed through a lens of consumer demand, changing needs and age based considerations.

For example, conventional food packaging serves to protect, preserve and present the food. Current food preservation and packaging technology has generally performed well for the delivery of fresh food to domestic markets and some international markets for certain food products and food commodities but there are still major deficiencies in their performance. While polymers are the most common packaging material due to a range of desirable properties such as transparency, low cost, good mechanical properties and controllable permeability, unfortunately these packaging materials are not totally recyclable or biodegradable. They do not add significantly to shelf life preservation and they are not able to indicate in a smart way whether the contents have been tampered with. Equally, we know that the source and food supply chain 'credentials' are of significant interest to consumers. The interest derives from unreliable supply chains in some Asian markets, a number of well publicised food adulteration scandals and a demand for clean and green foods with traceable production history can become valuable attributes for Australian agrifoods.

New preservation and packaging technologies would dramatically increase the ability of Australian producers to access foreign markets with premium value-added products that meet evolving consumer needs. There is a particular consumer need in China and other Asian markets for 'Food without fear' – that is, food in which the consumer can have reasonable assurances of quality and genuineness.

As an example, Australia's red meat industry exports approximately 80% of its production[1]. Even in the highly exported meat industry, new packaging and other solutions are required to increase market share of distant high value export markets in Asia. Issues to do with the shelf life of red meat exports are believed to have a negative impact on Australian trade.

[1] http://off-farm.mla.com.au/Value-adding/Co-products/Conventional-co-products

Additionally, shelf life restrictions in the domestic market impact on selling price and processor efficiencies and merchandising positioning. Roughly one-third of global fresh fruits and vegetables are thrown away because their quality has dropped below an acceptance limit [2]. This is occurring as the world's population increases, water supply issues arise and finite farming land is available. A high share of these losses is related to non-optimised handling during the supply chain processes.

The quality state of fresh packaged food is currently often hard to measure and gauge as it is not visible from the outside with prescribed 'use by dates' used. Remaining shelf life cannot be measured directly or accurately, however it may be predicted by different models calculating the effect of temperature and other influences. The opportunity also arises for labeling associated with the packaging to produce a positive market effect. The labeling and marketing materials are mostly static with little to no consumer interaction. Near Field Communication (NFC) has the potential to provide information to a consumer but also glean information from a consumer about their interests, wellbeing and tastes; cheap and flexible screens on the package could be used to change presentation based on the data provided from consumers; augmented reality using a smart phone will allow for overlay of best use of the product as well as recipe ideas, for example. This aptly named, "Smart Packaging" can inform status and information of the packaging and product integrity (security, quality, breaking of the seal etc) and can demonstrate the authenticity of Australian agrifood products, anti-theft, traceability of handling and distribution. In addition to intelligent packaging functions where "extra production and consumer information" is added to the pack, packaging innovations which are embedded in the material and interacts with the product will be developed – for example, pack materials "actively" control the oxygen levels and thereby growth of bacteria or fungi or confinement odor can also represent advancements and market development to previous sachets and modified atmosphere gas technologies.

Historically, most industries work within regulatory and customs frameworks over which they have little control. As a result, the introduction of innovation is limited by the authorities not having been engaged in the development processes. There is an opportunity here to use external expertise and consultancy to work with authorities to assist the introduction of new innovations arising from this project and more pertinently, to test tolerance and acceptability levels to the kinds of innovations that could be applied or applied with modifications.

This project will provide the underlying data and insight into patent and non-patent literature (NPL) in order to drive opportunity in relation to 'smart packing' technology and enable **Meat & Livestock Australia** to have earlier stage conversation with regulators to ensure comfort levels or the necessary innovation modifications.

[2] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4006167/

EXECUTIVE SUMMARY

This project was commissioned by **Meat & Livestock Australia** to provide information and useful insight from patent and published literature data into the structure and nature of innovation and research within the 'smart packaging' technology field, specifically to identify technologies that can assist Australian food producers to deliver food products to exports markets that deliver on food safety, provenance, shelf life, traceability, and integrity that can contribute to capturing a price premium.

Additionally, this project will provide information which will help **Meat & Livestock Australia** identify and overcome commercial impediments and barriers for Australian producers and brand owners in developing and adopting "Smart" packaging solutions to add value to Australian meat, seafood, grape, wine and produce products in both domestic and export markets. Further, these "Smart" packaging technology platforms can enable Australian food to be positioned and verify provenance, premiuminsation and quality consistency along with supply chain efficiencies that grow demand for producers.

This study focuses on patent and literature trends concerning"Smart Packing" technology. Specifically, patent and literature material related to the function / technical features, applications areas, materials, manufacturing process and the format of this technology. With this in mind, a collection of patent and literature documents with an earliest priority year of 1995 was searched and screened. A collection of **12930** patent invention families and **4441** published literature documents were identified for analysis in this report.

Patent publications have shown a small gradual increase in activity since 1995. The patent family expansion rate has been increasing rapidly however over this time period which indicates that entities are aggressively protecting their existing inventions globally even with the recent decrease in new patent filing activity.

The Asia Pacific region is the most prominent region for patent activity with 66% of the patent data originating from this region. North America is the next prominent region with 21% followed by Europe with 13%. The Asia Pacific region has shown substantial and sustained inventive activity growth from 2010 – 2012.

Japan, the United States and China are the major sources of patent activity. They are also the leading markets in which entities choose to gain patent protection for their innovation. Traditionally popular strategies for filing patents such as use of the PCT and EPO patent routes make up a smaller yet still significant portion of this landscape.

The period from 2011 – 2015 has seen a surge of inventive activity coming from China. Additionally, 84% of all patent activity originating from China has occurred recently since 2009. Japan and the United States have seen a gradual decrease of inventive activity which first occurred around 2007. Japan was the major source of innovation from 1995 – 2010, however it has now relinquished this title to China. Just 29% of all patent activity emanating from the United States and 22% emanating from Japan has occurred since 2009. Japan and the United States comprise just under 2/3 of all patented inventions in the data set. Chinese innovation has occurred in more recent years. China has achieved a 35% increase of patent innovation from 2003 – 2014. South Korea and Italy has also shown significant growth over this period.

Just 49% of patent families in the collection are considered “successful” by having at least one granted and enforceable patent family member. This indicates that this technology on the whole only has a ‘fair’ success rate. Germany has the highest level of success regarding patented innovation with 63%. Japan only has a success rate of 38%.

The majority of patents in the dataset (75%) are owned by commercial entities. Academic/Government activity is much lower (7%) however has been steadily increasing over time. Reaming documents in the dataset belong to individuals (18%).

There are 11 entities that hold large patent portfolios (have 101 or more patent inventions) in relation to this technology. These relatively large entities hold 22% of the patent landscape. **Toppan Printing** (Japan) and **Mitsubishi** (Japan) have the highest numbers of patents broadly related to this technology.

Many of the top entities in the dataset have a clear focus on the Japanese market, as many are based or have originated in Japan. The majority of the top entities also have a substantial cross geographic filing strategy meaning that they are filing in multiple countries, giving a good indication that these companies see the commercial value of this technology.

In terms of patent portfolio strength **Tetra Pak** (Sweden) and **Sealed Air** (United States) were deemed the strongest among the major entities in the dataset. Strength analysis is measured by metrics including patent volume, remaining life, geographic filing breadth, patent grant success, high technical breadth and citation frequency

Medium sized entities (126 in total) that hold between 10 and 97 inventions comprise 19% of the patent technology landscape. Additionally, there are a large number of entities (4004 in total) that hold between 1 and 9 inventions (41% of the landscape) indicating that there is a significantly large number of ‘small players’ undertaking innovative activity in this technology field. A smaller segment of the collection belongs to individuals. There are 2401 inventions in the name of at least one individual which accounts for 18% of the collection.

Many of the medium sized entities show a broad worldwide patent filing strategy indicated by the large filing breadth shown in different countries. **Multisorb Technologies Inc** (United

States) was deemed the strongest among the medium sized entities in terms of patent portfolio strength.

For the top academic and government entities across all entity tiers of the patent data, the **Korea Food Research Institute** (South Korea) was the stand out performer closely followed by the **University of Jiangnan** (China). Academic and government entities comprise only 7% of all patent data associated with this technology.

In terms of categorisation of data, smart packaging technology has been split into 5 broad categories which include **Function / Technical Features, Application Areas, Materials, Manufacturing Process** and **Format.** These categories were then separated further into 116 distinct sub-categories.

For patented innovation, technology associated with the **function of technical features** of smart packaging technology was highest in reference to **oxygen scavenging** and '**other' gases of interest** which included any gas not already highlighted in other categories. In terms of the **application area**, **general foodstuffs** were the most populated category with technology directed toward **pharmaceutica**l applications coming in a distant second. For **materials**, patent technology directed toward **other materials** technology not already highlighted in any other materials categories was the most highly populated. **Manufacturing processes** most populated category related to **lamination** technology. Finally, in relation to **format**, the most active technology areas included those incorporating **label / printable / graphics.** Technology associated with the technology format was generally lower than appeared in the other broad categories.

Technology associated with **self-heating / self-cooling, near field communication** enabled features and **renewable materials** all achieved strong growth recently of between 15% – 17%. Potentially emerging technologies, identifies as those recording high rates of recent patent filing included **thermostatic packaging**, **augmented reality** and materials which have **chemical properties**

There appear to be multiple patent technology areas in which a 'patent gap' is appearing. This gap represents technology areas within smart packaging where there is little or no activity, but where **Meat & Livestock Australia** experts may consider having potential. Innovation associated with the **interaction between product and shelf/environment**, **environmental sensing and reporting** and **near field communication enabled features** are just a few example technologies in which many potential patent gap's were observed.

Bostik Findley SA (France[3]) has the highest scoring invention ranked by Thomson Reuters IP Analytics Strength™ Index. This specific patent relates to 'Multilayer film, useful to manufacture flexible packaging used for packaging products of e.g. food industry, comprises thin material

[3] http://www.bostik.com/our-company/our-history/

layers bonded together by layer that is made of adhesive composition including styrene block copolymers'.

The most highly cited patent in the dataset was originally filed from **Binforma Group LLC** (United States) and **Kimberly-Clark Corporation** (United States). This patent relates to an 'RFID tag system for detecting product tampering and product packaging, has several antenna among which one is detachable antenna capable of wireless communication at wider range'. Highly cited patents can help show the 'influence' of a patent document in relation to others occurring in the dataset and potential highlight more valuable patents appearing in the dataset.

For literature, there appears to be an increasing publication trend in this technology when compared to patents, however literature publication totals are much smaller in total. More innovation and research appears to be directed in the form of literature from Universities and Government agencies which may be a good focus for **Meat & Livestock Australia** to look at for potential future partnerships or licensing opportunities.

Europe has the largest volume of literature publications produced with a little under half (46%) originating here. The Asia Pacific (23%) and North America (18%) are the next top regions for literature associated with this technology. The United States is the largest source of published literature followed by Spain, Italy, China and Turkey. Literature publications from China have witnessed the highest growth rate (32%) closely followed by Germany (26%) and Brazil (22%).

Citation impact shows how often an article was cited by other articles. This can also be seen as an indication of the influence of publications and therefore the country producing them. Countries appearing with a higher impact have more influence in producing publications associated with smart packaging technology. Denmark has the highest citation impact recorded from the dataset.

The **Spanish National Research Council** (Spain) is the leading source of published literature within smart packaging technology. This is followed by the **Foggia University** (Italy) and **Ghent University** (Belgium).

The United States, Spain and Italy have the most literature publications spread throughout multiple entities. In contrast, other countries such as China, Brazil, South Korea and Ireland, appear to have one or perhaps two institutions that are focusing heavily on this technology field.

Literature associated with the function / technical feature **other modified / controlled atmosphere** was highly represented in the dataset. Literature directed toward the application area of **general foodstuffs** was the next most populated category. For materials, literature associated with the **cost** of the technology has the highest representation however literature directed to materials technology generally was only found in small numbers in the dataset. **Other process technology** was the most populous fields in the dataset which related to manufacturing process technology. **Lamination** and **coating** technology followed. Finally, in

terms of the format of this technology, this was not a highly populated category within the dataset with only **built-in / embedded**) type technology the only real stand out.

Certain technology areas appear to be increasing in activity over time. Technology associated with **microbial growth sensors, other modified / controlled atmosphere packaging** and **general foodstuffs** can all be seen to be increasing in activity over time. In contrast, there are technology areas that are stagnant or have little to no literature activity occurring. Examples of this include **thermostatic packaging**, **tamper proof features** and **cook within packaging** features. A lack of literature activity could be attributed to perceived commercialisation intent of a specific sub-technology. If there is an opportunity to commercialise or save costs associated with a technology then it would be more prudent for an entity to protect the innovation via the patent route rather than publish it though literature.

There are technologies represented that have achieved 100% of its Literature published since 2009. Technology that matches these criteria includes **UV blockage**, **corrosion inhibition**, **near field communication**, **electronic article surveillance**, **augmented reality** and **resalable features** in relation to the function or technical feature. **Medical devices** in relation to the application area and **coating and edible films** relating to the specific technology format. As these technologies are recent, it may be worth further investigation to assess the viability of them in terms of commercialisation or integration into current processes and procedures for **Meat & Livestock Australia** before they become fully realised by competitors.

There appears to be multiple patent technology areas in which a literature ‘technology gap’ is appearing. This gap represents technology areas within smart packaging where there is little or no activity, but where **Meat & Livestock Australia** experts may consider having potential for partnership or licensing opportunities. Technology areas of low activity for literature data include **electronic article surveillance**, **augmented reality**, **easy opening of food packs** and **portioning / sizing**.

SUMMARY OF SMART PACKING TECHNOLOGY IP

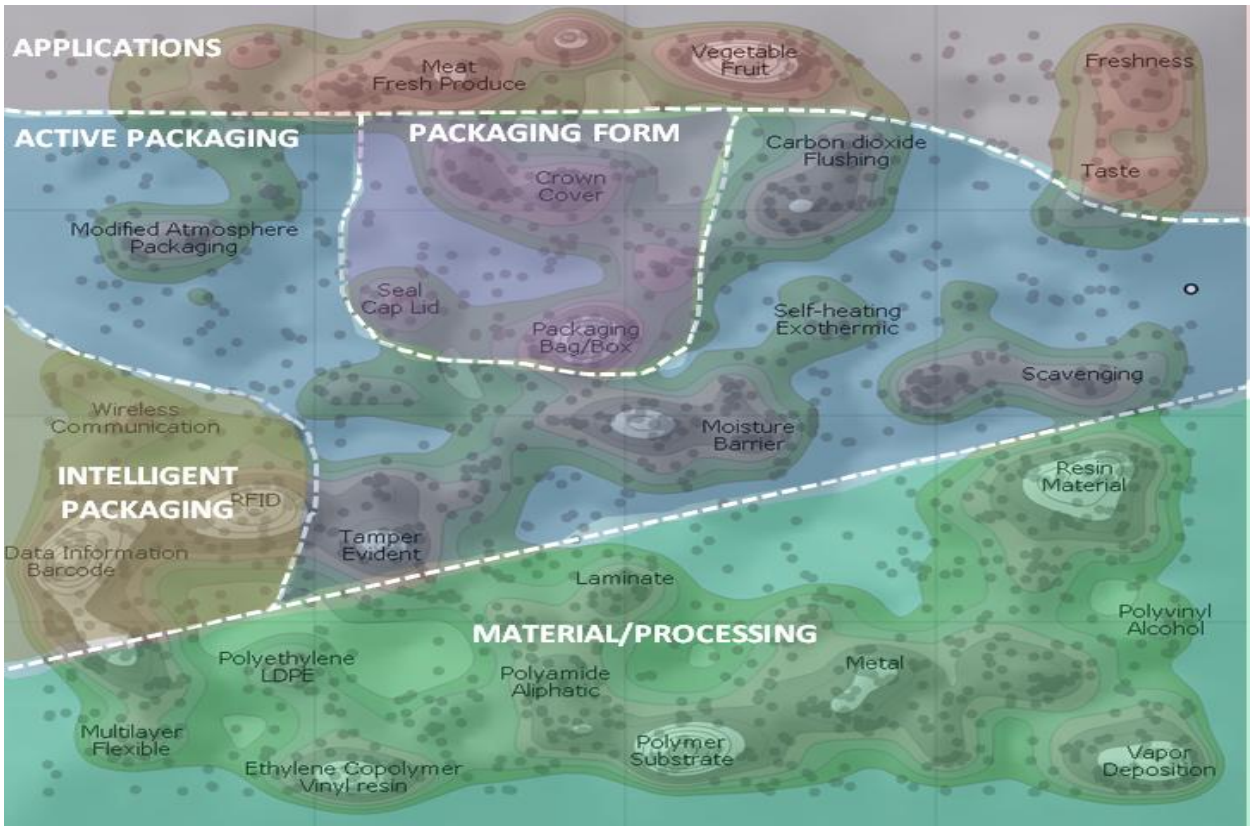
This chapter of the report introduces the patent and literature documents in the collection.

The thematic concept map has been produced using the ThemeScape algorithm from Thomson Reuters and uses advanced text analysis software to summarise the major concepts and subject matters within the **12930** documents in the patent collection and the **4441** documents in the literature publication collection.

Each patent family invention / literature publication is situated in a single location in the landscape map. Areas of higher density (i.e. the mountainous regions shaded white and brown) represent technical topics shared across many inventions – and therefore of greater popularity.

ThemeScape maps highlight vast amounts of data simply and visually. Themes appearing on a map generally represent technology which is more populous within a dataset, therefore enabling quick technology identification of the more active sub-technologies appearing with a dataset.

PATENT LANDSCAPE



Technology themes appearing within a patent ThemeScape map indicate technology which has a greater perceived commercialisation opportunity due to the process and investment that is applied in terms of the patent application process.

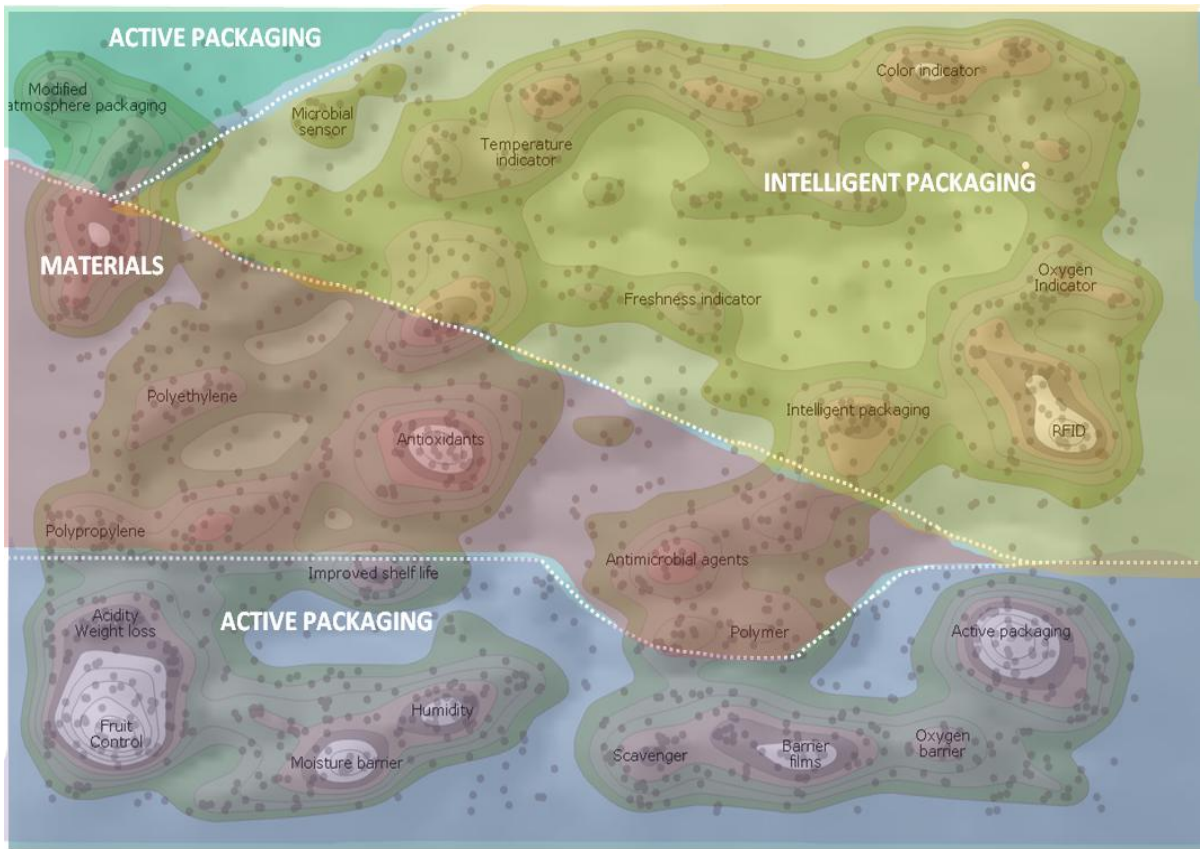
Various themes have been identified on the patent map. A large section of the map is dedicated to documents directed to '**material / processing'** technology, highlighting prominent themes such as **laminates**, **polymer substrates**, **flexible multilayer's**, **metals** and **resin materials**.

Innovation relating to the '**active packaging'** technology are also prominent with themes including **modified atmosphere packaging**, **tamper evident** packaging, **moisture barriers**, **scavenging** technology and **self heating exothermic** packaging.

'**Intelligent packaging'** innovation is also highlighted on the map which include **wireless communication**, **RFID** and **data information / barcode** technology. '**Applications**' of smart packaging technology are also prominent with theme's including **freshness**, **taste**, **fruit / vegetables** and **meat / fresh produce** being witnessed.

Finally, innovation linked with '**packaging form'** can be observed near the center of the map. These prominent themes relate generally to **packaging bag / box's**, **seal / cap lids** and **crown cover**.

LITERATURE LANDSCAPE



Technology themes appearing within a literature ThemeScape map generally indicate technology which has a lower perceived commercialisation opportunity (when compared to patents). Literature however can highlight new or different technology areas in which entities (e.g. University or government agencies) are conducting research and help emphasise potential partnership or licensing opportunities of technology. Literature can also be an excellent indication of emerging technology and its trends as publishing literature can be less time consuming and has a substantially lower cost to produce when compared to the patenting process.

Themes identified on the literature map include a large section related to '**intelligent packaging'** which includes innovation directed to **temperature indicators**, **color indicators**, **freshness indicators**, **microbial sensors** and **RFID** associated technology. '**Materials**' innovation is also well represented which themes including **antimicrobial agents**, **antioxidants** and various **polymer** material technology.

Finally, '**active packaging'** appears in two distinct areas of the ThemeScape map. The top left hand corner highlights technology associated with **modified atmospheric** packaging where the bottom section of the map highlights technology associated with **control, humidity, shelf life**, **moisture**, **oxygen** and **film barriers** in addition to the physical **packaging** in general.

TAXONOMY

The documents in the patent and literature collections are categorised in order to allow analysis on the technology areas. The ThemeScape maps above have assisted in the categorisation methods.

By use of collection sub-searching, a series of technical categories was established. The taxonomy was created by analysing the collection for commonly occurring themes, using patent classification codes and constructing relevant keyword strategies. More details and analysis on the technical categorisation can be found under the relevant heading below.

PATENTS

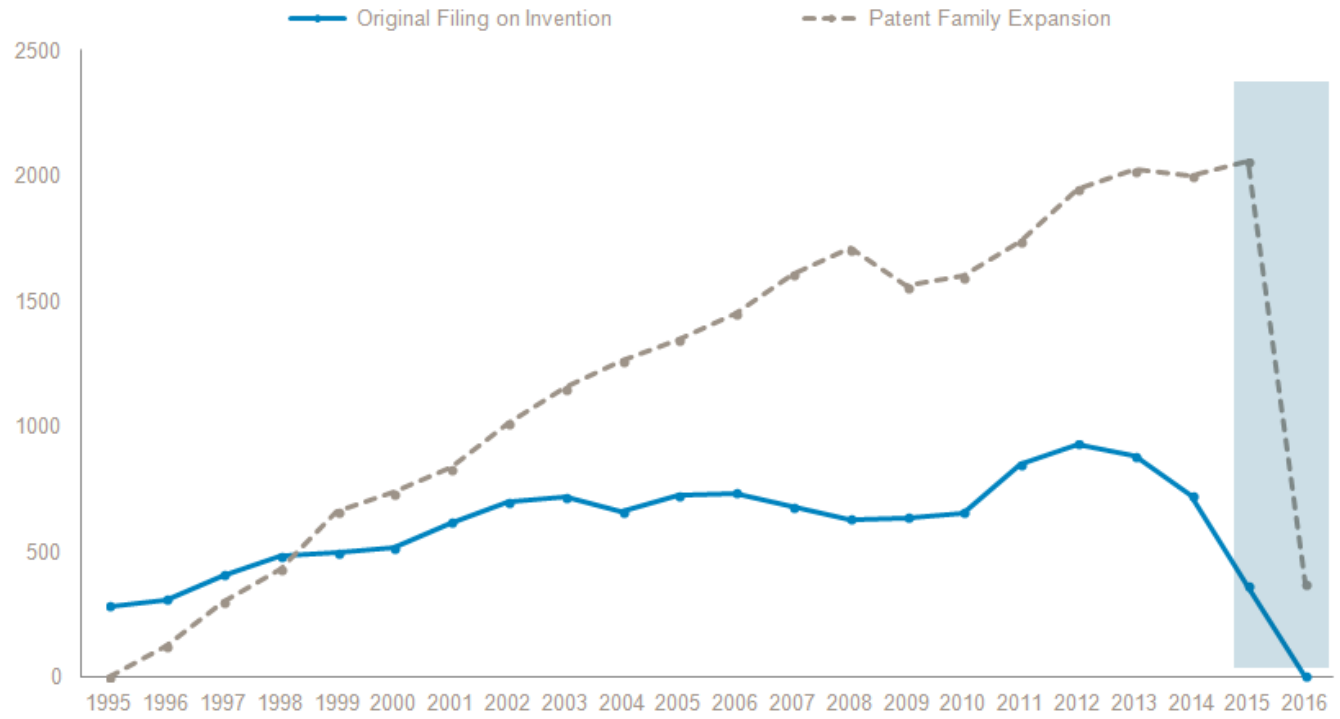
The patent collection was developed using the full patent content on Thomson Innovation®, which includes the Derwent World Patent Index® (DWPI). The use of the patent content in Thomson Innovation ensures a comprehensive collection. The patent collections were normalised on the DWPI database structure to allow for accurate analysis. Specifically, the search process returned a set of **12930** DWPI inventions over the time period of **1995** to **2015**.

ACTIVITY TIMELINES

The chart below shows the number of patent families or inventions first filed (blue) and the patent family expansion (grey) over the years **1995** to **2015**.

There is an 18-month publication delay between filing a patent application and publication of a patent application. Due to this delay, not all years of data are complete. The highlighted area (light blue) shows years in which data may not be complete.

Filing and Family Expansion



On average, there has been a slight gradual increase in patent activity since 1995, with a more substantial decrease observed during the 2013 - 2014 periods.

The patent family expansion rate has been increasing rapidly however over this time period which indicates that entities are aggressively protecting their existing inventions globally even with the recent decrease in new patent filing activity. If filing rates continue to decrease or decrease substantially in the future, it is reasonable to assume that the patent family expansion may inevitably follow.

GEOGRAPHICAL ANALYSIS

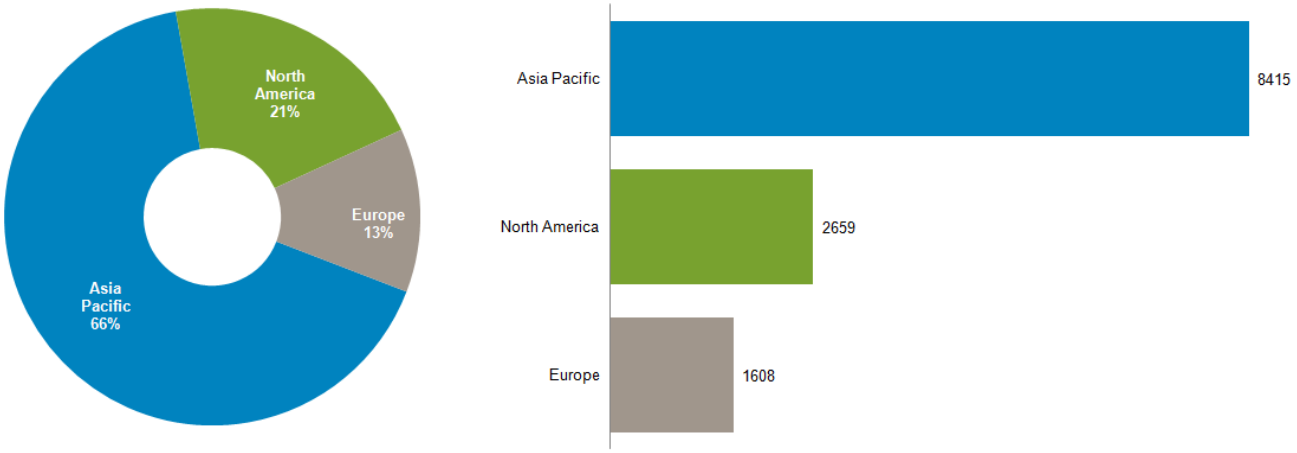
THE SOURCE OF INVENTION

Priority filing country is often used as a proxy measurement for the geographic source of the patented invention, due to the convenience and familiarity of corresponding with a local patent office and in some cases legal restrictions requiring local initial filing.

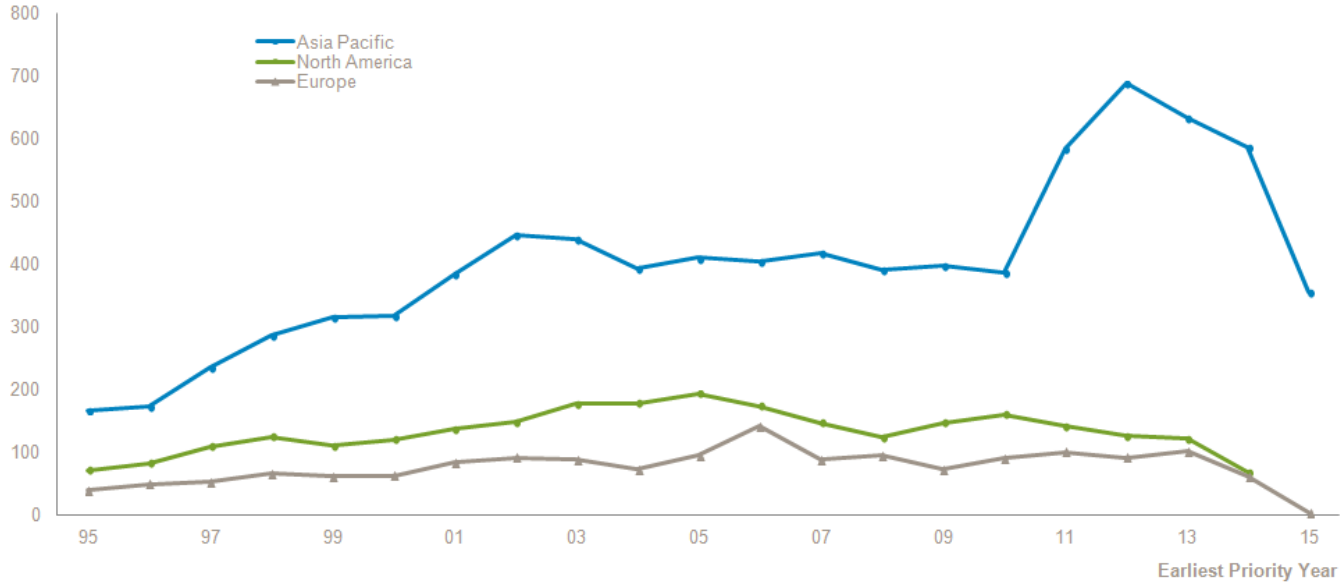
WHERE IS THE INNOVATION GOING?

A priority patent application must be progressed through the patent system in order to secure patent protection. The following chart shows the jurisdictions in which patent protection is ultimately sought.

Earliest prioirty country based on region (excluding WIPO)



Inventive Activity by Region - Timelines



These charts reveal that the Asia Pacific region is the most prominent region for inventive patent activity. 66% of patent activity (8415 inventions) in the data set has originated from this region. North America is the next prominent region with 21% (2659 inventions) followed by Europe with 13% (1608 inventions).

The Asia Pacific region has shown substantial and sustained inventive activity growth from 2010 – 2012. In contrast, activity in the United States and Europe has remained relatively flat up until 2013 where a decline in patent activity is starting to be observed.

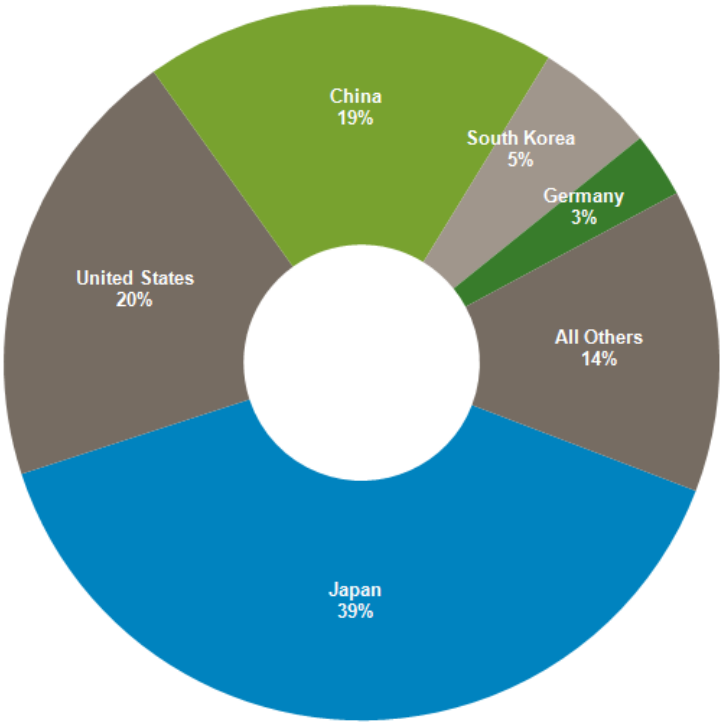
Timeline of Inventive Activity by Patent Authority

Priority Countries	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total Inventions	% Filed since 2009
Japan	160	163	218	267	296	281	346	411	404	342	350	300	230	186	192	161	187	207	203	149	7	5060	22%
United States	71	80	107	124	110	119	134	148	171	175	188	172	141	122	142	159	138	124	115	67		2607	29%
China	3	8	4	5	7	10	15	11	14	13	28	54	99	108	119	144	309	387	361	369	340	2408	84%
South Korea		1	5	9	7	10	7	16	14	21	18	34	70	82	72	70	70	82	56	52	8	704	58%
Germany	11	14	15	28	12	18	18	32	26	18	28	21	17	19	12	25	17	22	18	9	1	381	27%
EPO	5	4	5	6	6	9	19	7	14	18	17	29	31	40	24	24	18	22	36	19		353	41%
United Kingdom	5	10	16	6	16	14	12	10	14	9	20	11	11	7	9	11	16	10	11	7		225	28%
France	4	3	6	6	9	5	11	12	13	9	8	17	6	7	6	6	10	11	2	5		156	26%
Italy	1	4	1	7	9	5	8	9	3	5	8	10	7	5	6	10	14	10	6	6		134	39%
Sweden	4	5	7	9	4	3	2	5	5	7	3	3	2	4	5	4	8		3	5		88	28%
All Others	18	15	20	12	17	37	43	33	37	38	53	82	61	46	48	38	60	51	68	34	4	815	
Total	282	307	404	479	493	511	615	694	715	655	721	733	675	626	635	652	847	926	879	722	360	12931	

Japan, the United States and China are the major sources of inventive activity. The period from 2011 – 2015 has seen a surge of inventive activity coming from China. Additionally, a large proportion (84%) of all patent activity originating from China has occurred recently since 2009. This is the largest recently filed % of any country in the data set. Korea (south) also appears to be becoming a more prominent player in this technology field, with patent activity increasing from 2009 onwards with 58% of their filing occurring recently.

Japan and the United States has seen a gradual decrease of inventive activity which first occurred around 2007. Japan was the major source of innovation from 1995 – 2010, however it has now relinquished this title to China. Just 29% of all patent activity emanating from the United States and 22% emanating from Japan has occurred since 2009. The rise of China as an economic superpower appears to be directly affecting the more established countries where innovation in this technology is originating. More intense competition from China may be causing a decrease in patent activity in the United States and Japan.

Inventive Activity by Priority Country



Of all patent inventions in the patent data set (1995 – 2015), Japan (39%) and the United States (20%) comprise just under 2/3 of all patented inventions in the data set. Chinese innovation has occurred in more recent years (2011 – 2015), whereas the peak periods for innovation in Japan occurred over the 1997 – 2007 periods.

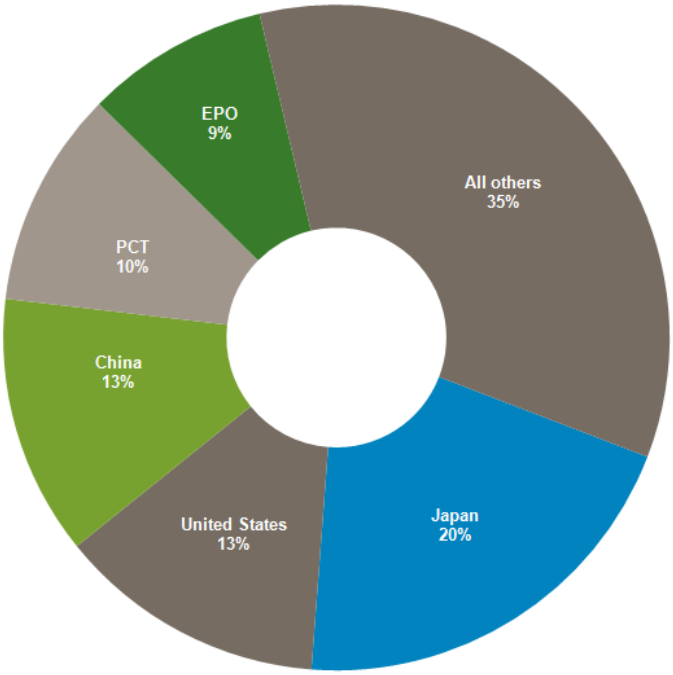
Annual % Growth or Decline

Priority Countries	Average Annual Growth Rate (2003-2014)
China	35%
South Korea	13%
Italy	7%
EPO	3%
Sweden	0%
United Kingdom	-6%
United States	-8%
France	-8%
Japan	-9%
Germany	-9%

The average annual growth rate (AAGR) shows the increase or decrease of patent innovation originating from a country over a specific time period. This data reveals that China has achieved a 35% increase of patent innovation from 2003 – 2014. This is very high result when compared to other countries listed. Much of this innovation has occurred recently in the last few years. South Korea (13%) and Italy (7%) has also shown significant growth over this period.

In contrast, many other countries have shown no growth or a decrease in patent innovation in over the 2003 – 2014 periods. The two countries with the highest number of inventions, Japan (-9%) and the United States (-8%) both showed a substantive decline in innovation. These declines in inventive activity can potentially be explained by countries such as China and South Korea increasing their inventive outputs, therefore causing a more competitive environment for other countries. Costs associated with research, human capitol and services are generally much lower in many Asian jurisdictions (especially China) than they are in more developed countries such as Japan and jurisdictions such North America and Europe. This can provide countries such as China with a significant cost advantage over their counterparts leading them to be more competitive and a more attractive option for investment.

Geographic Protection



Japan, the United States and China are the leading markets in which entities choose to gain patent protection for their innovation. This means that there is a perceived business advantage in obtaining patent protection in these geographic jurisdictions.

Traditionally popular strategies for filing patents such as use of the PCT and EPO patent routes make up a smaller yet still significant portion of this landscape. This indicates that many entities are using these strategies in order to determine where to file their innovation globally. This can be quite a prudent strategy when protecting innovation by allowing an entity more time in identifying appropriate jurisdictions for protection while still protecting the innovation's priority date. [1]

Interestingly, 35% of the landscape is comprised of 'other' countries. This reveals that a significant proportion of inventions are being protected in a geographically broad manner and that many different countries around the world are being targeted for protection depending on the innovation.

SUCCESS

Success according to this report is determined by measuring the patent grant to patent application ratio. Basically, if one member of a patent family has achieved grant anywhere following substantive examination, that invention is considered a "success".

Thomson Reuters believes that the total number of "successful" inventions as a function of the total number of inventions lodged in the patent system gives a fuller picture of innovation than

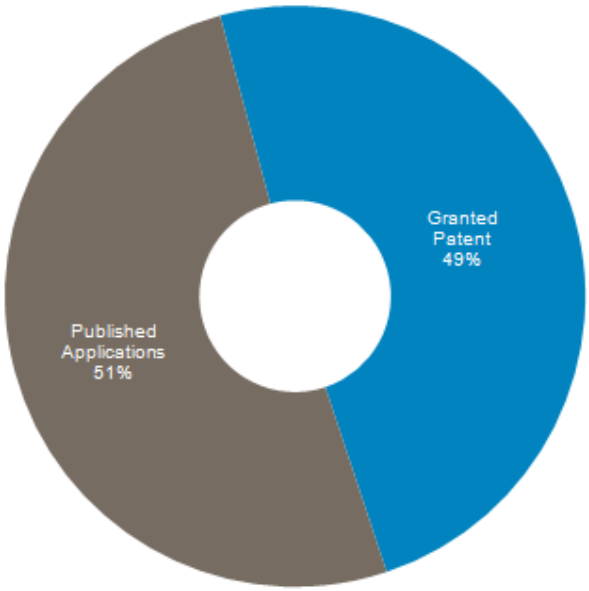
[1] A priority date is the date used to establish the novelty and/or obviousness of a particular invention relative to other art.

patent volumes alone. When considering this metric, it should be noted that there is a bias against younger patent portfolios because they have had less time to become successful.

Granted Patent Activity – Country

Priority Country of the Family	Family has Granted Patent in any Country	Family has only Published Applications	All families	% Families with at least one Granted Patent
Japan	1927	3133	5060	38%
United States	1468	1139	2607	56%
China	1335	1073	2408	55%
South Korea	404	300	704	57%
Germany	241	140	381	63%
All Others	969	802	1771	55%

Granted Patent Activity – Published Applications Vs Granted Patents



The graph above shows that 49% of patent families in the collection are considered “successful”. This means that half of the inventions in the collection have achieved at least one granted and enforceable patent family member. This indicates that this technology on the whole only has a ‘fair’ success rate.

Germany has the highest level of success regarding patented innovation with 63%. This can indicate that the novel, commercial and inventive aspects of many of these patents are quite high and marketable. Japan only has a success rate of 38%, this potentially indicates that even though Japan has the highest number of inventions in this technology, many of these did not proceed to grant indicating less commercial and inventive aspects are covered and contained.

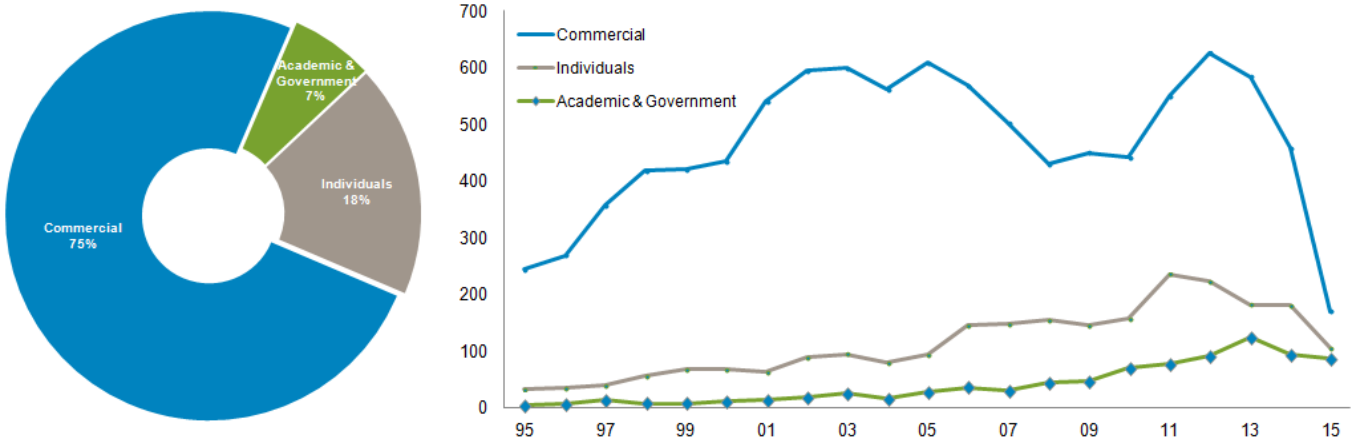
PATENT ENTITY ANALYSIS

The names of entities listed on the patent documents in the collection have been cleaned for typographical errors and researched for subsidiaries or name changes, so that a more accurate picture of the true level of activity for each listed entity is presented.

ANALYSIS OF PATENT LANDSCAPE BY ENTITY SECTOR

The entities in the landscape have been divided into three categories: commercial (and for-profit entities); academic and government institutions (and other not-for-profit entities); and patents assigned to individuals, where the individual could not be identified as an associate of an organisation elsewhere in the collection.

Patent Entity Sector



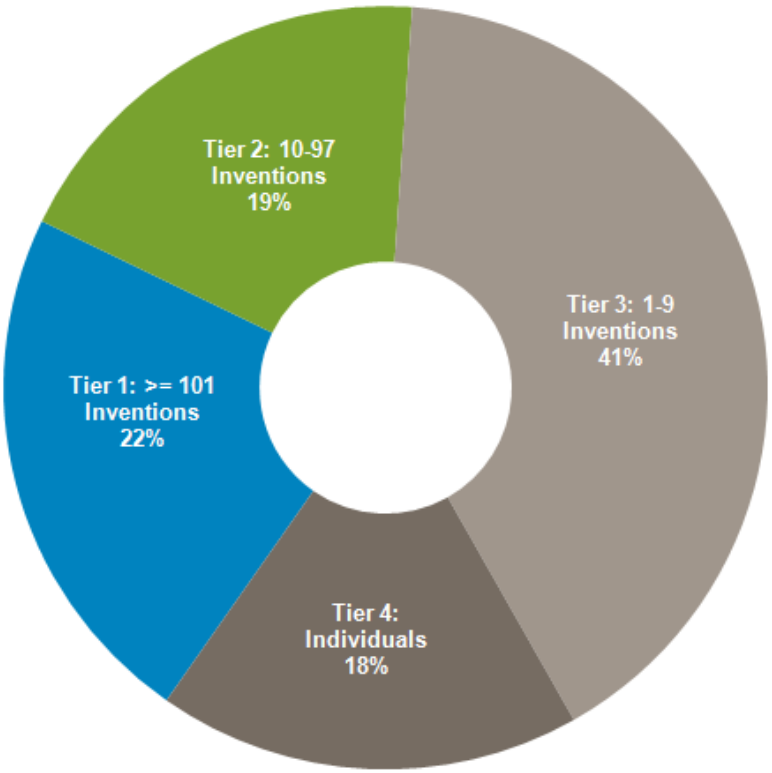
The graph (above-left) shows that most of the IP in the collection is owned by commercial entities (75%).The chart (above-right) shows that from 2005 – 2010, commercial activity has dropped before increasing again. Academic/Government activity (7%) has been steadily increasing over time however it still only appears in relatively low numbers.

PORTFOLIO SIZE ANALYSIS

The entities in the patent dataset were separated into four tiers based on the number of patent families they each have, i.e. those entities with 101 or more inventions (Tier 1); those with between 10 and 97 inventions (Tier 2) and those with 1 to 9 inventions each (Tier 3). “Individuals” also form a single tier (Tier 4).

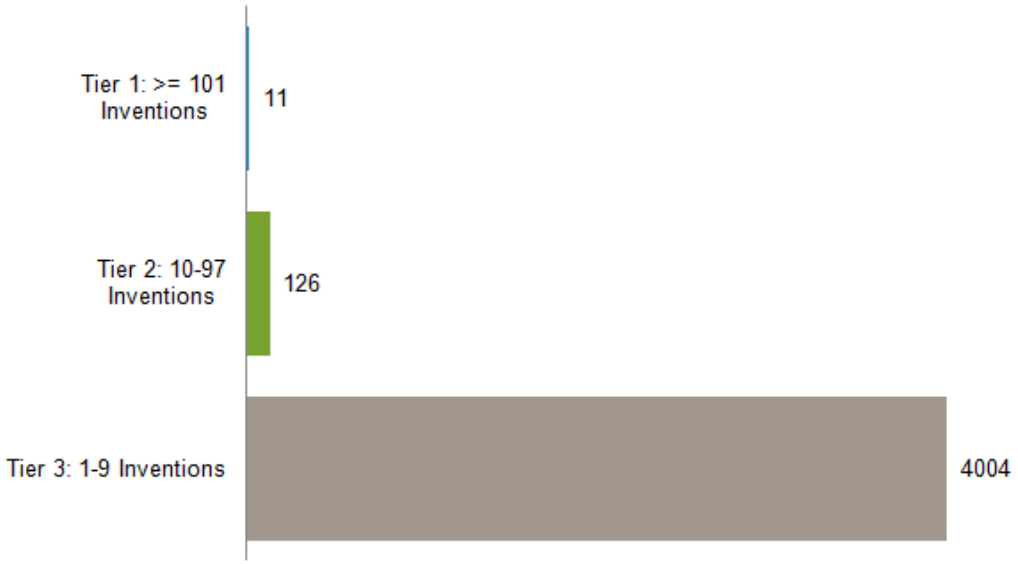
% Landscape by Entity Tier

Tier	Total Inventions	Number of Entities
Tier 1: >= 101 Inventions	3010	11
Tier 2: 10-97 Inventions	2534	126
Tier 3: 1-9 Inventions	5451	4004
Tier 4: Individuals	2401	



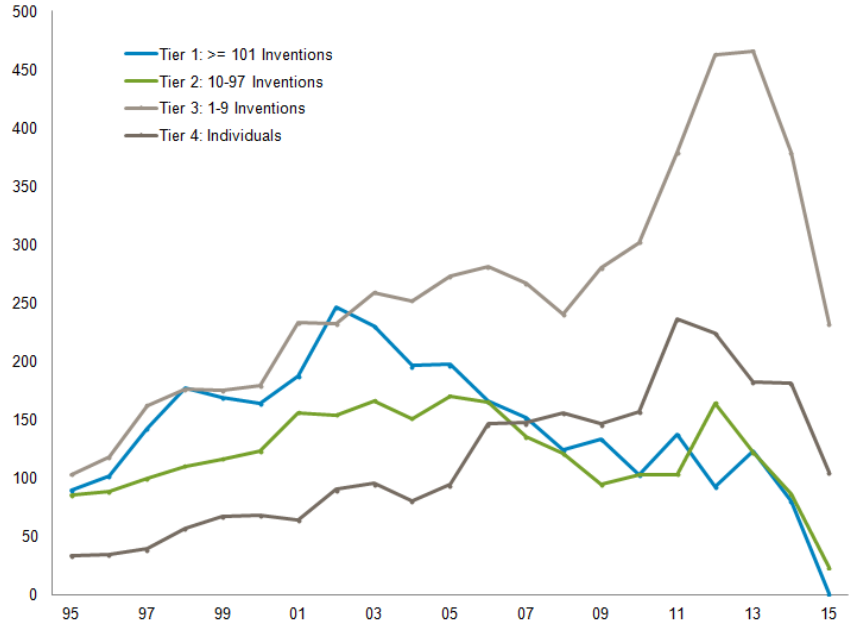
Tiers	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total Inventions
Tier 1: >= 101 Inventions	89	102	142	177	169	164	187	246	230	196	197	166	152	124	133	103	137	92	123	80	1	3010
Tier 2: 10-97 Inventions	85	88	99	110	116	123	156	154	166	151	170	165	135	121	94	103	103	164	122	86	23	2534
Tier 3: 1-9 Inventions	103	118	162	176	175	179	233	232	259	252	273	281	267	240	280	302	379	463	466	379	232	5451
Tier 4: Individuals	33	34	39	57	67	68	64	90	95	80	94	146	147	156	146	157	236	224	182	181	105	2401

Number of entities per Tier



There are 11 entities that hold 101 or more patent inventions. These relatively large entities hold 22% of the patent landscape. Medium sized entities (126 in total) that hold between 10 and 97 inventions comprise 19% of the patent technology landscape. Additionally, there are a large number of entities (4004 in total) that hold between 1 and 9 inventions (41% of the landscape). This indicates that there is a significantly large number of ‘small players’ undertaking innovative activity in this technology field, since larger entities tend to have larger patent portfolios. Overall, this picture would appear to show a highly competitive sector, in which a handful of companies control a significant proportion of IP rights; however a large number of smaller entities have noteworthy interest and view significant opportunity in this technology. A smaller segment of the collection belongs to individuals. There are 2401 inventions in the name of at least one individual which accounts for 18% of the collection.

Timeline of Activity by Tier



TIER 1 ENTITIES (GREATER THAN 101 INVENTIONS)

The table below lists the entities in tier 1 of the collection. There are total of 11 entities that fit the criteria of greater than 101 inventions.

The table shows the total number of patent inventions associated with these entities, as well as the number of inventions first filed each year that have progressed through the patent system (patent data from recent years may be incomplete due to publication lag).

Tier 1 Entities – Timeline and Total Activity

Tier 1 Entities	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total Inventions	% Filed Since 2009
Toppan Printing	15	20	24	28	31	26	58	48	75	60	43	58	38	31	29	18	35	33	43	22		735	24%
Mitsubishi	25	14	41	38	31	26	35	62	29	30	23	17	14	16	32	12	36	29	29	10		549	27%
DIC Corp	10	9	13	28	14	20	16	25	26	29	36	44	38	20	18	32	28	7	18	10	1	442	26%
Sumitomo Group	7	16	11	24	25	17	9	23	18	14	2	5	6	3	8	4	9	8	10	9		228	21%
Sealed Air	15	14	17	17	16	13	10	9	17	13	20	6	11	11	6	7	3	1	6	4		216	13%
Toyobo Group	2	9		15	16	15	16	18	21	9	27	3	11	6	3	4	2		2	3		182	8%
Toyo Seikan Group	2	2	7	3	10	18	9	25	20	15	14	9	8	8	4	6	3	4	3	4		174	14%
Kuraray	3	5	9	10	11	12	8	5	7	8	10	6	10	15	12	8	4	2	5	7		157	24%
Tetra Pak	9	6	9	6	5	6	11	9	5	7	7	7	6	3	7	6	7	2	2	6		126	24%
Mitsui Chemicals		6	10	8	9	10	8	9	8	4	6	8	5	5	5		6	4	3	2		116	17%
Toray Industries	2	3	4	3	3	1	8	14	5	7	9	3	5	6	9	7	5	2	2	3		101	28%
Tier 1: >= 101 Inventions	89	102	142	177	169	164	187	246	230	196	197	166	152	124	133	103	137	92	123	80	1	3010	
Tier 2: 10-97 Inventions	85	88	99	110	116	123	156	154	166	151	170	165	135	121	94	103	103	164	122	86	23	2534	
Tier 3: 1-9 Inventions	103	118	162	176	175	179	233	232	259	252	273	281	267	240	280	302	379	463	466	379	232	5451	
Tier 4: Individuals	33	34	39	57	67	68	64	90	95	80	94	146	147	156	146	157	236	224	182	181	105	2401	

The top entities in this technology field show an interesting picture. **Toppan Printing** (Japan) and **Mitsubishi** (Japan) have the highest numbers of patents broadly related to this technology. Both entities have roughly a quarter of their patent activity occurring from 2009 onwards, meaning that they are both continuing to be active within the smart packing technology area. Interestingly, nearly all of the entities appearing in this tier appear to have filed a substantive portion of their patent portfolio's recently. Only **Toyobo Group** (Japan), **Sealed Air** (United States) and **Toyo Seikan Group** (Japan) appear to have a lower number of inventions filed recently which could potentially indicate a diminishing interest in this technology field or perhaps a more savvy filing patent strategy being undertaken focusing only on innovation contributing to the bottom line of the business or which strategically protects innovation previous filed and protected.

FILING STRATEGIES

The table below shows the list of the countries that tier 1 entities are interested in for patent protection.

Tier 1 Entities – Geographic Protection Analysis

Tier 1 Entities	Japan	United States	China	PCT	EPO	South Korea	Australia	Germany	Canada	Mexico	Spain	Brazil	Taiwan	India	New Zealand	Russia	South Africa	France	United Kingdom	Singapore	Israel	Hong Kong	Norway	Italy	Philippines	Vietnam	Hungary	Sweden	Czech Republic	Malaysia	Argentina	Indonesia	Thailand	Switzerland
Toppan Printing	731	30	24	41	25	13	13	6	7	5		1	11	2		1	4								4								3	
Mitsubishi	520	143	78	97	144	101	16	73	11	7	5		72	19	2	9	8			1		3			3						2	2		
DIC Corp	436	27	16	32	26	11	4	5	7	4	1	3	5	6			3		8		1	1				2								
Sumitomo Group	227	18	15	13	16	10	2	8	5		2		11	2	1					2		3												
Sealed Air	64	180	31	144	153	20	137	75	91	62	44	54	4	6	107	16	4	2	1				6	2			4		2	1				
Toyobo Group	178	14	11	17	14	11	1	4	1				9	5																				
Toyo Seikan Group	173	37	35	36	36	33	13	4	5		3		3	2																			2	
Kuraray	149	41	38	35	40	31	22	17	23	2	9	1	12	6	1	1	2		1															
Tetra Pak	102	70	57	84	79	18	55	35	5	35	27	42	11	17	1	32	9	4					5	1		11		30		2			2	2
Mitsui Chemicals	113	17	15	19	16	15	1	4	2				13	5		2				2		1												
Toray Industries	73	37	10	30	25	12	7	4	6	3		1	6	2																				

Many tier 1 entities have a clear focus on the Japanese market. As many are based or have originated in Japan. It is reasonable to assume that these entities would be protecting their innovations locally in the first instance. Interestingly, all tier 1 entities have a substantial cross geographic filing strategy meaning that they are filing in multiple countries. This gives a good indication that these companies see the commercial value of this technology and need to protect it in many different jurisdictions.

This data can also highlight entities that view the Australian / New Zealand region of high importance. For example, **Sealed Air** (United States) appears to have invested heavily in patent protection in both the Australian and New Zealand territories which may warrant further investigation and scrutiny of their technology in terms of potential collaboration or technology licensing opportunities.

QUADLATERAL FILINGS

Geographic filing breadth is a measure of intent to commercialise. Quadlateral filing countries represent United States, Europe, China and Japan.

Interestingly, all tier 1 entities have quadlateral patent filings within their portfolio. This data supports the previous statement that tier 1 entities generally see the commercial value of this technology and see the need to protect it in many different jurisdictions

Tier 1 Entities – Quadlateral Filings.

Tier 1 Entities	Quadlateral Filings
Toppan Printing	18
Mitsubishi	62
DIC Corp	12
Sumitomo Group	8
Sealed Air	18
Toyobo Group	9
Toyo Seikan Group	31
Kuraray	34
Tetra Pak	46
Mitsui Chemicals	13
Toray Industries	8

STRENGTH ANALYSIS

A strength analysis can be performed in order to determine the quality and influence of IP. Quality and influence in patent portfolios can be measured by metrics including:

- Volume (number of inventions held)
- Remaining life (i.e. remaining patent term)
- Geographic filing breadth as a measure of intent to commercialise (in particular quadrilateral filings in US, EP, CN and JP)
- Grant success
- High technical breadth as an indicator of fundamental innovation
- Citation frequency statistics as a measure of impact in the field (older patents have more opportunity to be cited, so the statistic is adjusted to correct for patent age)

An overall strength score can be calculated based on these aggregated measurements. The strength score is a unit-less value that allows individual inventions or entire patent portfolios to be ranked relative to one another.

The table below lists the entities in tier 1 and their corresponding strength scores.

Ranking of Tier 1 Entities

Tier 1 Entity Rankings	Total Inventions	Average Remaining Life	Quad Filings	Novelty based on Grants	Average Family Citations	Average Age Weighted Citation Impact	Thomson Reuters IP Analytics Strength
Tetra Pak	126	7.4	46	85	8.9	0.7	27.7
Sealed Air	216	6.4	18	158	15.1	1.1	25.6
Toray Industries	101	8.8	8	47	4.2	0.5	23.9
Kuraray	157	8.1	34	97	5.9	0.5	23.4
Toyo Seikan Group	174	7.7	31	112	5.1	0.5	22.9
Mitsubishi	549	7.8	62	249	4.0	0.3	21.0
Mitsui Chemicals	116	7.2	13	49	4.3	0.4	17.4
DIC Corp	442	9.0	12	219	3.0	0.3	17.0
Toppan Printing	735	8.7	18	259	2.0	0.2	14.8
Sumitomo Group	228	6.8	8	72	2.5	0.2	11.2
Toyobo Group	182	6.7	9	72	2.4	0.2	10.9

- **Tetra Pak** (Sweden) has the top strength score (27.7) of all tier 1 entities. This is due to high quadrilateral filings (46) and a high score related to average patent family citations (8.9) and citation impact (0.7).
- **Sealed Air** (United States) has the second highest strength score (25.8) due to its average patent family citations count (15.1) and citation impact (1.1). It also scored high on novelty based on grant (158).

Interestingly, all of the tier 1 entities have, on average, a fairly mature patent portfolio. This is indicated by all entities having an average of 6 – 9 years patent life remaining on their portfolios. This means that these entities have been working in this technology field for a substantial amount of time and will be quite invested in its research and development.

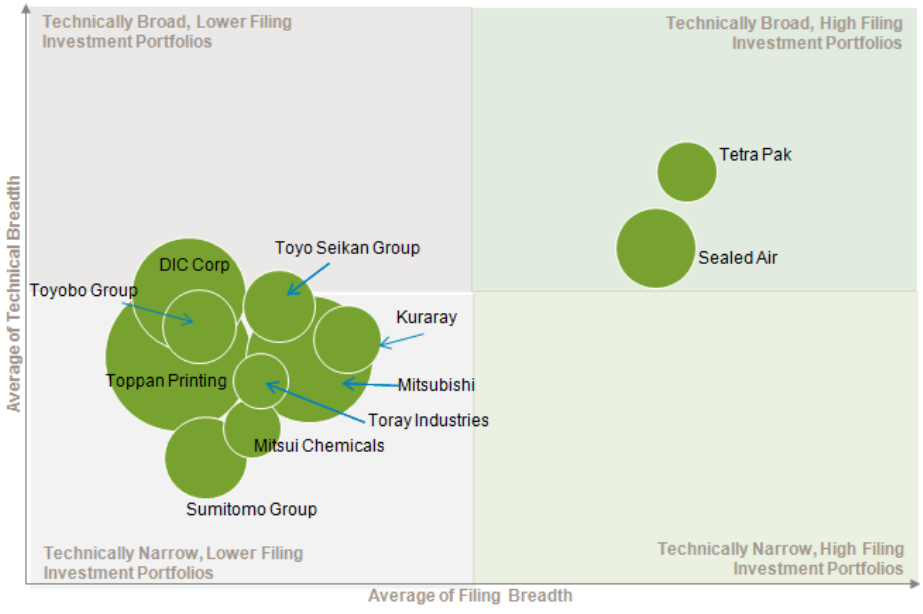
TECHNICAL BREADTH

Another indicator of patent quality is the breadth of technology each patent covers. Patents covering a broader technical range have a higher chance of being infringed or required for licensing by a third party – thus increasing the value of the patent. Technical breadth was measured using the technical classifications in this report. A full breakdown of technical breadth for all tier 1 entities is show below.

Tier 1 Entities – Technical Breadth

	Tier 1 Entity	Average of Filing Breadth (Based on Family Member Countries)	Average of Technical Breadth (Based on Technical Categories)	Total Inventions
1	Tetra Pak	5.2	10.0	126
2	Sealed Air	4.9	9.0	216
3	DIC Corp	1.3	8.5	442
4	Toyo Seikan Group	2.0	8.3	174
5	Toyobo Group	1.4	8.1	182
6	Kuraray	2.5	7.9	157
7	Toppan Printing	1.2	7.7	735
8	Mitsubishi	2.2	7.7	549
9	Toray Industries	1.8	7.4	101
10	Mitsui Chemicals	1.8	6.9	116
11	Sumitomo Group	1.4	6.5	228

Tier 1 Entities – Technical Breadth Bubble Chart



Tetra Pak (Sweden) and **Sealed Air** (United States) and have the highest instances of technical breadth of all tier 1 entities. This means that their inventions cover a broader number of technical

categories highlighted in this report and potentially, could be viewed as more valuable or important in terms of their technical scope when compared to other tier 1 entities. **Mitsui Chemicals** (Japan) and **Sumitomo Group** (Japan) are both shown to have the lowest average technical breadth associated with their patent portfolios for tier 1 entities. This means that these entities appear to be more focused on specific technical areas of this technology field rather than the broader technology field as a whole.

GRANT SUCCESS

Success according to this report is determined by measuring the patent grant to patent application ratio. Basically, if one member of a patent family had achieved grant anywhere following substantive examination, that invention is considered a "success".

Thomson Reuters believes that the total number of "successful" inventions as a function of the total number of inventions lodged in the patent system gives a greater picture of innovation that patent volumes alone. When considering this metric, it should be noted that there is a bias against younger patent portfolios because they have had less time to become successful.

Grant success for all tier 1 entities is shown below. The **Sealed Air** (United States) is by far the most successful, with 73% of its patent families containing patents that have been granted.

Tier 1 Entities – Grant Success

Tier 1 Entity	Grants	Apps	Total	% Granted
Toppan Printing	259	476	735	35%
Mitsubishi	249	300	549	45%
DIC Corp	219	223	442	50%
Sumitomo Group	72	156	228	32%
Sealed Air	158	58	216	73%
Toyobo Group	72	110	182	40%
Toyo Seikan Group	112	62	174	64%
Kuraray	97	60	157	62%
Tetra Pak	85	41	126	67%
Mitsui Chemicals	49	67	116	42%
Toray Industries	47	54	101	47%

TIER 2 ENTITIES (10 TO 97 INVENTIONS)

The table below lists the top entities in tier 2 of the collection. There is a total of 126 entities that fit the criteria of between 10 and 97 inventions. Only the top tier 2 entities are shown. The list highlights those entities with 21 or more inventions. The full list can be viewed in the corresponding excel work sheet.

Top Tier 2 Entities – Total Inventions

Tier 2 Entities	Total Inventions
Kureha Corp	97
Unitika	88
Asahi Kasei Kk	76
Du Pont De Nemours & Co E I	62
Toyo Ink Mfg Co Ltd	61
Oji Kako Kk	51
Showa Denko	58
Grace & Co W R	46
Curwood Inc	40
Kraft Foods Global Brands Llc	40
Nippon Synthetic Chem Ind Co Ltd	40
Basf Ag	38
Nestec S.A.	37
Semiconductor Energy Lab	37
Ajinomoto Co Inc	36
Multisorb Technologies Inc	35
Dow Corning Corp	34
Eastman Chem Co	34
Honeywell Int Inc	34
Idemitsu Petrochem Co	33
Nippon Zeon Kk	33
Sonoco Dev Inc	31
Amcor Limited	30
Nippon Seishi Kk	30
Otsuka Seiyaku Kogyo Kk	30
Hoechst Ag	29
Daicel Pack Systems Kk	28
Alcan Global Pharm Packaging Inc	26
Chevron Chem Co	26
Flexopack Plastics Ind Sa	26
Korea Food Res Inst	26
Kyodo Printing Co Ltd	25
Stora Enso Oy	24
Kao Corp	22
Sekisui Chem Co Ltd	22
Fuji Film Co Ltd	21
Qp Corp	21
Tokuyama Corp	21
Univ Jiangnan	21

The table below shows the total number of patent inventions associated with these entities, as well as the number of inventions first filed each year that have progressed through the patent system (patent data from recent years may be incomplete due to publication lag). This is only a partial list, the full list can be viewed in the corresponded excel file.

Top Tier 2 Entities – Timeline and Total Activity

Tier 2 Entities	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Total Inventions	% Filed Since 2009
Kureha Corp	6	10	3	4	4	4	4	8	9	10	11	7	9		2	1		1	3	1		97	8%
Unitika	1	1	4	6	8	10	8	4	3	5	8	4		1		2	1	5	2	15		88	28%
Asahi Kasei Kk	2	1	5	4	1	3	4	9	7	10	12	9	1	1	1	2	1	1	1	1		76	9%
Du Pont De Nemours & Co E I	2	2	2	1	1	4	2	3	4	7	6	7	6	4	1	2	2	5	1			62	18%
Toyo Ink Mfg Co Ltd		1					10	10	26	3	4	4				1			1	1		61	5%
Showa Denko			2	3	16	7	10	3	5		1	1	1		3	1	2	1	1	1		58	16%
Oji Kako Kk		2	5	1	6	7	4	2	3	8	1	2	3	4	1		1	1				51	6%
Grace & Co W R	18	16	8	1	1													2				46	4%
Kraft Foods Global Brands Llc		3		1	1		3	1			1	8	2	3	7	4	2	2	1	1		40	43%
Curwood Inc		1	1	3	2	3		2	1	6	4	7	1		3		2	2	1	1		40	23%
Nippon Synthetic Chem Ind Co Ltd			4	2	3	4	2	4	1	1	3	4	3	3			1	2		3		40	15%
Basf Ag	2	1	1	1			2	1	1	3	2	6	2	2	9		2	2	1			38	37%
Nestec S.A.	1	2		1	1	1	4	1	1	2			2	4		1	2	4	10			37	46%
Semiconductor Energy Lab										1	9	11	8	6	2							37	5%
Ajinomoto Co Inc	4	3	3	7	4	1	2	4	1	1		1		3				1	1			36	6%
Multisorb Technologies Inc						1	2		2	4	2	1	4		4	5	3	2	4	1		35	54%
Dow Corning Corp	1	2	6	1	1	2	2	1	1	2		1	1	3		2	2	4	2			34	29%
Honeywell Int Inc			1		1	2	11	4	2	2	4	1		2			1	2	1			34	12%
Eastman Chem Co	2		3	6	4		1		3	4	5	3			1			1	1			34	9%
Idemitsu Petrochem Co	2		2	1	2	1	2	2	1	2	2	1	3	1	1			7	3			33	33%
Nippon Zeon Kk					1					3	10	7	3		1	3	1	1	3			33	27%
Sonoco Dev Inc			2	1	2	1	3		4	5	2	2	1	3	1	1		1		2		31	16%
Nippon Seishi Kk	3					2		1								4	3	11	5	1		30	80%
Amcor Limited					1	1	1		5	3	1	2	2	7	1	4	1	1				30	23%

The table below shows a partial list of the countries that the top tier 2 entities are interested in for patent protection. The table is sorted based on the most prominent filing country based on patent activity.

Top Tier 2 Entities – Geographic Protection Analysis

Tier 2 Entities	Japan	United States	China	PCT	EPO	South Korea	Australia	Germany	Canada	Mexico	Spain	Brazil	Taiwan	India	New Zealand	Russia	South Africa	France	United Kingdom	Singapore	Israel	Hong Kong	Norway	Italy	Philippines	Vietnam	Hungary	Sweden	Czech Republic	Netherlands	Malaysia
Kureha Corp	94	26	21	30	33	13	12	13		1	1	1	6		1																
Unitika	86	10	10	12	10	10	3		2		1		7	7							1										
Asahi Kasei KK	76	4	2	4	2	2	1	2					5																		
Du Pont De Nemours & Co E I	36	54	34	49	37	12	24	8	9	8	3	18	2	16	4		2		1	2		1	2		1		1		1		
Toyo Ink Mfg Co Ltd	60	7	8	8	7	7	2		1				6	6																	
Oji Kako Kk	51	1	1	1																											
Showa Denko	57	4	7	7	3	3	4						3		1							1									
Grace & Co W R	31	37	14	36	40	13	41	34	30	32	22	26	5	1	33	1	8		1			1	2	1	1		3		3		1
Curwood Inc	8	36	4	5	21	2	17	11	20	17	8	16		4	13	2	1	2	2	2	3		2		1						1
Kraft Foods Global Brands Llc	11	36	13	8	21	6	15	6	28	17	11	9		7	7	11	7		1	3	4		5		8						1
Nippon Synthetic Chem Ind Co Ltd	39	7	3	8	3	2	2	2	1		1		1	1	1																
Basf AG	26	31	22	34	32	5	9	11	11	5	9	3	8	9		5	5			1											1
Nestec S.A.	19	28	20	33	30	7	26	10	21	18	13	9	4	9	6	10	4			5	6	5	3		6	1	2				4
Semiconductor Energy Lab	30	29	10	3	8	8		1					4									1									
Ajinomoto Co Inc	35	2	2	3	2	1							1																		
Multisorb Technologies Inc	24	32	23	35	31	18	21	2	25	22	5	12	1	21	2	12	15			5	19	14	2				2				
Dow Corning Corp	24	28	21	25	25	13	16	7	8	14	5	10	9	6	2	1	3			2	2	1	2		3		2		2		1
Eastman Chem Co	18	30	12	26	22	8	11	11	6	14	5	10	6	5	1	2	1	1	2	2					1						
Honeywell Int Inc	13	33	13	23	18	10	13	1	2	6	2	6	4	7	2								2						1		
Idemitsu Petrochem Co	32	4	3	10	2	5		3			1		7																		
Nippon Zeon KK	33	11	8	11	6	3																									
Sonoco Dev Inc	9	30	1	5	19	1	5	7	14	16	1	10		1	1	1					1				1						2
Amcor Limited	4	17	1	17	21	1	9	9	11	7	9	4		1	3	2	1	1	2	1											

Many tier 2 entities exhibit a broad worldwide patent filing strategy indicated by the large filing breadth shown in different countries. This helps highlight the high level of investment that these entities have committed to their patents in order to commercialise their portfolios.

Other entities such as **Oji Kako KK** (Japan) **Ajinomoto Co Inc** (Japan) and **Nippon Zeon KK** (Japan) have a more narrow patent filing strategy. These entities have only filed in their home jurisdiction and a handful of other markets which they perceive of importance. A potential explanation for this could be that these entities' primary business focus is their own country and therefore they do not see a need to protect their inventions elsewhere. The handful of other countries in which protection has been pursued could include locations where their technology is manufactured or where components are sourced.

STRENGTH

The table below lists a selection of the top entities in tier 2 based on number of total inventions, by their strength score. The complete list can be viewed in the corresponding excel work file.

Ranking of Tier 2 Entities

Tier 2 Entity Rankings	Total Inventions	Average Remaining Life	Quad Filings	Novelty based on Grants	Average Family Citations	Average Age Weighted Citation Impact	Thomson Reuters IP Analytics Strength Index
Multisorb Technologies Inc	35	11.7	21	23	6.5	0.7	53.7
Stora Enso Oy	24	10.5	8	16	8.1	0.7	49.7
Semiconductor Energy Lab	37	10.2	2	33	10.8	1.3	47.2
Nestec S.A.	37	11.0	12	21	14.1	1.1	44.9
Kraft Foods Global Brands Llc	40	10.4	8	26	8.2	0.9	40.6
Basf Ag	38	9.7	21	19	9.4	0.8	40.0
Flexopack Plastics Ind Sa	26	10.7		16	3.6	0.4	37.0
Alcan Global Pharm Packaging Inc	26	8.1	4	17	8.0	0.7	34.4
Fuji Film Co Ltd	21	10.6	1	10	4.7	0.4	34.0
Du Pont De Nemours & Co E I	62	8.7	28	29	9.3	0.7	33.6
Curwood Inc	40	8.4	2	30	12.6	1.1	33.5
Sonoco Dev Inc	31	8.4	1	24	10.1	0.8	32.4
Honeywell Int Inc	34	7.5	12	23	16.2	1.4	32.2
Dow Corning Corp	34	8.0	18	23	20.6	1.5	32.0
Amcor Limited	30	10.2	1	20	3.7	0.4	31.6
Korea Food Res Inst	26	14.3		23	0.5	0.1	31.0
Sekisui Chem Co Ltd	22	11.6	2	5	1.1	0.2	29.6
Nippon Zeon Kk	33	10.8	5	21	2.6	0.3	29.3
Eastman Chem Co	34	5.7	11	24	18.0	1.5	27.0
Univ Jiangnan	21	13.9		12	2.0	0.3	24.3
Nippon Seishi Kk	30	13.1		2	0.3	0.1	23.6
Idemitsu Petrochem Co	33	9.3	1	13	2.4	0.2	21.2
Unitika	88	8.6	9	30	2.6	0.2	20.6
Kyodo Printing Co Ltd	25	6.8	4	13	4.4	0.4	19.7
Otsuka Seiyaku Kogyo Kk	30	6.7	7	19	9.5	0.8	19.6
Nippon Synthetic Chem Ind Co Ltd	40	8.0	1	18	3.6	0.3	18.1
Hoechst Ag	29	2.9	2	25	17.4	1.1	17.7
Kureha Corp	97	6.6	17	47	8.5	0.6	17.7
Kao Corp	22	8.2	3	10	3.5	0.3	16.7
Toyo Ink Mfg Co Ltd	61	7.2	6	23	3.9	0.4	16.6
Chevron Chem Co	26	4.0	7	17	30.7	1.9	15.8
Qp Corp	21	9.7		12	0.9	0.1	14.3
Asahi Kasei Kk	76	7.4	2	25	1.5	0.1	10.0
Showa Denko	58	5.9	3	20	4.0	0.3	9.8
Tokuyama Corp	21	4.1		7	5.8	0.4	8.2
Ajinomoto Co Inc	36	4.5	1	18	2.1	0.2	8.1
Oji Kako Kk	51	6.4		6	2.3	0.2	6.5
Daicel Pack Systems Kk	28	4.6	1	6	3.8	0.2	4.4
Grace & Co W R	46	1.0	11	38	29.0	1.6	4.1

Multisorb Technologies Inc (United States) has an IP Analytics strength score of 53.7 due to high average remaining patent life (11.7) and high number of quadlateral filings in comparison to other tier 2 entities. In contrast, the **Grace & Co W R** (United States) has one of the lowest strength index values in the above list with a score of 4.1. This is mainly due to having a very low average remaining patent life (1 year on average) indicating that the majority of its technology is about to come off patent and loose protection.

QUADLATERAL FILINGS

Geographic filing breadth represents a measure of intent to commercialise. Quadlateral filing countries represent United States, Europe, China and Japan.

Du Pont de Nemours & Co (United States) is the stand out performer here with a substantial proportion of their patent portfolio filed in at least the United States, Europe, China and Japan. **BASF AG** (Germany) and **Multisorb Technologies Inc** (United States) are also strong quadlateral performers.

Tier 2 Entities – Quadlateral Filings

Tier 2 Entities	Quadlateral Filings
Du Pont De Nemours & Co E I	28
Basf Ag	21
Multisorb Technologies Inc	21
Dow Corning Corp	18
Kureha Corp	17
Nestec S.A.	12
Honeywell Int Inc	12
Grace & Co W R	11
Eastman Chem Co	11
Unitika	9
Int Paper Co	9
Otsuka Techno Kk	9
Kraft Foods Global Brands Llc	8
Stora Enso Oy	8
Procter & Gamble Co	8
Otsuka Seiyaku Kogyo Kk	7
Chevron Chem Co	7
Valspar Sourcing Inc	7
Dsm Nv	7
Sicpa Holdings Sa	7
Joseph Co	7
Baxter Int	7
Colormatrix Group	7
Toyo Ink Mfg Co Ltd	6
Lg Group	6
Csp Technologies North America Llc	6
Coca-Cola Co	6
Zeon Corp	6
Evergreen Packaging Inc	6
Nippon Zeon Kk	5

TECHNICAL BREDTH

A breakdown of technical filing breadth for the top tier 2 entities (based on total inventions) is show below. Patent portfolios of potential interest include those who have a high average technical breadth based on the technical categories for this technology. The complete list for all tier 2 entities is located in the corresponding excel work sheet. **Stora Enso Oy** (Finland) is the stand out performer of the top tier 2 entities shown.

Top Tier 2 Entities – Technical Breadth Vs Filing Breadth

Tier 2 Entity	Average of Filing Breadth (Based on Family Member Countries)	Average of Technical Breadth (Based on Technical Categories)	Total Inventions
Kureha Corp	2.3	8.5	97
Unitika	1.7	7.7	88
Asahi Kasei Kk	1.2	6.2	76
Du Pont De Nemours & Co E I	4.5	9.3	62
Toyo Ink Mfg Co Ltd	1.7	7.7	61
Oji Kako Kk	1.0	7.8	51
Showa Denko	1.4	8.0	58
Grace & Co W R	8.3	7.5	46
Curwood Inc	4.9	9.1	40
Kraft Foods Global Brands Llc	5.8	7.6	40
Nippon Synthetic Chem Ind Co Ltd	1.6	7.2	40
Basf Ag	5.1	9.2	38
Nestec S.A.	7.3	7.7	37
Semiconductor Energy Lab	2.5	6.6	37
Ajinomoto Co Inc	1.2	6.6	36
Multisorb Technologies Inc	8.8	8.6	35
Dow Corning Corp	6.2	7.2	34
Eastman Chem Co	4.9	8.9	34
Honeywell Int Inc	3.9	9.5	34
Idemitsu Petrochem Co	1.7	7.4	33
Nippon Zeon Kk	1.8	8.0	33
Sonoco Dev Inc	3.9	7.8	31
Amcor Limited	3.5	9.4	30
Nippon Seishi Kk	1.1	8.9	30
Otsuka Seiyaku Kogyo Kk	3.3	6.0	30
Hoechst Ag	5.7	8.2	29
Daicel Pack Systems Kk	1.3	8.0	28
Alcan Global Pharm Packaging Inc	5.5	9.3	26
Chevron Chem Co	5.0	9.3	26
Flexopack Plastics Ind Sa	2.8	8.2	26
Korea Food Res Inst	1.2	7.0	26
Kyodo Printing Co Ltd	2.0	7.0	25
Stora Enso Oy	5.8	11.0	24
Kao Corp	1.8	6.3	22
Sekisui Chem Co Ltd	1.7	5.9	22
Fuji Film Co Ltd	2.3	6.5	21
Qp Corp	1.4	6.2	21
Tokuyama Corp	1.4	5.9	21
Univ Jiangnan	1.0	7.6	21

ACADEMIC AND GOVERNMENT ENTITIES (all tiers)

The following table highlights the top academic and government entities across all entity tiers of the patent data. Academic and government entities comprise only 7% of all patent data associated with this technology. This shows that corporate entities (comprising 75% of the patent data) have a high interest in this technology and in general, have invested heavily in it. The **Korea Food Research Institute** (South Korea) is the stand out performer for the academic and government sector closely followed by the **University of Jiangnan** (China).

Academic & Government Entities (all tiers)

Academic and Government Entities	Inventions
Korea Food Res Inst	26
Univ Jiangnan	21
Univ Shanghai Maritime	17
Fraunhofer Ges Foerderung Angewandten	14
Dokuritsu Gyosei Hojin Sangyo Gijutsu So	13
Beijing Graphic Communication Inst	12
Commonwealth Sci & Ind Res Org	12
Seikatsu Kyodo Kumiai Coop Sap	11
Univ China Agric	11
Univ Zhejiang Ocean	11
CAS	10
Nat Eng Technology Res Cent	10
Inst Agro Food Sci & Technology Chinese	9
Rural Dev Administration	9
Valtion Teknillinen Tutkimuskeskus	9
Sapporo Coop	8
Univ Nanjing Agric	8
Univ Xian Technology	8
Univ Yonsei Ind Acad Coop Found	8
Univ Zhejiang Gongshang	8
Univ South China Agric	7
Tianjin Food Eng Cent	6
Univ Dongguk Ind Acad Coop Found	6
Univ South China Technology	6
Univ Tianjin Sci & Technology	6
Zhejiang Agric Sci Acad	6
Marine Fishery Inst Zhejiang Province	5
Nat Inst Advanced Ind Sci & Technology	5
Univ Fujian Agric & Forestry	5
Univ Henan Sci & Technology	5
Univ Kunming Sci & Technology	5
Univ Shandong Agric	5
Univ Shanghai Ocean	5
Univ Zhejiang	5

TIER 3 ENTITIES (1 - 9 INVENTIONS) **AND INDIVIDUALS**

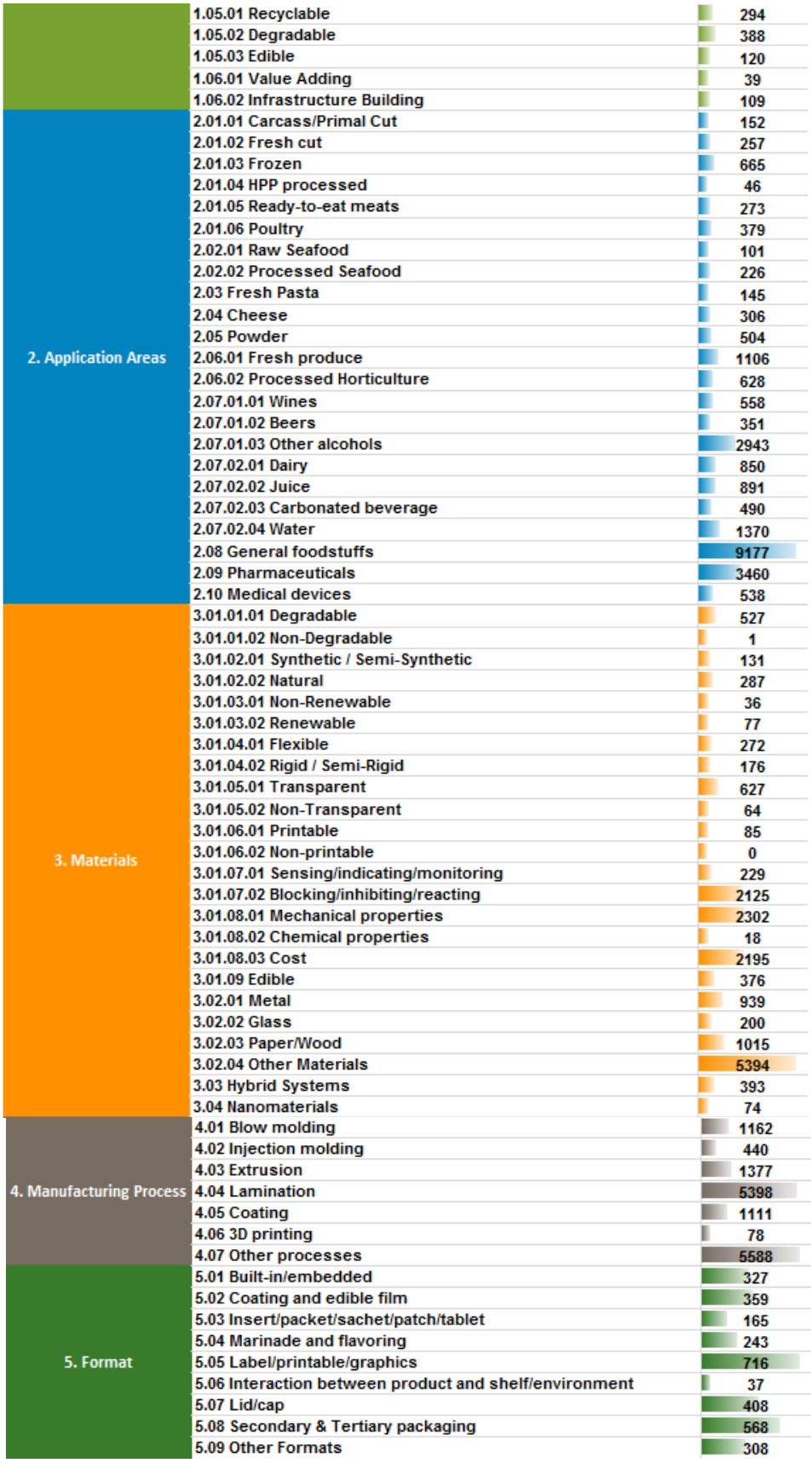
Due to the small number of patents associated with tier 3 entities and Individuals in the data set, constructing meaningful patent metrics around such small patent numbers is difficult and has not been undertaken. The patent records associated with these entities and individuals can be viewed in the accompanying cleaned 'raw' data with this report.

PATENT TECHNICAL ANALYSIS

This chapter of the report focuses on the technical attributes of the inventions in the collection. The patent documents in the collection were aggregated into the following technical categories.

Taxonomy – Technology Categories

	Technical Categories	Inventions
1. Function / Technical Features	1.01.01.01 Microbial growth sensor	219
	1.01.01.02.01 Anti-microbial agent	108
	1.01.01.02.02 Enzyme based microbial inactivation	23
	1.01.01.02.03 Other Anti-microbial systems	256
	1.01.02.01.01 Oxygen sensor	809
	1.01.02.01.02 Oxygen scavenging	4497
	1.01.02.01.03 Anti-oxidation systems	552
	1.01.02.02.01 Ethylene sensor	54
	1.01.02.02.02 Ethylene scavenging	877
	1.01.02.03 Other gases of interest	4612
	1.01.02.04.01 Low oxygen (or anoxic) packaging	983
	1.01.02.04.02 High oxygen packaging	260
	1.01.02.04.03 Vacuum packaging	907
	1.01.02.04.04 Other Modified/Controlled atmosphere packaging	1129
	1.01.03.01 Temperature sensor	1019
	1.01.03.02 Thermostatic packaging	32
	1.01.03.03 Self-heating/Self-cooling	539
	1.01.04.01 UV blockage	177
	1.01.04.02 Light barrier	387
	1.01.05.01 Moisture sensor	949
	1.01.05.02.01 Moisture barrier	3044
	1.01.05.02.02 Moisture content or humidity maintenance	1532
	1.01.06.01 Odor absorbing	76
	1.01.06.02 Flavor releasing	25
	1.01.07 Corrosion inhibition	113
	1.01.08 Integrity sensor	72
	1.01.09 Freshness sensor	430
	1.01.10 Eating profile enhancement	141
	1.01.11 Migration prevention	97
	1.01.12 Pathogens/microbial spoilage	66
	1.02.01 Temperature sensor	1021
	1.02.02 Physical shock/motion sensor	127
	1.02.03 Other environmental factors	690
	1.03.01 Tamper-proof	99
	1.03.02.01 Near field communication enabled	63
	1.03.02.02 RFID tags	818
	1.03.02.03 Printable electronics	90
	1.03.02.04 QR code	746
	1.03.03 Electronic article surveillance	29
	1.03.04 Wireless communication network	355
	1.03.05 Augmented reality	39
	1.03.06 Environment sensing and responding	2
	1.04.01 Easy opening of food packs	155
	1.04.02 Easy dispensing	17
	1.04.03 Portioning/sizing	6
	1.04.04 Resealable	87
	1.04.05 Cook within package	574
	1.04.06 On-the-go enabling	345


1.05.01 Recyclable 294
1.05.02 Degradable 388
1.05.03 Edible 120
1.06.01 Value Adding 39
1.06.02 Infrastructure Building 109
2. Application Areas
2.01.01 Carcass/Primal Cut 152
2.01.02 Fresh cut 257
2.01.03 Frozen 665
2.01.04 HPP processed 46
2.01.05 Ready-to-eat meats 273
2.01.06 Poultry 379
2.02.01 Raw Seafood 101
2.02.02 Processed Seafood 226
2.03 Fresh Pasta 145
2.04 Cheese 306
2.05 Powder 504
2.06.01 Fresh produce 1106
2.06.02 Processed Horticulture 628
2.07.01.01 Wines 558
2.07.01.02 Beers 351
2.07.01.03 Other alcohols 2943
2.07.02.01 Dairy 850
2.07.02.02 Juice 891
2.07.02.03 Carbonated beverage 490
2.07.02.04 Water 1370
2.08 General foodstuffs 9177
2.09 Pharmaceuticals 3460
2.10 Medical devices 538
3. Materials
3.01.01.01 Degradable 527
3.01.01.02 Non-Degradable 1
3.01.02.01 Synthetic / Semi-Synthetic 131
3.01.02.02 Natural 287
3.01.03.01 Non-Renewable 36
3.01.03.02 Renewable 77
3.01.04.01 Flexible 272
3.01.04.02 Rigid / Semi-Rigid 176
3.01.05.01 Transparent 627
3.01.05.02 Non-Transparent 64
3.01.06.01 Printable 85
3.01.06.02 Non-printable 0
3.01.07.01 Sensing/indicating/monitoring 229
3.01.07.02 Blocking/inhibiting/reacting 2125
3.01.08.01 Mechanical properties 2302
3.01.08.02 Chemical properties 18
3.01.08.03 Cost 2195
3.01.09 Edible 376
3.02.01 Metal 939
3.02.02 Glass 200
3.02.03 Paper/Wood 1015
3.02.04 Other Materials 5394
3.03 Hybrid Systems 393
3.04 Nanomaterials 74
4. Manufacturing Process
4.01 Blow molding 1162
4.02 Injection molding 440
4.03 Extrusion 1377
4.04 Lamination 5398
4.05 Coating 1111
4.06 3D printing 78
4.07 Other processes 5588
5. Format
5.01 Built-in/embedded 327
5.02 Coating and edible film 359
5.03 Insert/packet/sachet/patch/tablet 165
5.04 Marinade and flavoring 243
5.05 Label/printable/graphics 716
5.06 Interaction between product and shelf/environment 37
5.07 Lid/cap 408
5.08 Secondary & Tertiary packaging 568
5.09 Other Formats 308

The technical categories are not mutually exclusive – multiple categories can be applied to a single invention if warranted. The technical categorisation is performed using keywords and various patent classifications (IPC, CPC, ECLA, and Derwent Manual Codes) to separate the patent documents in the collection into groups.

Smart packaging technology has been split into 5 broad categories which include the following:

1. **Function / Technical Features**
2. **Application Areas**
3. **Materials**
4. **Manufacturing Process**
5. **Format**

The 5 broad categories were then separated further into 116 distinct sub-categories which aim to better segregate and define the technology appearing in the dataset.

Breaking the technology categories down broadly, technology associated with the **function of technical features** of smart packaging technology was highest in reference to **oxygen savaging** (category 1.01.02.01.02) and '**other' gases of interest** (category 1.01.02.03) which included any gas not already highlighted in other categories.

For the **application area**, technology directed to **general foodstuffs** (category 2.08) was the most populated technology area in the dataset with technology directed toward **pharmaceutica**l applications (category 2.09) coming in a distant second.

It terms of **materials**, patent technology directed toward **other materials** technology (category 3.02.04) not already highlighted in other materials categories was the most highly populated.

Manufacturing processes involving **lamination** (category 4.04) was the most populated category in relation to smart packaging technology. **Other manufacturing process** technologies (category 4.07) not specifically highlighting technology appearing in the remaining manufacturing process classifications also was highly populated.

Finally, in relation to **format**, the most active technology areas included those incorporating **label / printable / graphics** (category 5.05). Technology associated with the technology format was generally lower than appeared in the other broad categories.

TIMELINE

The table below shows the timelines of filing activity for all entities together with the percentage filed since 2009.

Technology Category Timeline and Technology Category Growth Rate

	Technical Categories	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Compound Annual Growth Rate (2003-2014)	% Filed from 2009
1. Function / Technical Features	1.01.01.01 Microbial growth sensor	5	4	12	5	3	7	8	5	14	7	12	10	13	10	10	10	10	35	17	15	7	1%	47%
	1.01.01.02.01 Anti-microbial agent	1		2	5	3	2	6	11	4	5	7	5	12	7	4	9	7	4	9	4	1	0%	35%
	1.01.01.02.02 Enzyme based microbial inactivation		2	1	1		2	1	1		2	1		3	1		1		2	1	2	2	-	35%
	1.01.01.02.03 Other Anti-microbial systems	5	1	9	11	11	7	17	20	11	10	12	16	22	14	9	15	16	14	17	15	4	3%	35%
	1.01.02.01.01 Oxygen sensor	23	31	30	42	31	31	46	25	46	44	62	50	41	34	41	44	60	38	40	27	23	-5%	34%
	1.01.02.01.02 Oxygen scavenging	142	158	189	208	203	220	262	295	293	279	311	263	233	200	211	169	246	202	220	151	42	-6%	28%
	1.01.02.01.03 Anti-oxidation systems	14	19	17	22	18	30	32	19	19	25	58	31	28	32	39	15	23	25	34	31	21	5%	34%
	1.01.02.02.01 Ethylene sensor	3	2	3	3	2	2	3	3	2	1	2	2	3	2	5	2	1	2	4	5	2	9%	39%
	1.01.02.02.02 Ethylene scavenging	20	19	23	31	37	58	54	62	55	45	45	54	49	33	48	43	38	34	57	49	23	-1%	33%
	1.01.02.03 Other gases of interest	123	132	190	232	246	222	263	311	312	252	287	249	220	181	195	220	224	249	238	189	77	-4%	30%
	1.01.02.04.01 Low oxygen (or anoxic) packaging	21	32	44	37	50	51	51	73	52	78	68	51	46	52	46	43	59	44	44	32	9	-4%	28%
	1.01.02.04.02 High oxygen packaging	1	12	8	18	10	11	21	14	15	15	18	13	16	10	14	8	16	11	15	6	8	-8%	30%
	1.01.02.04.03 Vacuum packaging	16	18	17	32	26	28	28	32	47	35	39	44	32	55	41	62	72	113	85	53	32	1%	50%
	1.01.02.04.04 Other Modified/Controlled atmosphere packaging	23	26	25	34	35	32	40	35	40	35	50	44	46	30	39	69	108	176	117	75	50	6%	56%
	1.01.03.01 Temperature sensor	7	6	12	23	26	27	21	30	26	44	66	53	45	52	47	35	91	93	105	112	98	14%	57%
	1.01.03.02 Thermostatic packaging					1			2						2	1	3	1	5	6	8	3	-	84%
	1.01.03.03 Self-heating/Self-cooling	3	5	7	3	18	15	21	13	11	13	14	23	34	17	27	43	50	63	50	62	47	17%	63%
	1.01.04.01 UV blockage		2	6	8	3	8	8	10	14	12	6	14	10	8	12	6	11	15	10	10	4	-3%	38%
	1.01.04.02 Light barrier	2	6	11	18	15	16	24	26	26	23	18	24	26	17	27	18	23	16	19	23	9	-1%	35%
	1.01.05.01 Moisture sensor	12	13	18	28	25	22	39	50	45	49	57	46	50	59	48	40	68	70	83	71	56	4%	46%
	1.01.05.02.01 Moisture barrier	66	61	94	129	128	119	195	200	236	159	176	195	162	136	141	141	181	155	189	144	37	-4%	32%
	1.01.05.02.02 Moisture content or humidity maintenance	20	24	50	40	62	44	67	74	77	74	82	80	96	66	77	79	118	102	120	113	67	4%	44%
	1.01.06.01 Odor absorbing		4	3	1	6	4	4	5	3	3	6	3	3	7	3	3	4	3	7	4		3%	32%
	1.01.06.02 Flavor releasing			1			1	2	2	2				3	2	3	1		2	1	4	1	7%	48%
	1.01.07 Corrosion inhibition	1	2	2	2		2	6	7	4	4	4	5	6	8	6	4	7	20	6	13	4	11%	53%
	1.01.08 Integrity sensor	1	1	2	4	2	4	2	1	4	8	8	5	6	5	4	3	5	1	3	3		-3%	26%
	1.01.09 Freshness sensor	6	2	9	9	12	15	5	8	11	12	10	53	23	20	21	23	30	43	40	45	33	14%	55%
	1.01.10 Eating profile enhancement	4	5		4	4		6	3	6	2	3	8	7	8	5	10	13	15	20	11	7	6%	57%
	1.01.11 Migration prevention	2	3	4	3	2	1	3	5	8	7	5	4	2	5	4	10	9	9	3	5	3	-4%	44%
	1.01.12 Pathogens/microbial spoilage	4	1	4	1	2	3	1	1	3	4	3	3	1	3	3	3	10	10	1	4	1	3%	48%
	1.02.01 Temperature sensor	7	6	12	23	26	27	21	30	26	44	66	53	45	52	47	35	92	94	105	112	98	14%	57%
	1.02.02 Physical shock/motion sensor			3	5	3	5	5	3	7	7	13	9	3	3	9	5	8	7	10	15	7	7%	48%
	1.02.03 Other environmental factors	13	11	17	30	25	20	26	27	21	32	46	23	42	31	28	40	52	55	57	52	42	9%	47%
	1.03.01 Tamper-proof	3	2	1	4	2	4	3	7	4	9	5	4	5	2	6	9	6	4	5	13	1	11%	44%
	1.03.02.01 Near field communication enabled					1	1		2	2	2	3	5	4	4	1	1	3	8	9	9	8	15%	62%
	1.03.02.02 RFID tags			4	2	4	8	4	14	33	58	69	80	59	70	61	59	62	80	54	72	25	7%	50%
	1.03.02.03 Printable electronics	1					2		5	4	9	7	5	1	5	6	6	11	8	6	11	3	10%	57%
	1.03.02.04 QR code	6	12	20	15	23	28	26	39	47	40	45	47	32	35	32	42	66	69	66	40	16	-1%	44%
	1.03.03 Electronic article surveillance						4		2	2	6	5		1	1	2	2	1	3				-100%	28%
	1.03.04 Wireless communication network		1	1	2	2	11	14	11	18	23	28	21	13	21	15	15	20	46	31	35	27	6%	53%
	1.03.05 Augmented reality								1	2	1	2	2	2	1	1	4	4	2	6	8	3	13%	72%
	1.03.06 Environment sensing and responding	1																1					-	50%
	1.04.01 Easy opening of food packs	2	2	1	5	12	3	6	8	11	6	12	8	12	14	6	9	14	8	9	2	5	-14%	34%
	1.04.02 Easy dispensing	1						1	1	1	2	2	1		1	2		1		2	2		7%	41%
	1.04.03 Portioning/sizing							1				1	1			1	1		1				-	50%
	1.04.04 Resealable	1	2	2	1	3	6		7	5	7	6	11	5	5	4	10	4	2	2	4		-2%	30%
	1.04.05 Cook within package	12	12	11	22	20	16	25	22	26	25	31	28	31	28	25	28	47	50	41	46	28	5%	46%
	1.04.06 On-the-go enabling	2	2	8	5	9	12	12	8	16	15	18	16	20	27	20	27	33	28	37	18	12	1%	51%
	1.05.01 Recyclable	3	3	10	11	22	22	21	18	13	16	19	6	15	9	7	22	26	22	20	7	2	-5%	36%
	1.05.02 Degradable	4	10	9	14	13	11	19	20	14	14	17	17	27	20	27	29	33	33	29	19	9	3%	46%
	1.05.03 Edible		1	6	8	1	8	1	5	6	3	1	10	5	5	10	7	13	7	6	9	8	4%	50%
	1.06.01 Value Adding	1	1		3	1	1			2	1	2		6	1	3	2	1	2	6	4	2	7%	51%
	1.06.02 Infrastructure Building			1			4	2	2	4	7	7	7	6	6	3	13	7	16	7	13	4	11%	58%
2. Application Areas	2.01.01 Carcass/Primal Cut	2	3	7	7	6	2	7	6	10	9	6	10	5	7	5	8	9	15	7	15	6	4%	43%
	2.01.02 Fresh cut	4	2	6	5	7	4	8	17	17	16	11	9	11	14	8	14	21	32	23	18	10	1%	49%
	2.01.03 Frozen	9	17	22	16	23	19	30	28	28	39	51	43	42	36	26	28	37	59	45	49	18	5%	39%
	2.01.04 HPP processed			2		3	1	1	2	4	2	2	1	2	3	1	4	3	3	7	5		2%	50%
	2.01.05 Ready-to-eat meats	6	7	10	11	8	10	6	13	19	16	17	10	18	13	9	15	23	24	14	17	7	-1%	40%
	2.01.06 Poultry	5	6	17	13	12	13	19	20	18	20	33	20	18	23	16	27	20	21	26	23	9	2%	37%
	2.02.01 Raw Seafood	2	3	2	4	4	4	5	7	13	5	2	5	1	6	3	4	6	8	8	2	7	-16%	38%
	2.02.02 Processed Seafood	1	4	6	12	9	11	9	12	22	6	9	9	7	12	5	10	22	24	14	13	9	-5%	43%
	2.03 Fresh Pasta	3	1	5	3	4	10	8	7	9	4	9	8	8	7	11	3	15	9	13	6	2	-4%	41%
	2.04 Cheese	11	7	6	11	9	9	22	17	27	22	23	23	17	20	16	15	9	16	12	8	6	-10%	27%
	2.05 Powder	3	14	11	13	16	14	15	25	20	18	16	21	23	31	38	31	38	38	52	35	32	5%	52%
	2.06.01 Fresh produce	18	17	30	31	47	31	38	52	47	45	33	67	72	60	41	50	77	107	90	92	61	6%	47%
	2.06.02 Processed Horticulture	5	7	8	10	11	18	9	33	35	28	30	41	29	40	33	30	44	54	63	69	31	6%	52%
	2.07.01.01 Wines	5	15	7	13	4	17	14	20	23	25	25	24	26	21	23	41	62	74	47	53	19	8%	57%
	2.07.01.02 Beers	5	8	3	17	14	26	18	23	30	22	28	20	18	9	22	23	16	12	23	13	1	-7%	31%
	2.07.01.03 Other alcohols	66	69	90	125	129	153	158	194	215	158	175	185	164	123	143	137	165	153	169	134	38	-4%	32%
	2.07.02.01 Dairy	11	12	23	13	17	31	35	48	46	44	53	56	51	48	46	52	59	46	53	51	55	1%	43%
	2.07.02.02 Juice	20	17	26	36	26	32	33	62	55	46	59	59	53	36	43	53	48	49	57	60	21	1%	37%
	2.07.02.03 Carbonated beverage	8	12	19	19	13	23	19	38	35	29	33	26	31	28	22	25	24	18	40	23	5	-4%	32%
	2.07.02.04 Water	21	25	44	50	43	47	53	62	85	72	63	61	71	69	64	78	102	105	102	88	65	0%	44%
	2.08 General foodstuffs	210	206	277	350	360	373	464	515	544	460	530	546	453	443	448	484	581	646	595	496	196	-1%	38%
	2.09 Pharmaceuticals	63	62	80	115	129	133	181	199	244	227	260	245	214	177	153	172	203	177	220	146	60	-5%	33%
	2.10 Medical devices	2	9	11	16	16	10	20	18	31	39	52	33	36	53	32	24	35	24	35	31	11	0%	36%

	Technical Categories	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Compound Annual Growth Rate (2003-2014)	% Filed from 2009
3. Materials	3.01.01.01 Degradable	5	11	3	17	9	18	21	23	33	29	25	42	39	39	40	35	33	26	46	20	13	-4%	40%
	3.01.01.02 Non-Degradable														1								-	0%
	3.01.02.01 Synthetic / Semi-Synthetic	1	1	8	5	2	5	8	12	10	2	5	7	7	9	3	5	9	10	15	6	1	-5%	37%
	3.01.02.02 Natural	2	4	2	6	5	7	10	10	14	10	11	22	18	13	14	16	20	21	50	21	11	4%	53%
	3.01.03.01 Non-Renewable				1	1	2	1		1		4	1	1	3	3	3	6	7	1	1		0%	58%
	3.01.03.02 Renewable	1	2				2	3		1	3	3	4	8	6	8	5	8	9	9	5		16%	57%
	3.01.04.01 Flexible	10	3	8	6	5	6	12	11	6	10	14	17	9	15	13	23	29	20	31	16	8	9%	51%
	3.01.04.02 Rigid / Semi-Rigid	6	4	6	6	7	5	10	5	8	7	5	6	5	8	13	10	13	12	27	9	4	1%	50%
	3.01.05.01 Transparent	11	12	14	29	34	28	27	22	39	33	42	36	31	25	29	25	48	44	47	36	15	-1%	39%
	3.01.05.02 Non-Transparent	4	1	1	3	3	3	2	1	3	5	3	3	3	4	1	3	6	4	5	4	2	3%	39%
	3.01.06.01 Printable	2	1	2		2	4	5	7	9	8	4	4	3	5		8	4	4	4	2	7	-13%	34%
	3.01.06.02 Non-printable																						-	0%
	3.01.07.01 Sensing/indicating/monitoring		4	7	10	9	6	2	4	11	6	11	9	3	5	13	21	34	20	34	13	7	2%	62%
	3.01.07.02 Blocking/inhibiting/reacting	35	39	62	100	87	92	116	113	143	112	119	117	88	79	84	112	150	151	180	118	28	-2%	39%
	3.01.08.01 Mechanical properties	47	60	73	113	93	105	122	137	155	135	141	130	124	123	104	88	142	123	142	109	36	-3%	32%
	3.01.08.02 Chemical properties							1			1	1	1				1	1	2	5	4	1	-	78%
	3.01.08.03 Cost	41	35	45	83	63	58	92	121	89	115	103	114	120	135	149	160	171	180	143	134	44	4%	45%
	3.01.09 Edible	6	6	4	17	8	14	13	21	30	15	11	30	20	16	19	19	21	25	52	21	8	-3%	44%
	3.02.01 Metal	12	12	23	34	39	22	38	37	52	40	45	51	59	43	40	64	77	89	65	69	28	3%	46%
	3.02.02 Glass	3	1	3	4	4	5	9	5	13	11	9	18	12	20	10	10	16	20	11	12	4	-1%	42%
	3.02.03 Paper/Wood	20	17	22	30	33	32	36	46	48	35	46	78	56	54	47	62	62	83	91	73	44	4%	46%
	3.02.04 Other Materials	118	122	145	191	207	225	282	331	340	259	294	284	260	209	238	273	368	410	403	307	128	-1%	39%
	3.03 Hybrid Systems	6	10	16	15	12	16	11	25	15	14	19	16	15	14	20	14	31	26	39	32	27	7%	48%
	3.04 Nanomaterials		1		1	4	2	1	1	1	4	8	6	4	8	3	4	4	4	7	4	7	13%	45%
4. Manufacturing Process	4.01 Blow molding	34	38	54	66	67	60	68	73	59	83	78	71	61	50	66	46	57	46	53	26	6	-7%	26%
	4.02 Injection molding	11	11	13	28	21	13	25	32	16	45	28	30	33	11	16	20	33	15	20	17	2	1%	28%
	4.03 Extrusion	27	30	54	68	60	68	71	86	74	84	89	79	84	54	68	62	68	65	86	66	34	-1%	33%
	4.04 Lamination	132	143	201	279	255	265	329	387	380	321	346	330	291	245	231	227	273	232	273	203	55	-6%	28%
	4.05 Coating	23	26	30	51	48	58	68	78	80	45	61	74	69	57	41	57	56	66	52	52	19	-4%	31%
	4.06 3D printing	2			1	2	2	4	2	3	3	2	6	9	11	3	5	5	4	6	6	2	7%	40%
	4.07 Other processes	113	119	179	235	210	195	243	280	317	284	342	308	312	257	289	317	368	383	416	290	131	-1%	39%
5. Format	5.01 Built-in/embedded	5	10	5	10	7	10	9	8	9	19	27	31	14	18	20	17	26	25	24	22	11	8%	44%
	5.02 Coating and edible film	4	14	13	20	14	21	23	20	19	14	18	25	19	16	19	16	21	23	18	16	6	-2%	33%
	5.03 Insert/packet/sachet/patch/tablet	3	8	2	3	5	6	7	8	6	5	7	11	9	3	12	11	11	18	12	16	2	9%	50%
	5.04 Marinade and flavoring	4	5	6	3	7	9	10	27	11	7	10	9	15	14	13	11	17	19	19	23	4	7%	44%
	5.05 Label/printable/graphics	2	1	5	6	8	13	10	13	34	55	63	68	51	63	49	41	50	62	46	59	17	5%	45%
	5.06 Interaction between product and shelf/environment	1		1		4	1		1	1	1	4	2	1		2	2	10	3	2	1		0%	54%
	5.07 Lid/cap	8	7	6	7	9	9	10	17	18	23	14	19	26	23	40	25	34	30	21	44	18	8%	52%
	5.08 Secondary & Tertiary packaging	14	7	16	27	23	12	15	37	23	29	42	42	38	30	25	24	52	28	44	28	12	2%	38%
	5.09 Other Formats	3	7	3	4	6	9	9	17	11	11	21	13	17	22	21	13	28	25	27	31	10	10%	50%

Technology within the dataset which has achieved the highest growth in terms of new patent filings from the 2003 – 2014 periods include technical features associated with **self-heating / self-cooling** (category 1.01.03.03), **near field communication** enabled features (category 1.03.02.01) and **renewable materials** (category 3.01.03.02), all which achieved between 15% – 17% growth in this period. This shows that there is the perception that there is potentially a growing need for technology of this kind within the smart packaging technology field and entities are filing increased amount of patents based on this perceived need.

Any technology appearing in the dataset which has a negative growth rate indicates technologies which are transitioning to a lesser perceived relevance to entities in the dataset. These technologies may be redundant, have been superseded or perhaps have no real viable technology solution yet. A good example are technical features related to **electronic article surveillance** (category 1.03.03), which has a high negative growth rate (-100%), the highest in the dataset. It should be noted that this technology has a low number of filings in general, which could also indicate the technology hasn't been perfected as yet or perhaps has no perceived commercial viability in the marketplace.

We can obtain a good understanding on what technologies are potentially emerging or those technologies in which there is a recent perceived commercial importance. These are the technologies in which the bulk of the patent filing has occurred recently (% filed from 2009). Technical features relating to **thermostatic packaging** (category 1.01.03.02), **augmented reality** (1.03.05) and materials which have **chemical properties** (3.04.08.02) all recorded high rates of recent patent filing, all over 72%.

TIER 1 – TECHNICAL CATEGORISATION

The table below shows the technology categorisation of all patent portfolios of tier 1 entities. Totals that are highlighted in the 'darker' shade of blue reveal entities which have high activity in a technical category. For example, **Toppan Printing** (Japan) has the highest activity recorded in the function / technical feature category related to **other gases of interest** (558 inventions). Categories shown in the table that are blank have no results. For example, none of the top tier 1 entities have inventions related to **enzyme based microbial inactivation** (category 1.01.01.02.02) in terms of function / technical feature.

Tier 1 Entities by Technical Category

	Technical Categories	Toppan Printing	Mitsubishi	DIC Corp	Sumitomo Group	Sealed Air	Toyobo Group	Toyo Seikan Group	Kuraray	Tetra Pak	Mitsui Chemicals	Toray Industries
1. Function / Technical Features	1.01.01.01 Microbial growth sensor	1	1						1			
	1.01.01.02.01 Anti-microbial agent		1	1		2		1				2
	1.01.01.02.02 Enzyme based microbial inactivation											
	1.01.01.02.03 Other Anti-microbial systems	2	1	1	3	2	2	3		2	2	4
	1.01.02.01.01 Oxygen sensor	51	27	12	7	58	3	5	7	14	4	2
	1.01.02.01.02 Oxygen scavenging	239	413	226	11	176	9	141	89	79	41	39
	1.01.02.01.03 Anti-oxidation systems	5	25	3	8	18	23	7	6	2	2	1
	1.01.02.02.01 Ethylene sensor	1	1			1	1		4			
	1.01.02.02.02 Ethylene scavenging	21	26	27	17	55	6	3	26	14	7	13
	1.01.02.03 Other gases of interest	558	321	325	114	57	154	66	126	76	86	77
	1.01.02.04.01 Low oxygen (or anoxic) packaging	5	113	37	24	39	29	28	2	11	1	4
	1.01.02.04.02 High oxygen packaging	2	17	7	11	13		5	2	1	1	1
	1.01.02.04.03 Vacuum packaging	1	1	7	13	37	1		14		1	3
	1.01.02.04.04 Other Modified/Controlled atmosphere packaging	5	4	2	23	37			1	3		
	1.01.03.01 Temperature sensor	13	5	5	3	12	17	3	1	3		2
	1.01.03.02 Thermostatic packaging											
	1.01.03.03 Self-heating/Self-cooling	4	1	1		1			1			
	1.01.04.01 UV blockage	16	4	14	1	3			2		3	
	1.01.04.02 Light barrier	51	11	28	6	2	2	2	2	13	7	3
	1.01.05.01 Moisture sensor	47	26	1	1	4	25	4	7	5	2	1
	1.01.05.02.01 Moisture barrier	351	98	259	58	3	79	27	46	34	52	62
	1.01.05.02.02 Moisture content or humidity maintenance	79	65	58	19		28	3	13	11	1	6
	1.01.06.01 Odor absorbing	9	14	1	4	2		6	1		1	
	1.01.06.02 Flavor releasing		1		1						1	
	1.01.07 Corrosion inhibition		5	2						1		
	1.01.08 Integrity sensor		1			2	1			1		
	1.01.09 Freshness sensor	1			3	9					8	
	1.01.10 Eating profile enhancement					1	1	1	1			
	1.01.11 Migration prevention	3	2		1	5		2			1	1
	1.01.12 Pathogens/microbial spoilage					1						
	1.02.01 Temperature sensor	13	5	5	3	12	17	3	1	3		2
	1.02.02 Physical shock/motion sensor	3		1		1	1	2		1	1	
	1.02.03 Other environmental factors	1	7	6	6	17	11			2	2	2
	1.03.01 Tamper-proof	2		2		1						
	1.03.02.01 Near field communication enabled		1					2				
	1.03.02.02 RFID tags	3	3	5		3		3				
	1.03.02.03 Printable electronics	1		2		2					3	
	1.03.02.04 QR code	9	3	13	2	5		3		4		
	1.03.03 Electronic article surveillance	1				1						
	1.03.04 Wireless communication network	1	1	1				4		1		1
	1.03.05 Augmented reality											
	1.03.06 Environment sensing and responding											
	1.04.01 Easy opening of food packs	7	6	5	6	13	4	3		1	2	
	1.04.02 Easy dispensing											
	1.04.02 Easy dispensing											
	1.04.03 Portioning/sizing											
	1.04.04 Resealable	8		1	1	1		1				
	1.04.05 Cook within package	9	13	16	6	2	1	1	2	2		
	1.04.06 On-the-go enabling	11	16	8	1	5	1	3	2	2	1	
	1.05.01 Recyclable	14	4	1	5	3		5		3		
	1.05.02 Degradable	23	11	17	5	4		2	3	4	3	4
	1.05.03 Edible	1	11	1				3	2			
	1.06.01 Value Adding	1										
	1.06.02 Infrastructure Building							1			1	

	Technical Categories	Toppan Printing	Mitsubishi	DIC Corp	Sumitomo Group	Sealed Air	Toyobo Group	Toyo Seikan Group	Kuraray	Tetra Pak	Mitsui Chemicals	Toray Industries
2. Application Areas	2.01.01 Carcass/Primal Cut				3							
	2.01.02 Fresh cut			7								
	2.01.03 Frozen	4	11	25	2	1	18	1	1	1		1
	2.01.04 HPP processed	6	3	1				1			1	
	2.01.05 Ready-to-eat meats	3	14	5		23		3				
	2.01.06 Poultry		11	2	1	48						
	2.02.01 Raw Seafood							6				
	2.02.02 Processed Seafood	2	4	2		7	1	7			1	
	2.03 Fresh Pasta	2	1	2		5		4				
	2.04 Cheese	9	17	2		3	1		2	2		1
	2.05 Powder	9	35	9	2	2		3	2	1		1
	2.06.01 Fresh produce	5	9	2	5	2	2	4		1	13	1
	2.06.02 Processed Horticulture	2	23	7	14	1		35	3	5	1	
	2.07.01.01 Wines	4	15	6		6		32	3	17		
	2.07.01.02 Beers		13	7	1	9		38	4	4		
	2.07.01.03 Other alcohols	243	98	183	69	19	56	58	115	42	36	33
	2.07.02.01 Dairy	12	55	18	3	5		4	4	34	1	
	2.07.02.02 Juice	28	63	36	4	1	2	48	1	41		
	2.07.02.03 Carbonated beverage	8	38	11	2	5	1	42	7	6	1	
	2.07.02.04 Water	55	33	56	29	8	19	14	9	11	8	6
	2.08 General foodstuffs	634	477	361	19	165	173	13	121	113	93	82
	2.09 Pharmaceuticals	495	275	234	52	4	96	66	56	1	49	37
	2.10 Medical devices	19	15	11	4	9	25	4	13		8	1
3. Materials	3.01.01.01 Degradable	36	7	17	8	13	1	3	1	9	5	19
	3.01.01.02 Non-Degradable											
	3.01.02.01 Synthetic / Semi-Synthetic	2	2	1	3					2		1
	3.01.02.02 Natural	23	2	7		4			3	8		3
	3.01.03.01 Non-Renewable	2	2		3				1		2	
	3.01.03.02 Renewable			1	1					3		2
	3.01.04.01 Flexible	4	12	15	1	5		2	7	1		
	3.01.04.02 Rigid / Semi-Rigid	2	3	1		6	4		1	6	1	1
	3.01.05.01 Transparent	11	31	22	14	16	2	13	1	5	8	14
	3.01.05.02 Non-Transparent	1	4		1	1		3	1		1	
	3.01.06.01 Printable	9	6	3	1	3				2		1
	3.01.06.02 Non-printable											
	3.01.07.01 Sensing/indicating/monitoring	7	11	4	5	7	1	1	6	2	1	1
	3.01.07.02 Blocking/inhibiting/reacting	25	133	127	37	83	28	48	55	59	34	32
	3.01.08.01 Mechanical properties	167	18	155	52	66	78	31	36	39	31	31
	3.01.08.02 Chemical properties											
	3.01.08.03 Cost	75	79	38	27	16	26	23	5	34	8	18
	3.01.09 Edible	32	4	7	14	5		7	4	14		2
	3.02.01 Metal	79	4	34	7	7	13	15	8	11	6	8
	3.02.02 Glass	4	13	1		1		3		1		
	3.02.03 Paper/Wood	57	1	28	5	8	2	7	14	41	5	1
	3.02.04 Other Materials	523	32	288	123	78	95	87	93	97	63	55
	3.03 Hybrid Systems	27	17	3	1	1			4	1	2	2
	3.04 Nanomaterials	2		3		2						
4. Manufacturing Process	4.01 Blow molding	2	9	31	16	36	49	3	31	27	24	15
	4.02 Injection molding	1	22	11	5	1	1	7	12	12		
	4.03 Extrusion	49	75	9	17	35	29	7	21	5	13	16
	4.04 Lamination	595	382	378	145	153	149	129	114	15	84	78
	4.05 Coating	148	38	19	9	5	3	11	1	21	16	23
	4.06 3D printing			1		6				1		
	4.07 Other processes	2	179	19	7	18	61	57	61	1	24	23
5. Format	4.06 3D printing	3	4			14				3		
	4.07 Other processes	29	10	22	2	13	3	5	6	5	1	3
	5.01 Built-in/embedded	4	2		1	4						
	5.02 Coating and edible film	2	13	1	3	3	2	5	4	5		1
	5.03 Insert/packet/sachet/patch/tablet	8	7	8		9	2	3	2	4		3
	5.04 Marinade and flavoring		1	2		3					1	
	5.05 Label/printable/graphics	11	15	4	3	5	4	4	2	3	2	
	5.06 Interaction between product and shelf/environment	27	11	40	5	10		11	3	8		1
	5.07 Lid/cap	17	26	7	10	1	2	5	11	2		4

TOP 5 ENTITIES BY CATEGORY

The following tables show the Top 5 entities in each technology category covering all entity tiers.

A percentage has been a located based on the following contributions:

- **Top 5** - The total % in which the Top 5 entities shown contribute to the overall total number of invention's in that category
- **Other Entities** - The total % in which entities appear whom are not in the Top 5 or are Individuals in that category.
- **Individuals** - The total % of invention's which appear in an Individual's name for that category.

Technical Category	Top 5 Entities	Inventions	Percentage Contribution		
			TOP 5	Other entities	INDIVIDUALS
1.01.01.01 Microbial growth sensor	Tianjin Taiyuan Industries Gas Co Ltd	9	12.0%	61.0%	27.0%
	Univ Shanghai Maritime	5			
	Tianjin Taiheng Gas Co Ltd	5			
	Korea Food Res Inst	4			
	Hormal Foods Corp	4			
1.01.01.02.01 Anti-microbial agent	Paper Pak Ind	5	15.0%	68.0%	18.0%
	Blueye Llc	3			
	Du Pont De Nemours & Co E I	3			
	Nomacore Llc	3			
	Korea Food Res Inst	2			
1.01.01.02.02 Enzyme based microbial inactivation	Kraft Foods Global Brands Llc	2	26.0%	43.0%	30.0%
	Du Pont De Nemours & Co E I	1			
	Oven Luv'N Llc	1			
	3M Innovative Properties	1			
	Segan Ind	1			
1.01.01.02.03 Other Anti-microbial systems	Paper Pak Ind	5	8.0%	75.0%	17.0%
	Nanobiomatters Res&Dev Sl	5			
	Du Pont De Nemours & Co E I	4			
	Toray Industries	4			
	Blueye Llc	3			
1.01.02.01.01 Oxygen sensor	Sealed Air	58	20.0%	64.0%	15.0%
	Toppan Printing	51			
	Mitsubishi	27			
	Grace & Co W R	15			
	Tetra Pak	14			
1.01.02.01.02 Oxygen scavenging	Mitsubishi	413	27.0%	63.0%	10.0%
	Toppan Printing	239			
	Dic Corp	226			
	Sealed Air	176			
	Toyo Seikan Group	141			
1.01.02.01.03 Anti-oxidation systems	Mitsubishi	25	17.0%	72.0%	12.0%
	Toyobo Group	23			
	Sealed Air	18			
	Basf Ag	17			
	Chevron Chem Co	10			
1.01.02.02.01 Ethylene sensor	Kuraray	4	22.0%	61.0%	17.0%
	Exxonmobil Chem Patents Co Ltd	2			
	Kureha Corp	2			
	Wuxi Delin Shipping Equip Co Ltd	2			
	Kjaerulf Pedersen As	2			

1.01.02.02.02 Ethylene scavenging	Sealed Air	55	19.0%	71.0%	10.0%
	Toyo Seikan Group	30			
	Dic Corp	27			
	Kuraray	26			
	Mitsubishi	26			
1.01.02.03 Other gases of interest	Toppan Printing	558	32.0%	59.0%	9.0%
	Dic Corp	325			
	Mitsubishi	321			
	Toyobo Group	154			
	Kuraray	126			
1.01.02.04.01 Low oxygen (or anoxic) packaging	Mitsubishi	113	27.0%	64.0%	9.0%
	Toppan Printing	50			
	Sealed Air	39			
	Dic Corp	37			
	Toyobo Group	29			
1.01.02.04.02 High oxygen packaging	Toppan Printing	20	26.0%	59.0%	15.0%
	Mitsubishi	17			
	Sealed Air	13			
	Sumitomo Group	11			
	Dic Corp	7			
1.01.02.04.03 Vacuum packaging	Sealed Air	37	9.0%	62.0%	29.0%
	Kuraray	14			
	Sumitomo Group	13			
	Kureha Corp	12			
	Toppan Printing	10			
1.01.02.04.04 Other Modified/Controlled atmosphere packaging	Sealed Air	37	9.0%	70.0%	21.0%
	Sumitomo Group	23			
	Suzhou Yahe Preservation Technology Co	17			
	Pactiv Corp	14			
	Air Liquide Sa	12			
1.01.03.01 Temperature sensor	Toyobo Group	17	5.0%	67.0%	28.0%
	Toppan Printing	13			
	Sealed Air	12			
	Seikatsu Kyodo Kumiai Coop Sap	7			
	Dongguan Jierong Technology Co Ltd	6			
1.01.03.02 Thermostatic packaging	Univ Shanghai Maritime	6	34.0%	47.0%	19.0%
	Suzhou Bec Biotechnology Co Ltd	2			
	Univ South China Technology	1			
	Carlsberg Breweries As	1			
	Xuzhou Lvzhiye Biological Foodstuff Co	1			
1.01.03.03 Self-heating/Self-cooling	Joseph Co	12	7.0%	41.0%	51.0%
	Heat Wave Technologies Llc	8			
	Thermotic Dev Ltd	8			
	Tempra Technology Inc	6			
	Thermagen Sa	6			
1.01.04.01 UV blockage	Toppan Printing	16	23.0%	67.0%	10.0%
	Dic Corp	14			
	Mitsubishi	4			
	Carlsberg Breweries As	3			
	Sealed Air	3			
1.01.04.02 Light barrier	Toppan Printing	51	28.0%	59.0%	12.0%
	Dic Corp	28			
	Tetra Pak	13			
	Mitsubishi	11			
	Mitsui Chemicals	7			
1.01.05.01 Moisture sensor	Toppan Printing	47	12.0%	66.0%	21.0%
	Mitsubishi	26			
	Toyobo Group	25			
	Dic Corp	10			
	Unitika	8			

1.01.05.02.01 Moisture barrier	Toppan Printing	351	28.0%	62.0%	10.0%
	Dic Corp	259			
	Mitsubishi	98			
	Toyobo Group	79			
	Toray Industries	62			
1.01.05.02.02 Moisture content or humidity maintenance	Toppan Printing	79	17.0%	62.0%	21.0%
	Mitsubishi	65			
	Dic Corp	58			
	Toyo Seikan Group	30			
	Toyobo Group	28			
1.01.06.01 Odor absorbing	Mitsubishi	14	46.0%	42.0%	12.0%
	Toppan Printing	9			
	Toyo Seikan Group	6			
	Sumitomo Group	4			
	Grace & Co W R	2			
1.01.06.02 Flavor releasing	Casematic S.A. De C.V.	2	24.0%	52.0%	24.0%
	Mitsubishi	1			
	Sumitomo Group	1			
	Mitsui Chemicals	1			
	Multisorb Technologies Inc	1			
1.01.07 Corrosion inhibition	Tianjin Taiyuan Industries Gas Co Ltd	7	20.0%	63.0%	17.0%
	Tianjin Taiheng Gas Co Ltd	6			
	Mitsubishi	5			
	Inmat Inc	3			
	Dic Corp	2			
1.01.08 Integrity sensor	Kraft Foods Global Brands Llc	4	24.0%	60.0%	17.0%
	Intercontinental Great Brands Llc	4			
	Philip Morris Prod	4			
	Valtion Teknillinen Tutkimuskeskus	3			
	Sealed Air	2			
1.01.09 Freshness sensor	Sealed Air	9	9.0%	57.0%	34.0%
	Seikatsu Kyodo Kumiai Coop Sap	9			
	Mitsui Chemicals	8			
	Univ Shanghai Maritime	8			
	Univ Jiangnan	6			
1.01.10 Eating profile enhancement	Xuzhou Lvzhiye Biological Foodstuff Co	4	9.0%	58.0%	33.0%
	Univ Jiangnan	3			
	Sapporo Coop	2			
	Air Liquide Sa	2			
	Hormal Foods Corp	2			
1.01.11 Migration prevention	Sealed Air	5	15.0%	71.0%	13.0%
	Kraft Foods Global Brands Llc	3			
	Toppan Printing	3			
	Toyo Seikan Group	2			
	Grace & Co W R	2			
1.01.12 Pathogens/microbial spoilage	Du Pont De Nemours & Co E I	2	14.0%	52.0%	35.0%
	Ecolab Inc	2			
	Johnson Matthey Plc	2			
	Korea Coop Agro Inc	2			
	Sealed Air	1			
1.02.01 Temperature sensor	Toyobo Group	17	5.0%	67.0%	28.0%
	Toppan Printing	13			
	Sealed Air	12			
	Seikatsu Kyodo Kumiai Coop Sap	7			
	Dongguan Jierong Technology Co Ltd	6			

1.02.02 Physical shock/motion sensor	Toppan Printing	3	9.0%	68.0%	24.0%
	Toyo Seikan Group	2			
	Univ South China Agric	2			
	Daikin Kogyo Kk	2			
	Asahi Breweries Ltd	2			
1.02.03 Other environmental factors	Sealed Air	17	8.0%	73.0%	20.0%
	Toyobo Group	11			
	Toppan Printing	10			
	Mitsubishi	7			
	Chiquita Brands L.L.C.	7			
1.03.01 Tamper-proof	Csp Technologies North America Llc	4	13.0%	71.0%	16.0%
	Airsec Sas	3			
	Toppan Printing	2			
	Dic Corp	2			
	Du Pont De Nemours & Co E I	2			
1.03.02.01 Near field communication enabled	Semiconductor Energy Lab	4	24.0%	48.0%	29.0%
	Alcan Global Pharm Packaging Inc	4			
	Hitachi Ltd	3			
	Toyo Seikan Group	2			
	Blupura Srl	2			
1.03.02.02 RFID tags	Semiconductor Energy Lab	31	8.0%	69.0%	23.0%
	Hitachi Ltd	10			
	Validfill Llc	8			
	Ricoh	7			
	Shanghai Gaocheng Art Packing Co Ltd	7			
1.03.02.03 Printable electronics	Shanghai Wuding Sensor Technology	4	17.0%	68.0%	16.0%
	Vorbeck Materials Corp	4			
	Mitsui Chemicals	3			
	Dic Corp	2			
	Sealed Air	2			
1.03.02.04 QR code	Sicpa Holdings Sa	15	7.0%	67.0%	26.0%
	Dic Corp	13			
	Toppan Printing	9			
	Nestec S.A.	6			
	Medco Health Solutions Inc.	6			
1.03.03 Electronic article surveillance	Mineral Lassen Llc	3	41.0%	41.0%	17.0%
	B&G Int Inc	3			
	Validfill Llc	2			
	Ruizhang Technology Limited Company	2			
	Checkpoint Systems Inc	2			
1.03.04 Wireless communication network	Semiconductor Energy Lab	21	12.0%	61.0%	27.0%
	Mineral Lassen Llc	8			
	Ricoh	5			
	Shanghai Wuding Sensor Technology	5			
	Symbol Technologies Inc.	4			
1.03.05 Augmented reality	Semiconductor Energy Lab	3	18.0%	44.0%	38.0%
	Shenzhen Acad Inspection & Quarantine	1			
	Zhongshan Datwah Smartech Co Ltd	1			
	Univ Northeast Forestry	1			
	Tianjin Lianyun Network Technology Co	1			
1.03.06 Environment sensing and responding	Transphere Systems Ltd	1	100.0%	0.0%	0.0%
	Agco Corp	1			
	-	-			
	-	-			
	-	-			

1.04.01 Easy opening of food packs	Sealed Air	13	25.0%	65.0%	10.0%
	Toppan Printing	7			
	Mitsubishi	6			
	Sumitomo Group	6			
	Curwood Inc	6			
1.04.02 Easy dispensing	Kraft Foods Global Brands Llc	1	29.0%	35.0%	35.0%
	Validfill Llc	1			
	Pepsico Inc	1			
	Blupura Srl	1			
	Tokyo Shokai Kk	1			
1.04.03 Portioning/sizing	Henkel Kgaa	1	50.0%	0.0%	50.0%
	Giardinetto Restaurants Ltd	1			
	Akzo Nobel Nv	1			
	-	-			
	-	-			
1.04.04 Resealable	Toppan Printing	8	31.0%	46.0%	23.0%
	Kraft Foods Global Brands Llc	6			
	Philip Morris Prod	5			
	Intercontinental Great Brands Llc	5			
	Sonoco Dev Inc	3			
1.04.05 Cook within package	Sealed Air	20	11.0%	54.0%	34.0%
	Dic Corp	16			
	Mitsubishi	13			
	Toppan Printing	9			
	Grace & Co W R	7			
1.04.06 On-the-go enabling	Mitsubishi	16	12.0%	57.0%	30.0%
	Toppan Printing	11			
	Dic Corp	8			
	Sealed Air	5			
	Du Pont De Nemours & Co E I	3			
1.05.01 Recyclable	Toppan Printing	14	14.0%	59.0%	27.0%
	Dic Corp	10			
	Showa Denko	6			
	Toyo Seikan Group	5			
	Sumitomo Group	5			
1.05.02 Degradable	Toppan Printing	23	15.0%	63.0%	21.0%
	Dic Corp	17			
	Mitsubishi	11			
	Sumitomo Group	5			
	Sealed Air	4			
1.05.03 Edible	Mitsubishi	11	17.0%	52.0%	32.0%
	Toyo Seikan Group	3			
	Kureha Corp	2			
	Kuraray	2			
	Nestec S.A.	2			
1.06.01 Value Adding	Semiconductor Energy Lab	5	28.0%	46.0%	26.0%
	Coca-Cola Co	2			
	Marine Fishery Inst Zhejiang Province	2			
	Toppan Printing	1			
	Honeywell Int Inc	1			
1.06.02 Infrastructure Building	Coca-Cola Co	3	10.0%	66.0%	24.0%
	Shenzhen Acad Inspection & Quarantine	2			
	Nec Corp	2			
	Qingkang Sci & Technology Co Ltd	2			
	Wuxi Chongan Technology Innovation Serv	2			

2.01.01 Carcass/Primal Cut	Best Pack Co Ltd	6	13.0%	64.0%	23.0%
	Curwood Inc	5			
	Foodcap Int Ltd	3			
	Sealed Air	3			
	Basf Ag	3			
2.01.02 Fresh cut	Sumitomo Group	7	9.0%	66.0%	26.0%
	Univ Shanghai Maritime	4			
	Qingdao Yulin Food Co Ltd	4			
	Freshxtend Technologies Corp	4			
	Univ Shandong Agric	3			
2.01.03 Frozen	Dic Corp	25	12.0%	63.0%	25.0%
	Toyobo Group	18			
	Nestec S.A.	13			
	Unitika	12			
	Mitsubishi	11			
2.01.04 HPP processed	Toppan Printing	6	26.0%	61.0%	13.0%
	Mitsubishi	3			
	Dic Corp	1			
	Du Pont De Nemours & Co E I	1			
	Daicel Pack Systems Kk	1			
2.01.05 Ready-to-eat meats	Sealed Air	23	20.0%	61.0%	19.0%
	Mitsubishi	14			
	Kraft Foods Global Brands Llc	7			
	Unitika	6			
	Dic Corp	5			
2.01.06 Poultry	Sealed Air	48	23.0%	52.0%	24.0%
	Curwood Inc	13			
	Mitsubishi	11			
	Grace & Co W R	9			
	Du Pont De Nemours & Co E I	8			
2.02.01 Raw Seafood	Toyo Seikan Group	6	13.0%	57.0%	30.0%
	Univ Zhejiang Ocean	2			
	Panasonic Group	2			
	Marine Fishery Inst Zhejiang Province	2			
	Kureha Corp	1			
2.02.02 Processed Seafood	Toyo Seikan Group	7	14.0%	57.0%	30.0%
	Kureha Corp	7			
	Sealed Air	7			
	Univ Zhejiang Ocean	6			
	Mitsubishi	4			
2.03 Fresh Pasta	Mitsubishi	10	17.0%	59.0%	23.0%
	Sealed Air	5			
	Toyo Seikan Group	4			
	Tres Fresh Llc	3			
	Nestec S.A.	3			
2.04 Cheese	Sealed Air	30	25.0%	61.0%	14.0%
	Mitsubishi	17			
	Kraft Foods Global Brands Llc	12			
	Toppan Printing	9			
	Kureha Corp	9			
2.05 Powder	Mitsubishi	35	13.0%	57.0%	29.0%
	Toppan Printing	9			
	Dic Corp	9			
	Qingdao Jinhaiyuan Food Co Ltd	8			
	Ajinomoto Co Inc	7			

2.06.01 Fresh produce	Sumitomo Group	50	8.0%	62.0%	30.0%
	Mitsui Chemicals	13			
	Mitsubishi	9			
	Univ Jiangnan	9			
	Beijing Graphic Communication Inst	8			
2.06.02 Processed Horticulture	Toyo Seikan Group	35	14.0%	61.0%	24.0%
	Mitsubishi	23			
	Sumitomo Group	14			
	Unitika	11			
	Univ Jiangnan	7			
2.07.01.01 Wines	Toyo Seikan Group	32	14.0%	54.0%	33.0%
	Tetra Pak	17			
	Mitsubishi	15			
	Shanghai Gaocheng Art Packing Co Ltd	7			
	Sealed Air	6			
2.07.01.02 Beers	Toyo Seikan Group	38	21.0%	62.0%	17.0%
	Mitsubishi	13			
	Sealed Air	9			
	Invista Tech Sarl	8			
	Dic Corp	7			
2.07.01.03 Other alcohols	Toppan Printing	243	25.0%	64.0%	10.0%
	Dic Corp	183			
	Kuraray	115			
	Sealed Air	109			
	Mitsubishi	98			
2.07.02.01 Dairy	Mitsubishi	55	19.0%	60.0%	22.0%
	Toyo Seikan Group	40			
	Tetra Pak	34			
	Dic Corp	18			
	Du Pont De Nemours & Co E I	14			
2.07.02.02 Juice	Mitsubishi	63	24.0%	59.0%	17.0%
	Toyo Seikan Group	48			
	Tetra Pak	41			
	Dic Corp	36			
	Toppan Printing	28			
2.07.02.03 Carbonated beverage	Toyo Seikan Group	42	23.0%	58.0%	19.0%
	Mitsubishi	38			
	Coca-Cola Co	12			
	Dic Corp	11			
	Eastman Chem Co	9			
2.07.02.04 Water	Dic Corp	56	14.0%	60.0%	26.0%
	Toppan Printing	55			
	Mitsubishi	33			
	Sumitomo Group	29			
	Toyobo Group	19			
2.08 General foodstuffs	Toppan Printing	634	20.0%	62.0%	18.0%
	Mitsubishi	477			
	Dic Corp	361			
	Sumitomo Group	190			
	Toyobo Group	173			
2.09 Pharmaceuticals	Toppan Printing	495	34.0%	57.0%	9.0%
	Mitsubishi	275			
	Dic Corp	234			
	Toyobo Group	96			
	Toyo Seikan Group	66			

2.10 Medical devices	Toyobo Group	25	15.0%	72.0%	12.0%
	Toppan Printing	19			
	Mitsubishi	15			
	Kuraray	13			
	Dic Corp	11			
3.01.01.01 Degradable	Toppan Printing	36	18.0%	72.0%	10.0%
	Toray Industries	19			
	Dic Corp	17			
	Sealed Air	13			
	Basf Ag	10			
3.01.01.02 Non-Degradable	-	-			
	-	-			
	-	-			
	-	-			
	-	-			
3.01.02.01 Synthetic / Semi-Synthetic	Basf Ag	4	12.0%	69.0%	19.0%
	Sumitomo Group	3			
	Sirap-Gema Spa	3			
	Fujimori Kogyo Kk	3			
	Nomacore Llc	3			
3.01.02.02 Natural	Toppan Printing	23	18.0%	70.0%	13.0%
	Tetra Pak	8			
	Teva Pharma	8			
	Dic Corp	7			
	Nippon Seishi Kk	5			
3.01.03.01 Non-Renewable	Rockwell Automation Technologies Inc.	4	36.0%	56.0%	8.0%
	Sumitomo Group	3			
	Toppan Printing	2			
	Mitsubishi	2			
	Roquette Freres Sa	2			
3.01.03.02 Renewable	Nanobiomatters Res&Dev Sl	4	17.0%	66.0%	17.0%
	Tetra Pak	3			
	Toray Industries	2			
	Tera-Barrier Films Pte Ltd	2			
	Wipak Walsrode Gmbh & Co Kg	2			
3.01.04.01 Flexible	Dic Corp	15	16.0%	67.0%	17.0%
	Mitsubishi	12			
	Kuraray	7			
	Sealed Air	5			
	Bemis Co Inc	5			
3.01.04.02 Rigid / Semi-Rigid	Sealed Air	6	14.0%	67.0%	19.0%
	Tetra Pak	6			
	Curwood Inc	4			
	Nestec S.A.	4			
	Toyobo Group	4			
3.01.05.01 Transparent	Toppan Printing	101	29.0%	58.0%	13.0%
	Mitsubishi	31			
	Dic Corp	22			
	Sealed Air	16			
	Toray Industries	14			
3.01.05.02 Non-Transparent	Mitsubishi	4	22.0%	64.0%	14.0%
	Toyo Seikan Group	3			
	Gunze Ltd	3			
	Showa Denko	2			
	Exxonmobil Chem Patents Co Ltd	2			

3.01.06.01 Printable	Toppan Printing	9	27.0%	54.0%	19.0%
	Mitsubishi	6			
	Sealed Air	3			
	Dic Corp	3			
	Tetra Pak	2			
3.01.06.02 Non-printable	-	-			
	-	-			
	-	-			
	-	-			
	-	-			
3.01.07.01 Sensing/indicating/monitoring	Mitsubishi	11	16.0%	67.0%	17.0%
	Toppan Printing	7			
	Sealed Air	7			
	Kuraray	6			
	Sumitomo Group	5			
3.01.07.02 Blocking/inhibiting/reacting	Toppan Printing	205	29.0%	63.0%	8.0%
	Mitsubishi	133			
	Dic Corp	127			
	Sealed Air	83			
	Tetra Pak	59			
3.01.08.01 Mechanical properties	Mitsubishi	180	28.0%	63.0%	9.0%
	Toppan Printing	167			
	Dic Corp	155			
	Toyobo Group	78			
	Sealed Air	66			
3.01.08.02 Chemical properties	Univ Shanghai Maritime	1	28.0%	44.0%	28.0%
	Marusho Sangyo Kk	1			
	Empire Technology Dev Llc	1			
	Insignia Technologies Limited	1			
	Qingdao Daohe Biological Technology Co	1			
3.01.08.03 Cost	Mitsubishi	79	12.0%	69.0%	20.0%
	Toppan Printing	75			
	Dic Corp	38			
	Tetra Pak	34			
	Sumitomo Group	27			
3.01.09 Edible	Toppan Printing	32	20.0%	70.0%	10.0%
	Tetra Pak	14			
	Sumitomo Group	14			
	Teva Pharma	8			
	Dic Corp	7			
3.02.01 Metal	Toppan Printing	79	19.0%	59.0%	21.0%
	Mitsubishi	40			
	Dic Corp	34			
	Toyo Seikan Group	15			
	Asahi Kasei Kk	14			
3.02.02 Glass	Semiconductor Energy Lab	19	21.0%	55.0%	25.0%
	Mitsubishi	13			
	Toppan Printing	4			
	Toyo Seikan Group	3			
	Du Pont De Nemours & Co E I	3			
3.02.03 Paper/Wood	Toppan Printing	57	17.0%	58.0%	26.0%
	Tetra Pak	41			
	Dic Corp	28			
	Nippon Seishi Kk	27			
	Semiconductor Energy Lab	15			

3.02.04 Other Materials	Toppan Printing	523	25.0%	63.0%	13.0%
	Mitsubishi	302			
	Dic Corp	288			
	Sumitomo Group	123			
	Tetra Pak	97			
3.03 Hybrid Systems	Toppan Printing	27	17.0%	65.0%	18.0%
	Mitsubishi	17			
	Sumitomo Group	10			
	Kureha Corp	7			
	Beijing Graphic Communication Inst	6			
3.04 Nanomaterials	Hubei Zhihe Printing & Packaging Co Ltd	5	20.0%	59.0%	20.0%
	Dic Corp	3			
	Nanobiomatters Res&Dev Sl	3			
	Toppan Printing	2			
	Univ Jiangnan	2			
4.01 Blow molding	Mitsubishi	90	20.0%	72.0%	8.0%
	Toyobo Group	49			
	Sealed Air	36			
	Dic Corp	31			
	Kuraray	31			
4.02 Injection molding	Mitsubishi	22	16.0%	69.0%	15.0%
	Kuraray	12			
	Tetra Pak	12			
	Csp Technologies North America Llc	12			
	Dic Corp	11			
4.03 Extrusion	Dic Corp	90	22.0%	67.0%	11.0%
	Mitsubishi	75			
	Tetra Pak	50			
	Toppan Printing	49			
	Sealed Air	35			
4.04 Lamination	Toppan Printing	595	31.0%	61.0%	8.0%
	Mitsubishi	382			
	Dic Corp	378			
	Sealed Air	153			
	Toyobo Group	149			
4.05 Coating	Toppan Printing	148	31.0%	60.0%	8.0%
	Dic Corp	109			
	Mitsubishi	38			
	Toyobo Group	30			
	Toray Industries	23			
4.06 3D printing	Sealed Air	6	18.0%	54.0%	28.0%
	Nanobiomatters Res&Dev Sl	3			
	Du Pont De Nemours & Co E I	2			
	Vorbeck Materials Corp	2			
	Dic Corp	1			
4.07 Other processes	Toppan Printing	200	15.0%	67.0%	18.0%
	Dic Corp	190			
	Sealed Air	180			
	Mitsubishi	179			
	Tetra Pak	100			
5.01 Built-in/embedded	Sealed Air	14	13.0%	62.0%	25.0%
	Semiconductor Energy Lab	12			
	Multisorb Technologies Inc	7			
	Mitsubishi	4			
	Grace & Co W R	4			

5.02 Coating and edible film	Toppan Printing	29	23.0%	70.0%	7.0%
	Dic Corp	22			
	Sealed Air	13			
	Mitsubishi	10			
	Basf Ag	8			
5.03 Insert/packet/sachet/patch/tablet	Multisorb Technologies Inc	10	21.0%	54.0%	25.0%
	Idemitsu Petrochem Co	9			
	Pactiv Corp	7			
	Toppan Printing	4			
	Sealed Air	4			
5.04 Marinade and flavoring	Mitsubishi	13	13.0%	60.0%	27.0%
	Ajinomoto Co Inc	5			
	Tetra Pak	5			
	Toyo Seikan Group	5			
	Kuraray	4			
5.05 Label/printable/graphics	Semiconductor Energy Lab	26	8.0%	72.0%	20.0%
	Sealed Air	9			
	Toppan Printing	8			
	Dic Corp	8			
	Hitachi Ltd	8			
5.06 Interaction between product and shelf/environment	Shanghai Wuding Sensor Technology	4	35.0%	54.0%	11.0%
	Sealed Air	3			
	Dic Corp	2			
	Pactiv Corp	2			
	Future Technology (R&D) Ltd.	2			
5.07 Lid/cap	Mitsubishi	15	11.0%	63.0%	26.0%
	Toppan Printing	11			
	Dongguan Jierong Technology Co Ltd	8			
	Sealed Air	5			
	Multisorb Technologies Inc	5			
5.08 Secondary & Tertiary packaging	Dic Corp	40	17.0%	62.0%	21.0%
	Toppan Printing	27			
	Mitsubishi	11			
	Toyo Seikan Group	11			
	Sealed Air	10			
5.09 Other Formats	Mitsubishi	26	23.0%	56.0%	21.0%
	Toppan Printing	17			
	Kuraray	11			
	Sumitomo Group	10			
	Dic Corp	7			

Technology areas in which low patent activity and low entity interest are occurring may represent potential technology areas in which to conduct further investigations (for R&D purposes) because of this perceived low interest.

CROSS TECHNOLOGY CHARTS

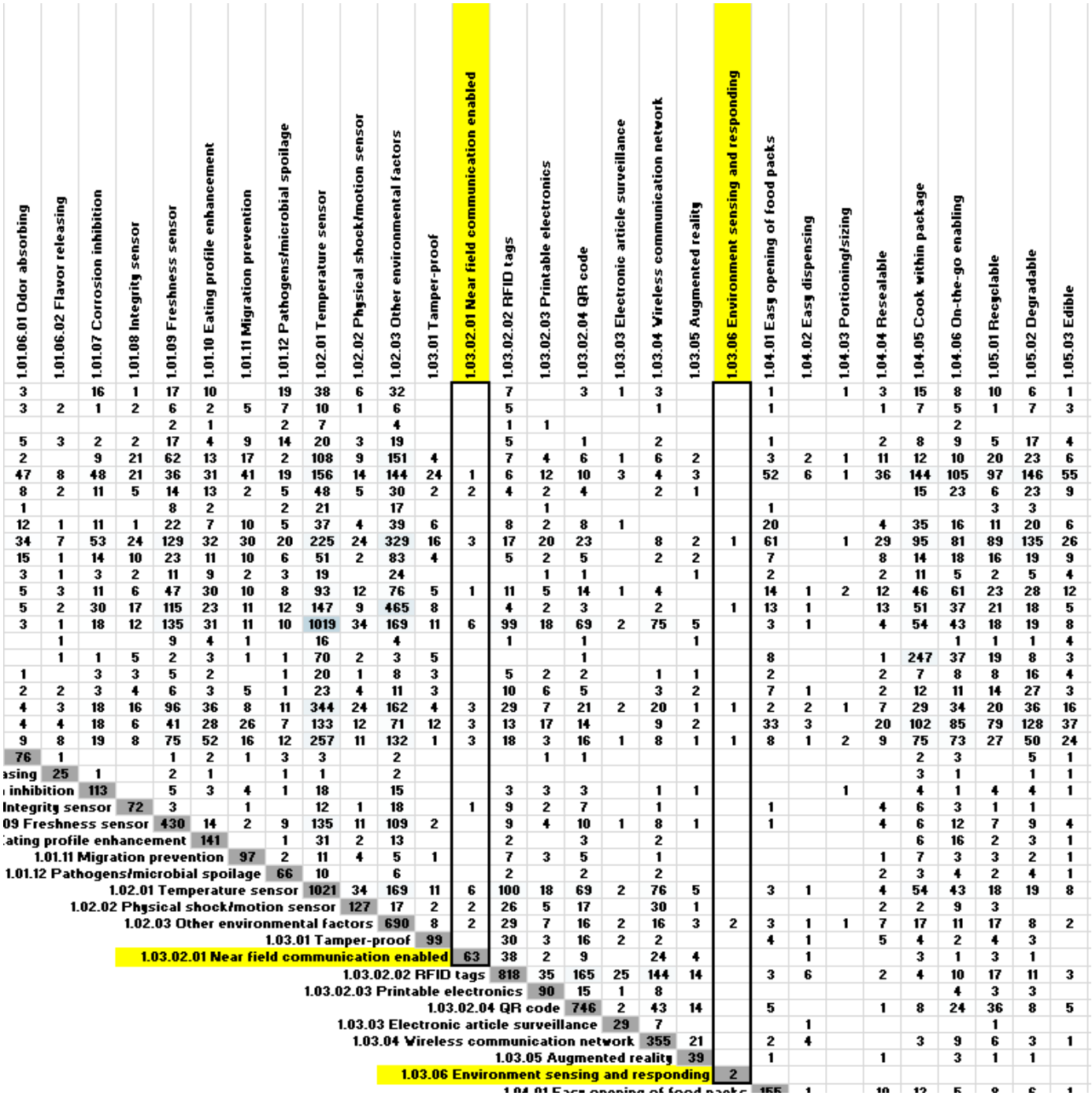
The matrix shown in a partial view on the next page highlights a sample section of the cross-correlation of all technical categories in the data set, with the heat-map showing highly correlated categories. The matrix suggests there could be a “patent gap” (areas in a lighter shade of blue or white) in technology areas where there is little or no activity, but where **Meat & Livestock Australia** experts may consider having potential. Please note that due to the number of technology categories and large size of the cross technology chart, the full table has not been placed in the report. The full cross technology table can be viewed in the corresponding excel work file under the tab **‘Technology Analysis – Matrices’.**

A good method of navigating a cross technology chart is to focus on technology areas where there is there is little or no activity. These technology areas will highlight where these is potential opportunity to innovate. In terms of patent publications, these charts will help highlight which specific sub technology may be best to focus on as a lower amount of activity is being observed when compared to other areas.

There appears to be multiple areas of low patent activity occurring within the dataset. Innovation associated with the **interaction between product and shelf/environment** (category 5.06), **environmental sensing and reporting** (category 1.03.06) and **near field communication enabled features** (category 1.03.02.01) are just a few example technologies in which many potential patent gap’s can be observed.

Additionally, there are a few technology categories in which low numbers of patent results is understandable in terms of its perceived use or commercialisation opportunity regarding smart packaging. Categories such as **non degradable** materials (category 3.01.01.02) and **non printable** materials (category 3.01.06.02) aren’t represented highly in the dataset indicating a perceived low need or opportunity in relation to these technologies by entities.

Patent Cross Technology Chart (partial chart example)



	1.01.06.01 Odor absorbing	1.01.06.02 Flavor releasing	1.01.07 Corrosion inhibition	1.01.08 Integrity sensor	1.01.09 Freshness sensor	1.01.10 Eating profile enhancement	1.01.11 Migration prevention	1.01.12 Pathogens/microbial spoilage	1.02.01 Temperature sensor	1.02.02 Physical shock/motion sensor	1.02.03 Other environmental factors	1.03.01 Tamper-proof	1.03.02.01 Near field communication enabled	1.03.02.02 RFID tags	1.03.02.03 Printable electronics	1.03.02.04 QR code	1.03.03 Electronic article surveillance	1.03.04 Wireless communication network	1.03.05 Augmented reality	1.03.06 Environment sensing and responding	1.04.01 Easy opening of food packs	1.04.02 Easy dispensing	1.04.03 Portioning/sizing	1.04.04 Resealable	1.04.05 Cook within package	1.04.06 On-the-go enabling	1.05.01 Recyclable	1.05.02 Degradable	1.05.03 Edible
1.01.06.01 Odor absorbing	76	1			1	2	1	3	3		2				1	1											2	3		5	1
1.01.06.02 Flavor releasing	1	25	1		2	1		1	1		2															3	1		1	1
1.01.07 Corrosion inhibition		1	113		5	3	4	1	18		15			3	3	3		1	1				1		4	1	4	4	1
1.01.08 Integrity sensor			72	3			1		12	1	18		1	9	2	7		1			1			4	6	3	1	1	
1.01.09 Freshness sensor	1			430	14	2	9	1	135	11	109	2		9	4	10	1	8	1		1			4	6	12	7	9	4
1.01.10 Eating profile enhancement					141		1		31	2	13			2		3		2							6	16	2	3	1
1.01.11 Migration prevention						97	2		11	4	5	1		7	3	5		1						1	7	3	3	2	1
1.01.12 Pathogens/microbial spoilage							66		10		6			2		2		2						2	3	4	2	4	1
1.02.01 Temperature sensor								1021	34	169	11	6	6	100	18	69	2	76	5		3	1		4	54	43	18	19	8
1.02.02 Physical shock/motion sensor									127	17	2	2	2	26	5	17		30	1					2	2	9	3		
1.02.03 Other environmental factors										690	8	2	2	29	7	16	2	16	3	2	3	1	1	7	17	11	17	8	2
1.03.01 Tamper-proof											99			30	3	16	2	2			4	1		5	4	2	4	3	
1.03.02.01 Near field communication enabled												63	63	38	2	9		24	4			1			3	1	3	1	
1.03.02.02 RFID tags														818	35	165	25	144	14		3	6		2	4	10	17	11	3
1.03.02.03 Printable electronics															90	15	1	8								4	3	3	
1.03.02.04 QR code																746	2	43	14		5			1	8	24	36	8	5
1.03.03 Electronic article surveillance																	29	7				1					1		
1.03.04 Wireless communication network																		355	21		2	4			3	9	6	3	1
1.03.05 Augmented reality																			39		1			1		3	1	1	
1.03.06 Environment sensing and responding																				2									
1.04.01 Easy opening of food packs																					155	1		10	13	5	8	6	1

HIGH SCORING INVENTIONS

High scoring inventions ranked by Thomson Reuters IP Analytics Strength™ Index are shown in a partial list below with the complete list of the top 50 inventions available in the accompanying excel file.

Bostik Findley SA (France[6]) has the highest scoring invention. This specific patent relates to 'Multilayer film, useful to manufacture flexible packaging used for packaging products of e.g. food industry, comprises thin material layers bonded together by layer that is made of adhesive composition including styrene block copolymers'.

High Scoring Inventions	Thomson Reuters IP Analytics Strength Index™
EP2687362B1	**125.3**
BOSTIK FINDLEY SA	
2012-07-19	
Multilayer film, useful to manufacture flexible packaging used for packaging products of e.g. food industry, comprises thin material layers bonded together by layer that is made of adhesive composition including styrene block copolymers	
IN201208790P4	**121.2**
Mitsubishi	
2010-04-20	
Polyamide compound used in polyamide composition, contains diamine unit comprising alicyclic diamine unit, dicarboxylic acid unit comprising aromatic dicarboxylic unit and aliphatic dicarboxylic acid unit and carbonyl-containing unit	
US9260622B2	**114.8**
Kuraray	
2010-03-30	
Composite structure for e.g. packaging material for retort food, has layer containing reaction product obtained by reacting metal oxide and phosphorus compound, and having specified infrared ray absorption wavenumber	
EP2976946A1	**113.2**
CELLRESIN TECH LLC	
2011-03-27	
Container, useful for packaging of respiring produce or produce materials, including whole plant or plant parts e.g. fruit and flower,	
JP05764812B2	**112.3**
SICPA HOLDINGS SA	
2011-05-27	
Marking on substrate e.g. label, comprises chiral liquid crystal polymer composition layer with areas which exhibit modified set of optical property by contacting chiral liquid crystal precursor composition in areas with modifying agent	
US20140208699A1	**111.3**
KHS GMBH	
2011-09-02	
Apparatus for performing multi-color printing on packaging structure e.g. bottle, has holding and centering unit which holds	
RU2559461C2	**111.0**
CLARIANT AG	
2010-06-30	
Plastic material, useful in packaging e.g. beverages, comprises polyester, polyamide, transition metal catalyst, and organic	

[6] http://www.bostik.com/our-company/our-history/

TOP CITED INVENTIONS

The influence of a patent document can be measure by looking at how frequently an invention is cited again another patent case pending in the system. Citations can come from many sources including by the applicant themselves during patent drafting or prosecution, citation by Examiners during patent examination or citation by other during their own patenting processes.

The following are the most highly cited patent documents of relevance in the collection. The most highly cited patent was originally filed from **Binforma Group LLC** (United States) and **Kimberly-Clark Corporation** (United States) and is entitled 'RFID tag system for detecting product tampering and product packaging, has several antenna among which one is detachable antenna capable of wireless communication at wider range'. A partial list is shown below and the complete list of the top 50 cited patent inventions is available in the accompanying excel file.

High Citation Impact Inventions	Age-weighted Citation Impact
KR2007007165A **BINFORMA GROUP LLC; KIMBERLY-CLARK CORP** 2004-04-30 RFID tag system for detecting product tampering and product packaging, has several antenna among which one is detachable antenna capable of wireless communication at wider range	**20.8**
US20020101197A1 **PHILIP MORRIS PROD** 1997-08-26 Information provision method for warehouse inventory management, involves actuating LED device based on control signal so as to change lighting colors relevant to information signal	**17.4**
AU2003249257A1 **BATTELLE MEMORIAL INST** 2002-07-15 Monitoring apparatus for tracking a medical device, has RFID tag adapted for attachment to medical device and having stored thereon information about medical device and configured to transmit information upon interrogation	**17.4**
US6021392A **CARE FUSION 303 INC** 1996-12-09 Drug distribution system for use in hospitals comprises a cabinet, where information collection units read the drug information from package containing bar codes and communicates with computer	**15.9**
JP05027378B2 **Dow Corning Corp** 2001-11-06 Film for use in making articles, e.g. food and non-food packing films, comprises first polymer comprising propylene, and ethylene and unsaturated comonomer	**14.5**
US7916032B2 **FUJITSU LIMITED** 2004-08-13 Radio frequency identification (RFID) tag for use on e.g. wine bottle, human body has integrated circuit (IC) chip having built-in communication circuit and built-in memory circuit, and which is connected to antenna pattern	**14.4**
US6982640B2 **CALLAHAN CELLULAR L.L.C.** 2002-11-21 Stored food product e.g. milk, freshness or expiration date tracking method for e.g. hospital, involves alerting user if product information associated with smart tags indicates that product has expired, and storing information	**12.5**

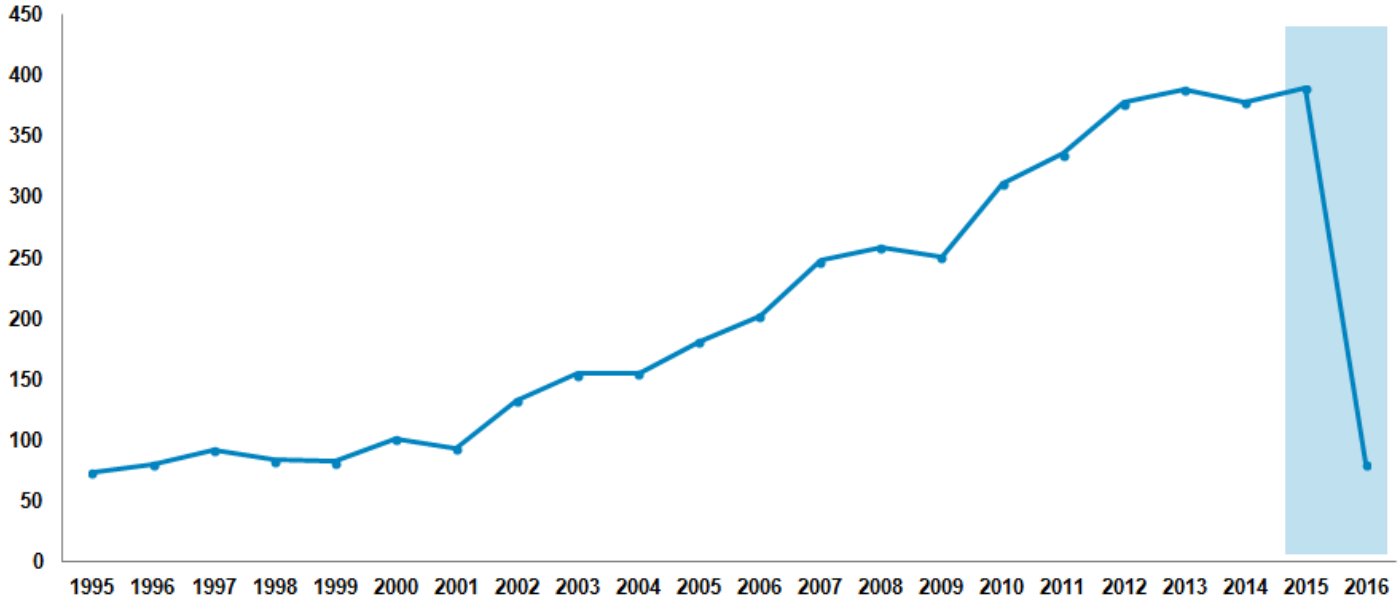
LITERATURE

The Literature collection was also developed using the full content literature coverage on Thomson Innovation®, which includes Web of Science, Conference proceedings, Current Contents Connect and Inspec. There were **4441** published literature results returned from the search process which had a priority year of at least **1995**.

PUBLICATION VELOCITY

The assembled collection has been plotted against publication year to analyse the publication rate. Literature publication data in 2015-2016 (highlighted in blue) may be partial due to publication lag.

Literature Publication Velocity



The chart above shows the filing activity of literature publications within the collection. It can be seen that there is a strong continual upward trend occurring in literature since 2001. A small dip in 2009 can be seen before a strong surge in publications in 2010. Most recently, the literature trend in this technology field appears to be constant.

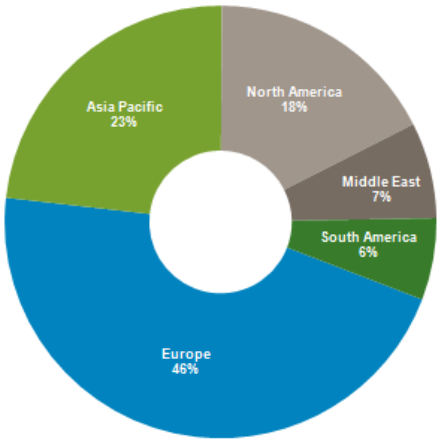
Literature appears to be increasing at a faster rate than patents in this technology albeit in much smaller numbers. In comparison, patent activity in general appears to be constant in terms of filings. More innovation and research appears to be directed in the form of literature from Universities and Government agencies which may be a good focus for **Meat & Livestock Australia** to look at for potential future partnerships or licensing opportunities.

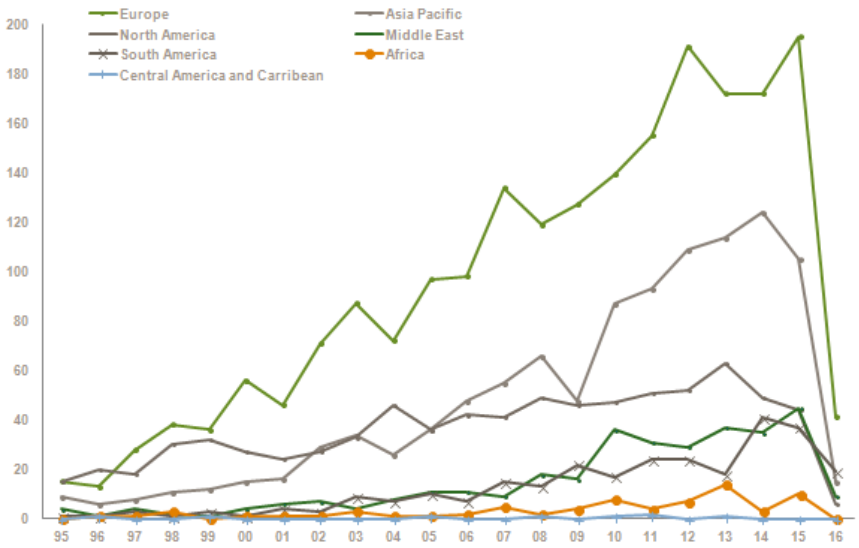
GEOGRAPHIC ANALYSIS

The region or specific country where an entity is based is a good indicator of the site where the research is undertaken. The regional analysis is based on the entity country. Each entity country has been grouped into its respective region and plotted in the chart below.

The chart reveals that Europe has the largest volume of literature publications produced. A little under half (46%) of literature publications in the data set have originated from Europe. The Asia Pacific (23%) and North America (18%) are the next top regions for literature associated with this technology.

Literature Activity by Region





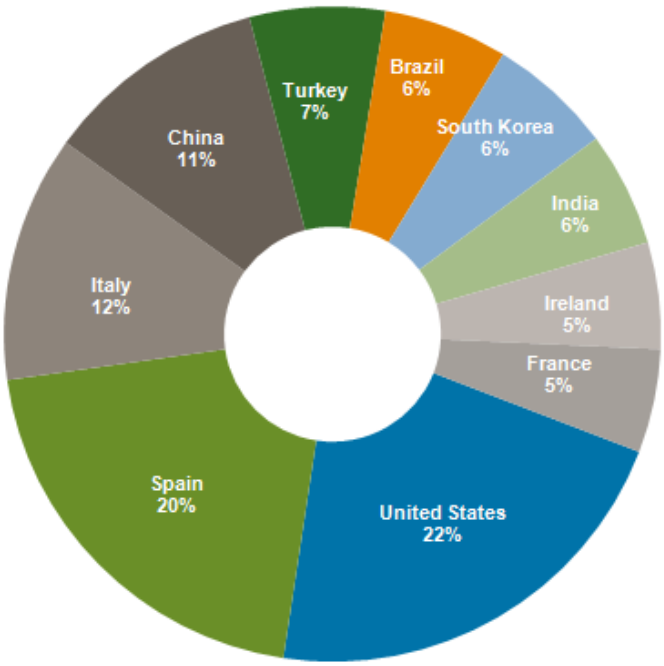
Region	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total Publications
Europe	15	13	28	38	36	56	46	71	87	72	97	98	134	119	127	139	155	191	172	172	195	41	2102
Asia Pacific	9	6	8	11	12	15	16	29	34	26	36	48	55	66	48	87	93	109	114	124	105	15	1066
North America	15	20	18	30	32	27	24	27	33	46	36	42	41	49	46	47	51	52	63	49	44	6	798
Middle East	4	1	4	2	1	4	6	7	4	8	11	11	9	18	16	36	31	29	37	35	45	9	328
South America	1	1	3	1	3	1	4	3	9	7	10	7	15	13	22	17	24	24	18	41	37	19	280
Africa		1	1	3		1	1	1	3	1	1	2	5	2	4	8	4	7	14	3	10		72
Central America and Carribean		1			1						1			1		1	2		1				8

TIMELINE OF ACTIVITY BY ENTITY COUNTRY

The heat map below shows the number of literature publications by country within this technology field. This shows where entites are publishing literature related to this technology. The United States (630 publicaitons) is the largest source of published literature followed by Spain, Italy, China and Turkey.

Literature Activity by Country

Entity Countries	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total Publications
United States	15	15	12	24	21	18	15	22	24	34	28	33	35	43	35	42	42	41	50	43	34	4	630
Spain	3	3	4	7	7	11	13	21	38	22	28	23	32	41	25	39	40	58	59	57	52	12	595
Italy		1	4	4	1	3	6	3	15	10	18	13	22	17	38	25	29	33	32	32	42	7	355
China						1		3	2	5	6	14	14	6	15	29	45	47	40	43	46	5	321
Turkey	1		2		1	2	2	3	2	7	5	9	5	11	14	25	24	18	23	15	23	3	195
Brazil		1	1		1		3	2	3	5	6	6	10	9	12	12	15	17	13	26	28	9	179
South Korea	1	1			5	1	5	2	9	7	4	8	10	13	5	16	14	15	23	27	12	1	179
India				1		1	1	7	3	1	4	8	13	14	15	11	16	12	12	19	25	2	165
Ireland	2	1	1	5	6	6	4	7	5	5	10	9	13	9	12	8	8	11	14	8	9		153
France	1	2	1	1	4	4	3	4	5	1	6	6	3	9	3	14	7	14	19	14	22	6	149
Greece	1	3	3			5	1	6	3	2	6	8	11	11	12	12	19	7	6	5	7	1	129
Canada		6	5	6	10	9	7	6	6	10	5	8	6	3	7	2	1	10	7	3	8	1	126
Belgium	2	1	2	5	5	9	5	8	5	8	6	9	4	3	4	10	5	5	7	6	9	2	120
Germany				1	3	2		3	1	2	2	4	12	5	6	6	14	12	13	13	15	2	116
Thailand	1			2		2		2	4	4	5	6	7	11	5	16	5	13	8	9	7	1	108
Japan	4	5	5	4	4	5	5	6	5	6	7	2	5	8	3	2	4	4	9	4	2	2	101
Denmark	2		3	4	2	8	2	7	6	2	7	8	7	4	6	5	5	7	4	2	2	4	97
Australia	1		2	3	2	3	2	7	6		6	4	4	3	4	2	2	7	3	11	9		81
Portugal				1	2	3	1	3	4	1	1	1	5	4	1	3	6	9	6	12	12	2	77
United Kingdom	3		6	3		6	2	5	1	2	4	3	3	1	2	8	6	5	4	6	2	1	73
All Others	11	8	13	16	11	18	23	22	31	33	41	41	48	55	49	60	72	98	101	107	106	29	993



Looking at the country specific growth rates, it can be seen that literature publications from China have witnessed the highest growth rate (32%) from 2003 – 2014. This is closely followed by Germany (26%) and Brazil (22%).

Growth Rate and Citation Impact

Entity Countries	Compound Annual Growth Rate (2003-2014)
China	32%
Germany	26%
Brazil	22%
Turkey	20%
India	18%
United Kingdom	18%
South Korea	11%
Portugal	11%
France	10%
Thailand	8%
Italy	7%
Australia	6%
United States	5%
Greece	5%
Ireland	4%
Spain	4%
Belgium	2%
Japan	-2%
Canada	-6%
Denmark	-10%

In terms of citation metrics, citation impact shows how often an article was cited by other articles. This can also be seen as an indication of the influence of publications and therefore the country producing them. Countries appearing with a higher impact have more influence in producing publications associated with smart packaging technology. Denmark has the highest citation impact recorded from the dataset.

Geographic Activity by Entity Country	Total Publications	Total Citations	Citation Impact
Denmark	97	2699	27.82
Belgium	120	2961	24.68
Ireland	153	3672	24.00
Greece	129	2859	22.16
United Kingdom	73	1510	20.68
Japan	101	1964	19.45
Canada	126	2317	18.39
Spain	595	9918	16.67
France	149	2145	14.40
United States	630	8875	14.09
Australia	81	1086	13.41
Germany	116	1524	13.14
Italy	355	3959	11.15
Portugal	77	768	9.97
Thailand	108	1045	9.68
Turkey	195	1601	8.21
South Korea	179	1418	7.92
Brazil	179	1221	6.82
India	165	965	5.85
China	321	1677	5.22

LITERATURE ENTITY ANALYSIS

ENTITIES AND TIMELINES

The table below highlights the top entities within the literature dataset. The **Spanish National Research Council** (Spain) is the leading source of published literature within smart packaging technology. This is followed by the **Foggia University** (Italy) and **Ghent University** (Belgium).

Top Entities – Literature

Top Entities	Total Publications
Spanish National Research Council	154
Foggia University	88
Ghent University	85
US Dept. of Agriculture	82
Zaragoza University	82
National University of Ireland	59
Technical University of Cartagena	51
Tianjin University of Science & Technology	44
Federal University of Vicosa	42
Lleida University	41
National Research Council (CNR)	41
Agricultural University of Athens	40
Michigan State University	40
Milan University	40
Helsinki University	38
Ioannina University	38
Kyungnam University	36
Technical University of Denmark	33
Catania University	32
Florida University	32
Kansas State University	32
Agriculture & Agri-Food Canada	31
Vigo University	30
Kasersart University	29
Univ Santiago de Compostela	29
University of Naples Federico 2	29

Top Entities (Total) – Timeline and Total Activity

Top Entities	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total Publications	% of Collection Published from 2009 to present
Spanish National Research Council	1	1	3	6	4	2	5	10	14	7	5	2	5	5	7	10	6	17	18	12	10	4	154	55%
Foggia University									5	5	5	4	5	6	18	8	12	4	4	3	9		88	66%
Ghent University	1	1	2	4	5	7	5	7	5	6	4	7			3	5	4	4	5	5	4	1	85	36%
US Dept. of Agriculture				2	2	5	3	3	5	8	4	1	3	3	4	4	7	8	8	7	5		82	52%
Zaragoza University						2	2	3	5	2	3	7	5	8	6	4	9	7	8	6	4	1	82	55%
National University of Ireland				1	1	1	2	4		3	3	5	4	3	2	5		7	11	1	6		59	54%
Technical University of Cartagena							2	3	8	6	7	1	6	2	1	5	4	2	2		1	1	51	31%
Tianjin University of Science & Technology																3	20	9	3	8	1		44	100%
Federal University of Vicosa									1		1	2	4	5	5	2	8	3	1	6	4		42	69%
Lleida University						1	1	3	4	2	1		6	10	2	5		1	1	1	2	1	41	32%
National Research Council (CNR)							1		1		1		2	3	3		3	4	6	6	9	2	41	80%
Agricultural University of Athens	1	3	2			3	1	4	1	1		1		1		3	5	3	4	2	4	1	40	55%
Michigan State University	1		2	1	2		1	1	2	2		1	3	1	1	7	3	3	1	5	2	1	40	58%
Milan University			1			1	3		2		1		1	1	3	6	2	6	7	3	3		40	75%
Helsinki University						1	1		1	3	3	2	4	2	1		4	4	3	1	7	1	38	55%
Ioannina University								1			2	4	6	8	6	4	4	1	1	1			38	45%
Kyungnam University		1				1	2	1	1		1	5		2	1	2	2	4	8	4	1		36	61%
Technical University of Denmark			2	4		4	1	5	1		3	3	1	1	2	2		1	2			1	33	24%
Catania University									1		1	2	7		5	1	3	3	3	1	3	2	32	66%
Florida University	2			2	2	1	1	2	3		3	2		1		3	2	2	1	4	1		32	41%
Kansas State University		2					1			4	5	7	2	3	2	4	1			1			32	25%
Agriculture & Agri-Food Canada			3	2	2	3	2	3	2	3		1	3	1		1		1	3	1			31	19%
Vigo University														5	1	2	6	5	2	5	3	1	30	83%
Kasersart University				1						3		1	2	1	1	6		5	3	3	3		29	72%
Univ Santiago de Compostela			1		1			1	1	1				1		1	6	7	2	6		1	29	79%
University of Naples Federico 2									2	2	3	3	2	2	3	2	3	2	1	3		1	29	52%

The chart above shows the timeline of activity for the top entities in the literature collection. **The Spanish National Research Council** (Spain) recently reached a peak of literature publication activity in the 2012 – 2013 periods.

Interestingly, the **Tianjin University of Science & Technology** (China) has seen the bulk of its publications occur in the 2011 period (20 publications). Prior to this, this entity only has 3 published literature documents in total in this technology field, all which occurred in the 2010 period.

ENTITIES VS COUNTRIES

The following table shows the country publication activity of the top literature producing entities. The United States, Spain and Italy have the most literature publications spread throughout multiple entities. In contrast, other countries such as China, Brazil, South Korea and Ireland, appear to have one or perhaps two institutions that are focusing heavily on this technology field.

Literature Entity Country

Entities	United States	Spain	Italy	China	Turkey	Brazil	South Korea	India	Ireland	France	Greece	Canada	Belgium	Germany	Thailand	Japan	Denmark	Australia	Portugal	United Kingdom	Iran	Finland	Mexico	Israel	Netherlands	Sweden	Poland	Chile	South Africa	New Zealand	Argentina	Czech Republic	United Kingdom	Serbia	Colombia	Uruguay	Hungary	Iceland	Romania	Austria	Croatia	Morocco	Slovenia	Egypt	Russia	Costa Rica	Ethiopia	Oman	Venezuela
Spanish National Research Council	8	152	3	1		2		2	1	3	1		2			2		1	2				1		1			2				1			2														
Foggia University		2	88		2								1																																						
Ghent University	1	5			3					1			85	1			2					7			3		1							2			3				1	3				1		1	
US Dept. of Agriculture	82	1	2	10		2	1					1		1	1	1		1	1				3		1																1								
Zaragoza University	1	82	3			1								1	1					1	1		4																1	1								
National University of Ireland	2	5		1				2	59									3										3								1								1		1		
Technical University of Cartagena	3	51	1			1						2											1				1			1				4								1						
Tianjin University of Science & Technology	2			44															2																														
Federal University of Vicosa	1	2				42																					1						1															
Lleida University		41														1	1					1	1																						2				
National Research Council (CNR)			41							1		1																														1							
Agricultural University of Athens			2							40						1			6																														
Michigan State University	40	1					7							6			1	2		1		1																											
Milan University	7	3	40																															1															
Helsinki University	1	1										6	1			2					38			1	1																								
Ioannina University										38																																1							
Kyungnam University	6			1			36			1				1			1																																
Technical University of Denmark		1								1	1		1			33	1					2			1																2								
Catania University		3	32						1					1														1		1					1					1									
Florida University	32			1		1			5			2		1					7							1														1									
Kansas State University	32																																																
Agriculture & Agri-Food Canada	1	3							1		31				1					3																														
Vigo University		30																4																															
Kasersart University	7			1			1							29	1		1							2					1																			
Univ Santiago de Compostela		29	1									1						4			1	4		2										1														
University of Naples Federico 2		1	29															1				1									1																	

LITERATURE TECHNICAL ANALYSIS

This chapter of the report focuses on the technical attributes of the literature in the collection. The documents in the collection were aggregated into the following technical categories. The following table shows the number of publications relating to these categories and it should be noted that one publication can appear in multiple categories.

Taxonomy - Literature

	Technical Categories	Total Inventions
1. Function / Technical Features	1.01.01.01 Microbial Growth Sensor	1045
	1.01.01.02.01 Anti-microbial Agent	103
	1.01.01.02.02 Enzyme based Microbial Inactivation	34
	1.01.01.02.03 Other Anti-microbial Systems	505
	1.01.02.01.01 Oxygen Sensor	206
	1.01.02.01.02 Oxygen Scavenging	342
	1.01.02.01.03 Anti-oxidation Systems	401
	1.01.02.02.01 Ethylene Sensor	112
	1.01.02.02.02 Ethylene Scavenging	158
	1.01.02.03 Other Gases of Interest	439
	1.01.02.04.01 Low Oxygen (or Anoxic) Packaging	20
	1.01.02.04.02 High Oxygen Packaging	19
	1.01.02.04.03 Vacuum Packaging	450
	1.01.02.04.04 Other Modified/Controlled Atmosphere	2829
	1.01.03.01 Temperature Sensor	381
	1.01.03.02 Thermostatic packaging	0
	1.01.03.03 Self-Heating/Self-Cooling	5
	1.01.04.01 UV Blockage	2
	1.01.04.02 Light Barrier	35
	1.01.05.01 Moisture Sensor	256
	1.01.05.02.01 Moisture Barrier	84
	1.01.05.02.02 Moisture content or humidity maintenance	0
	1.01.06.01 Odor Absorbing	5
	1.01.06.02 Flavor Releasing	301
	1.01.07 Corrosion Inhibition	2
	1.01.08 Integrity sensor	0
	1.01.09 Freshness Sensor	311
	1.01.10 Eating Profile Enhancement	181
	1.01.11 Migration Prevention	16
	1.01.12 Pathogens/Microbial Spoilage	377
	1.02.01 Temperature Sensor	411
	1.02.02 Physical Shock/Motion Sensor	87
	1.02.03 Other Environmental Factors	350
	1.03.01 Tamper-proof	0
	1.03.02.01 Near Field Communication Enabled	1
	1.03.02.02 RFID Tags	107

	Technical Categories	Total Inventions
	1.03.02.03 Printable Electronics	5
	1.03.02.04 QR Code	322
	1.03.03 Electronic Article Surveillance	1
	1.03.04 Wireless Communication Network	30
	1.03.05 Augmented Reality	4
	1.03.06 Environment sensing and responding	0
	1.04.01 Easy Opening of Food Packs	2
	1.04.02 Easy dispensing	0
	1.04.03 Portioning/Sizing	4
	1.04.04 Resealable	2
	1.04.05 Cook within package	0
	1.04.06 On-the-Go Enabling	121
	1.05.01 Recyclable	25
	1.05.02 Degradable	85
	1.05.03 Edible	28
	1.06.01 Value Adding	35
	1.06.02 Infrastructure Building	0
2. Application Areas	2.01.01 Carcass/Primal Cut	72
	2.01.02 Fresh Cut	425
	2.01.03 Frozen	357
	2.01.04 HPP Processed	24
	2.01.05 Ready-to-Eat Meats	224
	2.01.06 Poultry	209
	2.02.01 Raw Seafood	338
	2.02.02 Processed Seafood	33
	2.03 Fresh Pasta	15
	2.04 Cheese	128
	2.05 Powder	14
	2.06.01 Fresh Produce	395
	2.06.02 Processed Horticulture	129
	2.07.01.01 Wines	24
	2.07.01.02 Beers	12
	2.07.01.03 Other Alcohols	124
	2.07.02.01 Dairy	104
	2.07.02.02 Juice	5
	2.07.02.03 Carbonated Beverage	34
	2.07.02.04 Water	103
	2.08 General Foodstuffs	1682
	2.09 Pharmaceuticals	152
	2.10 Medical Devices	5

Technical Categories		Total Inventions
3. Materials	3.01.01.01 Degradable	175
	3.01.01.02 Non-Degradable	6
	3.01.02.01 Synthetic / Semi-Synthetic	17
	3.01.02.02 Natural	37
	3.01.03.01 Non-Renewable	9
	3.01.03.02 Renewable	67
	3.01.04.01 Flexible	11
	3.01.04.02 Rigid / Semi-Rigid	6
	3.01.05.01 Transparent	21
	3.01.05.02 Non-Transparent	2
	3.01.06.01 Printable	4
	3.01.06.02 Non-printable	0
	3.01.07.01 Sensing/Indicating/Monitoring	33
	3.01.07.02 Blocking/Inhibiting/Reacting	95
	3.01.08.01 Mechanical Properties	154
	3.01.08.02 Chemical Properties	1
	3.01.08.03 Cost	236
	3.01.09 Edible	85
	3.02.01 Metal	45
	3.02.02 Glass	30
	3.02.03 Paper/Wood	209
	3.02.04 Other Materials	185
	3.03 Hybrid Systems	59
	3.04 Nanomaterials	131
4. Manufacturing Process	4.01 Blow Molding	6
	4.02 Injection Molding	3
	4.03 Extrusion	75
	4.04 Lamination	327
	4.05 Coating	374
	4.06 3D Printing	13
	4.07 Other Processes	890
5. Format	5.01 Built-in/Embedded	52
	5.02 Coating and Edible Film	28
	5.03 Insert/Packet/Sachet/Patch/Tablet	14
	5.04 Marinade and Flavoring	19
	5.05 Label/Printable/Graphics	32
	5.06 Interaction between Product and Shelf/Environment	38
	5.07 Lid/Cap	8
	5.08 Secondary & Tertiary Packaging	11
	5.09 Other Formats	30

Literature associated with the function / technical feature **other modified / controlled atmosphere** (category 1.01.02.04.04) was highly represented in the dataset. Literature directed toward the application area of **general foodstuffs** (category 2.08) was the next most populated category. In terms of materials, literature associated with the **cost** (category 3.01.08.03) of the technology has the highest representation however literature directed to materials technology generally was only found in small numbers in the dataset.

Other process technology (category 4.07) was the most populous fields in the dataset which related to manufacturing process technology. **Lamination** (category 4.04) and **coating** (category 4.05) technology followed.

In terms of the format of this technology, this was not a highly populated category within the dataset with only **built-in / embedded** (category 5.01) type technology the only real stand out category.

TIMELINE OF TECHNICAL CATEGORY

The table below shows the filing activity timelines for all literature publications in the dataset sorted by technology. Darker shades of blue in the following table help show where increased literature activity has occurred. Lighter shades of blue / gray highlight where less activity has occurred.

With this in mind, it can be clearly seen that some of the technology areas highlighted are increasing in activity over time. Technology associated with **microbial growth sensors** (category 1.01.01.01), **other modified / controlled atmosphere packaging** (category 1.01.02.04.04) and **general foodstuffs** (category 2.08) can all be seen to be increasing in activity over time.

In contrast, there are technology areas that are stagnant or have little to no literature activity occurring. These technologies can be located by their low levels of activity or complete lack of activity (shown by blank or white cells). Examples of this include **thermostatic packaging** (category 1.01.03.02), **tamper proof features** (category 1.03.01) and **cook within packaging** (category 1.04.05) features. A lack of literature activity could be attributed to perceived commercialisation intent of a specific sub-technology. If there is an opportunity to commercialise or save costs associated with a technology then it would be more prudent for an entity to protect the innovation via the patent route rather than publish it though literature.

Timeline of Technology

	Technical Categories	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total Inventions
1. Function / Technical Features	1.01.01.01 Microbial Growth Sensor	18	19	19	19	12	29	16	28	41	35	48	58	60	66	60	73	88	85	86	77	85	23	1045
	1.01.01.02.01 Anti-microbial Agent	1				2	2		1	3	2	4	4	5	5	7	11	6	11	13	13	10	3	103
	1.01.01.02.02 Enzyme based Microbial Inactivation	1	2		1	1	1	2	1	1		1			2	2	1	5	2	5	4	2		34
	1.01.01.02.03 Other Anti-microbial Systems	1	2	4	3	4	8		7	5	12	11	17	22	26	33	40	38	57	52	68	70	25	505
	1.01.02.01.01 Oxygen Sensor	2	2	6	4	5	2	4	16	9	10	9	9	13	8	11	15	15	22	19	13	12		206
	1.01.02.01.02 Oxygen Scavenging	2	3	4	11	9	4	5	7	15	12	17	12	23	20	20	27	36	35	29	21	26	4	342
	1.01.02.01.03 Anti-oxidation Systems	2	4	2	3	2	4	2	6	9	6	9	17	20	24	17	32	36	40	53	54	51	8	401
	1.01.02.02.01 Ethylene Sensor			4		1	2	1	5	5	4	5	5	6	5	6	11	8	9	11	11	11	2	112
	1.01.02.02.02 Ethylene Scavenging		2	5	4	1	7	5	4	6	9	9	5	9	7	10	11	9	17	13	11	12	2	158
	1.01.02.03 Other Gases of Interest	5	7	10	12	9	11	18	16	24	12	24	21	20	25	29	24	32	38	33	30	33	6	439
	1.01.02.04.01 Low Oxygen (or Anoxic) Packaging		2		1		1		1		1	1			1	2	2	3		2	2	1		20
	1.01.02.04.02 High Oxygen Packaging		1		1		1	1	3	1	1	1	1		1		1		3	1	1		1	19
	1.01.02.04.03 Vacuum Packaging	16	24	10	7	10	8	12	19	8	19	21	28	30	21	22	30	32	33	26	37	31	6	450
	1.01.02.04.04 Other Modified/Controlled Atmosphere Packaging	67	72	67	68	62	80	74	108	119	108	137	154	169	165	154	212	207	212	198	166	197	33	2829
	1.01.03.01 Temperature Sensor	4	7	7	2	6	13	7	9	16	12	11	13	28	16	22	25	35	39	29	37	33	10	381
	1.01.03.02 Thermostatic packaging																							0
	1.01.03.03 Self-Heating/Self-Cooling											2					2			1				5
	1.01.04.01 UV Blockage																		1			1		2
	1.01.04.02 Light Barrier		1				1		1	1		4		5	1	4	3	1	2	3	3	4	1	35
	1.01.05.01 Moisture Sensor	4	1	4	2	2	4	9	6	8	2	6	10	17	14	18	20	21	26	20	26	30	6	256
	1.01.05.02.01 Moisture Barrier			1	3		1	2	1	2		5	5	3	4	6	5	6	9	7	11	9	4	84
	1.01.05.02.02 Moisture content or humidity maintenance																							0
	1.01.06.01 Odor Absorbing					1											2		2					5
	1.01.06.02 Flavor Releasing	1	2	2	1	4	4	1	2	4	7	10	5	11	12	19	22	16	39	43	46	40	10	301
	1.01.07 Corrosion Inhibition																				2			2
	1.01.08 Integrity sensor																							0
	1.01.09 Freshness Sensor	4	5	11	3	5	5	6	9	14	6	12	16	20	15	18	31	22	32	25	26	21	5	311
	1.01.10 Eating Profile Enhancement	1	2	2	9	5	7	5	4	7	10	12	16	9	10	12	12	10	18	7	8	14	1	181
	1.01.11 Migration Prevention									1	1	1	1			3	1		1	4		3		16
	1.01.12 Pathogens/Microbial Spoilage	1	13	10	8	4	11	9	12	10	8	14	17	22	25	23	30	29	38	32	24	34	3	377
	1.02.01 Temperature Sensor	5	8	8	4	7	14	8	9	17	14	14	14	29	16	24	26	37	41	32	39	34	11	411
	1.02.02 Physical Shock/Motion Sensor	1	4	2	2	1	2	1	4	2	3	4	3	5	6	5	8	7	4	4	4	13	2	87
	1.02.03 Other Environmental Factors	11	8	14	7	9	6	7	10	13	13	20	21	20	21	15	26	18	29	24	24	30	4	350
	1.03.01 Tamper-proof																							0
	1.03.02.01 Near Field Communication Enabled																	1						1
	1.03.02.02 RFID Tags									1	4	3	6	10	7	16	6	11	7	13	12	10	1	107
	1.03.02.03 Printable Electronics														1			1	1	1		1		5
	1.03.02.04 QR Code	1	1	4	2	3	3	3	2	2	8	12	8	15	18	15	21	21	34	50	50	45	4	322

	Technical Categories	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	Total Inventions
	1.03.03 Electronic Article Surveillance																	1						1
	1.03.04 Wireless Communication Network										1			1		3		2	4	5	9	3	2	30
	1.03.05 Augmented Reality																		2	2				4
	1.03.06 Environment sensing and responding																							0
	1.04.01 Easy Opening of Food Packs												1						1					2
	1.04.02 Easy dispensing																							0
	1.04.03 Portioning/Sizing									2	2													4
	1.04.04 Resealable																		2					2
	1.04.05 Cook within package																							0
	1.04.06 On-the-Go Enabling		1	1	1	2	4	3	2	3	2	4	2	6	7	11	7	10	15	12	11	16	1	121
	1.05.01 Recyclable			1	1				1		1	1	1	1	1	3	3	2	3	3	1	1	1	25
	1.05.02 Degradable		2	2				4	1	2	3	2	3	4	4	3	5	4	4	14	11	13	4	85
	1.05.03 Edible			1					1	1			4	1	1	1	4		3	2	4	4	1	28
	1.06.01 Value Adding			1						2	2		1	3	3	1	1	7	1	3	2	7	1	35
	1.06.02 Infrastructure Building																							0
2. Application Areas	2.01.01 Carcass/Primal Cut	3	3	1	1		2			2	3	5	10	3	4	3	7	6	7	3	3	5	1	72
	2.01.02 Fresh Cut	5	8	3	5	9	10	8	15	26	13	17	17	34	31	21	44	33	34	30	22	36	4	425
	2.01.03 Frozen	6	11	10	7	7	12	12	13	7	14	18	20	24	22	19	27	33	28	21	20	18	8	357
	2.01.04 HPP Processed			1					1	1			2	1	2		1	2	2	3	4	4		24
	2.01.05 Ready-to-Eat Meats	6	4		5	4	11	9	11	4	10	10	10	14	15	13	15	13	18	14	17	18	3	224
	2.01.06 Poultry	5	5	2	2	4	8	4	4	2	6	6	15	16	10	8	11	19	26	12	26	17	1	209
	2.02.01 Raw Seafood	4	10	13	8	6	6	7	13	10	9	15	11	20	16	19	25	21	30	32	32	25	6	338
	2.02.02 Processed Seafood			1	1		1	1	1	1		1	3	1	2	2	4	4	3	2	1	3	1	33
	2.03 Fresh Pasta				1	1	2		1	1		1	1			1	2	1		2			1	15
	2.04 Cheese		2	1	3	1	9	2	5	6		2	9	11	7	15	6	18	4	8	9	7	3	128
	2.05 Powder					1							2	2		3	1	1	1	1	1	1		14
	2.06.01 Fresh Produce	8	4	9	5	9	7	5	11	25	11	17	16	27	21	17	47	29	28	34	23	38	4	395
	2.06.02 Processed Horticulture	1	3	5	2		3	1	4	6	4	11	8	7	11	5	11	11	5	13	8	10		129
	2.07.01.01 Wines			1						1	1		1	1	1	1	3	4	1	2	3	4		24
	2.07.01.02 Beers				1	1					1	1		1	2	1		1		1	1	1		12
	2.07.01.03 Other Alcohols	1			2	2	3	1	3	6	4	5	5	8	4	5	12	10	14	10	12	14	3	124
	2.07.02.01 Dairy	1	1		2	3	3	2	1	4	2	5	4	8	4	8	6	12	8	4	11	13	2	104
	2.07.02.02 Juice				1										1	1						1	1	5
	2.07.02.03 Carbonated Beverage	1		1	2	2		5	1		1			3	7			2	2	1	2	4		34
	2.07.02.04 Water			3	1		3	1	4	5	4	2	3	6	9	6	13	5	13	7	4	12	2	103
	2.08 General Foodstuffs	9	23	36	21	30	31	25	41	50	51	54	70	84	82	96	112	114	160	175	178	199	41	1682
	2.09 Pharmaceuticals		1				2	1	2	3	3	9	4	10	13	9	8	7	18	19	25	15	3	152
	2.10 Medical Devices															1			1		2	1		5
	3.01.01.01 Degradable			2		1	1	4		3	2	3	3	7	4	15	12	12	21	32	20	26	7	175
	3.01.01.02 Non-Degradable													2						2		2		6
	3.01.02.01 Synthetic / Semi-Synthetic								2		1				1	4				3	1	4	1	17
	3.01.02.02 Natural									1			2	2	3	3	2	1	6	4	3	9	1	37
	3.01.03.01 Non-Renewable													2			1			1	2	2	1	9
	3.01.03.02 Renewable			1						1	2	1	2	2	2	7	9	6	5	11	10	5	3	67
	3.01.04.01 Flexible							1		1				1	1				4	1	1		1	11
	3.01.04.02 Rigid / Semi-Rigid							1	2										1	1	1			6
	3.01.05.01 Transparent		1	1	2	1	1			3	1		1				1		1	2	4	2		21
	3.01.05.02 Non-Transparent					1													1					2
3. Materials	3.01.06.01 Printable														1			1		1	1			4
	3.01.06.02 Non-printable																							0
	3.01.07.01 Sensing/Indicating/Monitoring								1			1		2	3		1		7	5	3	7	3	33
	3.01.07.02 Blocking/Inhibiting/Reacting		1		7	2	2	1	1	8	3	4	5	5	3	3	8	4	11	8	11	5	3	95
	3.01.08.01 Mechanical Properties				2		1	2	2	1	1	4	3	4	7	10	12	11	16	13	30	28	7	154
	3.01.08.02 Chemical Properties								1															1
	3.01.08.03 Cost	5	2	3	5	3	5	3	6	4	13	16	15	13	18	11	15	16	15	14	21	27	6	236
	3.01.09 Edible			1					2	1	2	2	1	4	8	6	5	6	9	10	14	12	2	85
	3.02.01 Metal		1		1	1		1	5	1				5	4	3	4	1	5	4	3	6		45
	3.02.02 Glass		2	1	2	1		2	2	1	5	2	2		3	1	1	1	1	1		1	1	30
	3.02.03 Paper/Wood		2	1	3	4	4	3	4	5	7	9	3	7	14	8	18	16	16	27	20	30	8	209
	3.02.04 Other Materials	1	3	2	3		3	5	8	6	8	3	8	14	12	12	14	15	18	13	16	17	4	185
	3.03 Hybrid Systems				1	1		1	1		1	2	1		3	1	4	4	12	8	11	7	1	59
	3.04 Nanomaterials									1	1		1	5	4	4	9	9	9	18	32	30	8	131
4. Manufacturing Process	4.01 Blow Molding		1								1								1		2	1		6
	4.02 Injection Molding														2				1					3
	4.03 Extrusion			1			1	1		1	2	1		5	3	11	7	6	4	7	15	5	5	75
	4.04 Lamination	2	2	9	7	7	3	9	9	11	8	6	12	17	19	25	28	25	36	33	25	29	5	327
	4.05 Coating		3	3	6	2	2	3	4	7	13	8	14	13	28	21	33	21	40	44	52	46	11	374
	4.06 3D Printing							1	1	1						2		2	1		3	1	1	13
	4.07 Other Processes	13	18	22	17	19	20	17	29	30	34	35	31	47	41	46	57	65	79	94	88	74	14	890
5. Format	5.01 Built-in/Embedded		1					1		1	3		4	3	1	2		7	5	9	8	6	1	52
	5.02 Coating and Edible Film																	3	4	5	9	4	3	28
	5.03 Insert/Packet/Sachet/Patch/Tablet							3					1			1	3		2	2	2			14
	5.04 Marinade and Flavoring				1	1		1		1	1	1	2	1	2		2	1	1			4		19
	5.05 Label/Printable/Graphics											2	2	2	1	2	5	2	6	4	3	2	1	32
	5.06 Interaction between Product and Shelf/Environment	1	1				4	2			2	1	1	2	2	2	5	2		5	3	5		38
	5.07 Lid/Cap							1	2					1	1				1	2				8
	5.08 Secondary & Tertiary Packaging										1			1	1	1			3	2		1	1	11
	5.09 Other Formats						2			1		2	2	1		2	2		4	3	3	7	1	30

ENTITY TECHNICAL CATEGORY

The following table shows the top literature entities split by technical category. This helps highlight which entity is producing the most publications in terms of the technology categories in the dataset.

Entities by Technical Category

Technical Categories		Spanish National Research Council	Foggia University	Ghent University	US Dept. of Agriculture	Zaragoza University	National University of Ireland	Technical University of Denmark	Tianjin University of Cartagena	Federal University of Science & Technology	Lleida University	National Research Council (CNR)	Agricultural University of Athens	Michigan State University	Milan University	Helsinki University	Ioannina University	Kyungpook University	Technical University	Catania University	Florida University	Kansas State University	Agriculture & Agri-Food Canada	Mgp University	Kaeersart University	Univ Santiago de Compostela	University of Naples Federico 2
1. Function / Technical Features	1.01.01.01 Microbial Growth Sensor	37	60	33	15	26	7	24	8	18	14	16	19	6	9	14	24	9	14	9	4		4	2	7	1	12
	1.01.01.02.01 Anti-microbial Agent	10	4			8	1			6		3		2	3	1				1	1						2
	1.01.01.02.02 Enzyme based Microbial Inactivation		1	1			1							2													
	1.01.01.02.03 Other Anti-microbial Systems	37	25	7	8	19	3	3	3	21	4	11	2	6	9	2	4	1	4	4	1	1		5	3	6	11
	1.01.02.01.01 Oxygen Sensor	6	5	2	5	1	11	1		1		1		4	3	1	1		2	3	2	2	2				3
	1.01.02.01.02 Oxygen Scavenging	10	10	2	3	2	1			5	1			4	7		6		2	6		1	3	2	4	4	4
	1.01.02.01.03 Anti-oxidation Systems	18	5	3	6	31	10	9	3	3	14	7		6	3		1	3	1	5		4	4	11	1	15	4
	1.01.02.02.01 Ethylene Sensor	4	2	1	5	1	1	8	1					5							1		1		2		1
	1.01.02.02.02 Ethylene Scavenging	9	5	5	3	1		3		1				2	1		2			1		1	2	2	3	2	3
	1.01.02.03 Other Gases of Interest	26	13	8	11	5	5	9		1	3	2	1	5	3	3	6	11	1	2	2		1	2	5	2	3
	1.01.02.04.01 Low Oxygen (or Anoxic) Packaging	1		1	1					1			1		2			1					1				
	1.01.02.04.02 High Oxygen Packaging		1	1		1	4			1															1		1
	1.01.02.04.03 Vacuum Packaging	11	2	8	3	4	7			3	1	2	6	2		2	9	3	3	3	3	10		2		4	5
	1.01.02.04.04 Other Modified/Controlled Atmosphere Packaging	92	53	72	61	45	50	43	31	5	38	21	39	20	16	36	35	24	31	22	20	27	27	2	18	6	14
	1.01.03.01 Temperature Sensor	9	4	7	8	7	3	7	1	1	3	3	5	3	4	1		2	4	2	9		2	6	3	4	1
	1.01.03.02 Thermostatic packaging																										
	1.01.03.03 Self-Heating/Self-Cooling																				2						
	1.01.04.01 UV Blockage	1																									
	1.01.04.02 Light Barrier	3			1									1			3		1								1
	1.01.05.01 Moisture Sensor	8	1	4	8	3	5	3		1		3	1	2	2	1		1		2	2		2	1	3	1	
	1.01.05.02.01 Moisture Barrier	4			1	1												1			1						
	1.01.05.02.02 Moisture content or humidity maintenance																										
	1.01.06.01 Odor Absorbing																							2		2	
	1.01.06.02 Flavor Releasing	36	8	4	6	6	1			6		6		4	7	1		4			2			7	1	5	3
	1.01.07 Corrosion Inhibition											1															
	1.01.08 Integrity sensor																										
	1.01.09 Freshness Sensor	15	8	7	11	4	4	10	2		5	2	2	4	4		6	4	3	2	7	1	3	2	7	3	2
	1.01.10 Eating Profile Enhancement	4	2	3	1	6	7			1	3	2			4		1			1		14	1			2	
	1.01.11 Migration Prevention	1		1		3			1																	1	
	1.01.12 Pathogens/Microbial Spoilage	11	27	20	7	3	1	5	1	1	5	9	17	1	3	13	5	3	15	1		1		1	2	2	6
	1.02.01 Temperature Sensor	10	4	7	8	7	7	8	1	1	3	3	5	3	4	1		2	4	3	9	1	2	6	3	4	1
	1.02.02 Physical Shock/Motion Sensor	3				1			1	2		1	1					2	2		1	1					1
	1.02.03 Other Environmental Factors	8	7	5	12	6	6	4	2	2	4	2	3	4	1	5	4	6	3	3	2	1	2	1			2
	1.03.01 Tamper-proof																										
	1.03.02.01 Near Field Communication Enabled																										
	1.03.02.02 RFID Tags				1		1	1						3							3			4			
	1.03.02.03 Printable Electronics															1											
	1.03.02.04 QR Code	4	1	2	1		5	2		5		3		2	1	2		1			4		1	13	3	4	
	1.03.03 Electronic Article Surveillance																										
	1.03.04 Wireless Communication Network																				2						
	1.03.05 Augmented Reality																										
	1.03.06 Environment sensing and responding																										
	1.04.01 Easy Opening of Food Packs											1															
	1.04.02 Easy dispensing																										
	1.04.03 Portioning/Sizing																										
	1.04.04 Resealable																										
	1.04.05 Cook within package																										
	1.04.06 On-the-Go Enabling	4	5	5		2	1	1	1	2	3	1	1	4			2	2	2			3			1	1
	1.05.01 Recyclable												1	1		1	1										
	1.05.02 Degradable	1	4		1			1		1		1	2	2	1	1				1			1				1
	1.05.03 Edible				2					1		1												1	1		
	1.06.01 Value Adding		5		2	1					1							1		1				2	1		
	1.06.02 Infrastructure Building																										
	2.01.01 Carcass/Primal Cut		1	2	1	1	3									3						9	2			1	
	2.01.02 Fresh Cut	26	19	14	37	8	11	25	9	1	32	4	1	8	5		1			6	5		10		7	1	2
	2.01.03 Frozen	16	1	8	8	4	6	7	1	2		1	5		1	3	6	4	14	6	2	4	3	6	6	7	3
	2.01.04 HPP Processed	2					1																				
	2.01.05 Ready-to-Eat Meats	1	1	16	1	4	14			3	1		3		2	6	2	1			1	5	1				
	2.01.06 Poultry	3	2	8	5	1	2						3	3	2	12	15			1		1				1	
	2.02.01 Raw Seafood	12	9	10	3	1	6	1				4	6		2	3	5	4	19	3	1			2		8	3
	2.02.02 Processed Seafood	3	1	2			3									1			5	1							
	2.03 Fresh Pasta		2							1																	

	Technical Categories	Spanish National Research Council	Foggia University	Ghent University	US Dept. of Agriculture	Zaragoza University	National University of Ireland	Technical University of Ireland	Tianjin University of Cartagena	Federal University of Science & Technology	Lleida University	National Research Council of Vicosa	Agricultural Research Council (CNR)	Michigan State University	Milan University	Helsinki University	Ioannina University	Kyungnam University	Technical University	Calabria University of Denmark	Florida University	Kansas State University	Agriculture & Agri-Food Canada	Vigo University	Kaserstuhl University	Univ Santiago de Compostela	University of Naples Federico 2
2. Application Areas	2.04 Cheese	2	17	3		1	2			4		3		1			5		3	1				2			
	2.05 Powder	2				2																					
	2.06.01 Fresh Produce	23	11	11	26	6	6	16	8	3	15	2	4	4	2					5	4		9		5		3
	2.06.02 Processed Horticulture	4	2	1	9	3		3	2	2	3	1			1					2			2		2		
	2.07.01.01 Wines		2			1																		3			
	2.07.01.02 Beers	1	1				1					2												1		1	
	2.07.01.03 Other Alcohols	20	3		5	4			4			1	2	3			4	1	2	1				1			2
	2.07.02.01 Dairy	8	7		1	1				3		5							1					3		1	1
	2.07.02.02 Juice																										
	2.07.02.03 Carbonated Beverage			2	1		1									1		3			1				1	1	
	2.07.02.04 Water	1		4	3	1	1	6	1			2		1				2	1	1			4	1			
	2.08 General Foodstuffs	73	28	37	23	36	22	14	15	30	14	21	12	14	23	10	5	22	15	15	10	2	4	18	10	18	11
	2.09 Pharmaceuticals	3		1	6	1				2		3		1	3						1			6			
	2.10 Medical Devices																										
3. Materials	3.01.01.01 Degradable	17	7		1	2		1		1		6	3	2	7	2				3	1		1				2
	3.01.01.02 Non-Degradable													2		1											
	3.01.02.01 Synthetic / Semi-Synthetic	1										1															
	3.01.02.02 Natural	3	1		1	2				2		2	1	1	1									1		1	
	3.01.03.01 Non-Renewable													2													
	3.01.03.02 Renewable	10	2		1							2		2	7												
	3.01.04.01 Flexible	1																									
	3.01.04.02 Rigid / Semi-Rigid	1																					1				
	3.01.05.01 Transparent	3													1												
	3.01.05.02 Non-Transparent																										
	3.01.06.01 Printable																									1	
	3.01.06.02 Non-printable																										
	3.01.07.01 Sensing/Indicating/Monitoring	2			1	1	2	1												2							1
	3.01.07.02 Blocking/Inhibiting/Reacting	11	2	1	1			1					1	1	1			2		3							2
	3.01.08.01 Mechanical Properties	4			3				5	7		1		3	4	1		1		1	1			1	2	1	1
	3.01.08.02 Chemical Properties			1																							
	3.01.08.03 Cost	5	4	2		4	3		3	1	1	2	2	3		3	10	1		1	1	4	4	2		3	1
	3.01.09 Edible	6	1		2		1		3	3	1	1	1	2	5									2	1		1
	3.02.01 Metal	2	1				1			1	1						1										
	3.02.02 Glass		7		1												1			2				1			1
	3.02.03 Paper/Wood	4	5	5	1	6	3	3	4	7		2		1	5	3		3			4			2	4	3	1
	3.02.04 Other Materials	5		1	2	2	3			2	3	3	1	1			4	1	1	2			3	1	2		
	3.03 Hybrid Systems	5	1						2			1			2						1						
	3.04 Nanomaterials	9	5				1		2	1		3		2	1	1								4		1	1
4. Manufacturing Process	4.01 Blow Molding								2																		
	4.02 Injection Molding								1																		
	4.03 Extrusion	4	3	2	2	1			1	1		3		1	1									1		3	3
	4.04 Lamination	19	11	5	3	6	1	7	9	5	2	3	5	7	2			3	1	5	2		2	2	1	1	2
	4.05 Coating	20	23	3	3	10	6	2	9	5	4	8			8	2	2			7	1		1	1	5	2	9
	4.06 3D Printing	1								1																	
	4.07 Other Processes	24	16	27	19	12	17	7	8	6	6	7	5	18	11	15	4	26	4	5	7	1	4	3	7	6	5
5. Format	5.01 Built-in/Embedded					1	4		1	4										1				1			1
	5.02 Coating and Edible Film	3			1			1		2		1												1		1	
	5.03 Insert/Packet/Sachet/Patch/Tablet						1			1				1				1									
	5.04 Marinade and Flavoring							1								2											
	5.05 Label/Printable/Graphics					1	1							1							2		1		1		
	5.06 Interaction between Product and Shelf/Environment	2	1		5	2	1		2					1				1							2		
	5.07 Lid/Cap		1				2					2											1				
	5.08 Secondary & Tertiary Packaging										1							3									
	5.09 Other Formats	1		1		2		2						1										2		2	

PROFILE OF TECHNICAL CATEGORIES

The table below shows a summary profile for each of the technical categories. The analysis includes the following measurements and indicators for each technical category:

- The total number of publications in each technical area.
- The most prolific entity within the field based on all entities in the literature dataset
- Total citations
- The average citation impact of the publications associated with the topic
- Recency of the inventive effort (% filed since 2009)

	Technical Categories	Total Publications	Most Prolific Entity	Total Citations	Citation Impact*	% of Collection Published from 2009 to present
1. Function / Technical Features	1.01.01.01 Microbial Growth Sensor	1045	Foggia University	17464	16.7	55%
	1.01.01.02.01 Anti-microbial Agent	103	Spanish National Research Council	1735	16.8	72%
	1.01.01.02.02 Enzyme based Microbial Inactivation	34	Multiple	1060	31.2	62%
	1.01.01.02.03 Other Anti-microbial Systems	505	Spanish National Research Council	9518	18.8	76%
	1.01.02.01.01 Oxygen Sensor	206	National University of Ireland	2867	13.9	52%
	1.01.02.01.02 Oxygen Scavenging	342	Multiple	4049	11.8	58%
	1.01.02.01.03 Anti-oxidation Systems	401	Zaragoza University	6124	15.3	73%
	1.01.02.02.01 Ethylene Sensor	112	Technical University of Cartagena	857	7.7	62%
	1.01.02.02.02 Ethylene Scavenging	158	Spanish National Research Council	1610	10.2	54%
	1.01.02.03 Other Gases of Interest	439	Spanish National Research Council	6185	14.1	51%
	1.01.02.04.01 Low Oxygen (or Anoxic) Packaging	20	Milan University	231	11.6	60%
	1.01.02.04.02 High Oxygen Packaging	19	National University of Ireland	266	14.0	37%
	1.01.02.04.03 Vacuum Packaging	450	Univ Iowa State	7349	16.3	48%
	1.01.02.04.04 Other Modified/Controlled Atmosphere Packaging	2829	Spanish National Research Council	38929	13.8	49%
	1.01.03.01 Temperature Sensor	381	Multiple	4938	13.0	60%
	1.01.03.02 Thermostatic packaging	-	-	-	-	-
	1.01.03.03 Self-Heating/Self-Cooling	5	Florida University	60	12.0	60%
	1.01.04.01 UV Blockage	2	Multiple	4	2.0	100%
	1.01.04.02 Light Barrier	35	Multiple	444	12.7	60%
	1.01.05.01 Moisture Sensor	256	Multiple	2580	10.1	65%
	1.01.05.02.01 Moisture Barrier	84	Spanish National Research Council	874	10.4	68%
	1.01.05.02.02 Moisture content or humidity maintenance	-	-	-	-	-
	1.01.06.01 Odor Absorbing	5	Multiple	207	41.4	80%
	1.01.06.02 Flavor Releasing	301	Spanish National Research Council	3538	11.8	78%
	1.01.07 Corrosion Inhibition	2	Multiple	5	2.5	100%
	1.01.08 Integrity sensor	-	-	-	-	-
	1.01.09 Freshness Sensor	311	Spanish National Research Council	3961	12.7	58%
	1.01.10 Eating Profile Enhancement	181	Kansas State University	3176	17.5	45%
	1.01.11 Migration Prevention	16	Zaragoza University	205	12.8	75%
	1.01.12 Pathogens/Microbial Spoilage	377	Foggia University	7855	20.8	56%
	1.02.01 Temperature Sensor	411	Spanish National Research Council	5254	12.8	59%
	1.02.02 Physical Shock/Motion Sensor	87	Univ Mustafa Kemal	798	9.2	54%
	1.02.03 Other Environmental Factors	350	US Dept. of Agriculture	4274	12.2	49%
	1.03.01 Tamper-proof	-	-	-	-	-
	1.03.02.01 Near Field Communication Enabled	1	Hewlett-Packard Labs	0	0.0	100%
	1.03.02.02 RFID Tags	107	Multiple	663	6.2	71%
	1.03.02.03 Printable Electronics	5	Univ Mid Sweden	28	5.6	80%
	1.03.02.04 QR Code	322	Univ Bremen	2959	9.2	75%
	1.03.03 Electronic Article Surveillance	1	Multiple	11	11.0	100%
	1.03.04 Wireless Communication Network	30	Univ Bremen	103	3.4	93%
	1.03.05 Augmented Reality	4	Univ Utah State	0	0.0	100%
	1.03.06 Environment sensing and responding	-	-	-	-	-
	1.04.01 Easy Opening of Food Packs	2	Multiple	1	0.5	50%
	1.04.02 Easy dispensing	-	-	-	-	-
	1.04.03 Portioning/Sizing	4	Ind Technol Res Inst	2	0.5	0%
	1.04.04 Resealable	2	Multiple	5	2.5	100%
	1.04.05 Cook within package	-	-	-	-	-
	1.04.06 On-the-Go Enabling	121	Multiple	1468	12.1	69%
	1.05.01 Recyclable	25	Multiple	127	5.1	68%
	1.05.02 Degradable	85	Foggia University	1300	15.3	68%
	1.05.03 Edible	28	Multiple	444	15.9	68%
	1.06.01 Value Adding	35	Foggia University	309	8.8	66%
	1.06.02 Infrastructure Building	-	-	-	-	-

Technical Categories		Total Publications	Most Prolific Entity	Total Citations	Citation Impact*	% of Collection Published from 2009 to present
2. Application Areas	2.01.01 Carcass/Primal Cut	72	Kansas State University	981	13.6	49%
	2.01.02 Fresh Cut	425	US Dept. of Agriculture	6506	15.3	53%
	2.01.03 Frozen	357	Spanish National Research Council	5475	15.3	49%
	2.01.04 HPP Processed	24	CTCPA	199	8.3	67%
	2.01.05 Ready-to-Eat Meats	224	Ghent University	3678	16.4	50%
	2.01.06 Poultry	209	Ioannina University	2672	12.8	57%
	2.02.01 Raw Seafood	338	Technical University of Denmark	5927	17.5	56%
	2.02.02 Processed Seafood	33	Multiple	598	18.1	61%
	2.03 Fresh Pasta	15	Univ Estadual Londrina	79	5.3	47%
	2.04 Cheese	128	Foggia University	1827	14.3	55%
	2.05 Powder	14	Univ Antioquia	200	14.3	64%
	2.06.01 Fresh Produce	395	US Dept. of Agriculture	5547	14.0	56%
	2.06.02 Processed Horticulture	129	US Dept. of Agriculture	1229	9.5	49%
	2.07.01.01 Wines	24	Multiple	180	7.5	75%
	2.07.01.02 Beers	12	National Research Council (CNR)	44	3.7	42%
	2.07.01.03 Other Alcohols	124	Spanish National Research Council	1354	10.9	65%
	2.07.02.01 Dairy	104	Spanish National Research Council	968	9.3	62%
	2.07.02.02 Juice	5	Multiple	8	1.6	60%
	2.07.02.03 Carbonated Beverage	34	Multiple	482	14.2	32%
	2.07.02.04 Water	103	Technical University of Cartagena	916	8.9	60%
	2.08 General Foodstuffs	1682	Spanish National Research Council	22612	13.4	64%
	2.09 Pharmaceuticals	152	Multiple	2016	13.3	68%
	2.10 Medical Devices	5	Multiple	6	1.2	100%
3. Materials	3.01.01.01 Degradable	175	Spanish National Research Council	2572	14.7	83%
	3.01.01.02 Non-Degradable	6	Univ Mokpo Natl	361	60.2	67%
	3.01.02.01 Synthetic / Semi-Synthetic	17	Izmir Inst Technol	566	33.3	76%
	3.01.02.02 Natural	37	Spanish National Research Council	599	16.2	78%
	3.01.03.01 Non-Renewable	9	Univ Mokpo Natl	485	53.9	78%
	3.01.03.02 Renewable	67	Spanish National Research Council	1800	26.9	84%
	3.01.04.01 Flexible	11	Multiple	98	8.9	64%
	3.01.04.02 Rigid / Semi-Rigid	6	Multiple	99	16.5	50%
	3.01.05.01 Transparent	21	Univ Texas A&M	154	7.3	48%
	3.01.05.02 Non-Transparent	2	Multiple	46	23.0	50%
	3.01.06.01 Printable	4	Multiple	11	2.8	75%
	3.01.06.02 Non-printable	-	-	-	-	-
	3.01.07.01 Sensing/Indicating/Monitoring	33	Multiple	302	9.2	79%
	3.01.07.02 Blocking/Inhibiting/Reacting	95	Spanish National Research Council	1065	11.2	56%
	3.01.08.01 Mechanical Properties	154	Federal University of Vicosa	1759	11.4	82%
	3.01.08.02 Chemical Properties	1	Ghent University	87	87.0	0%
	3.01.08.03 Cost	236	Ioannina University	2572	10.9	53%
	3.01.09 Edible	85	Spanish National Research Council	1687	19.8	75%
	3.02.01 Metal	45	Univ Massachusetts	470	10.4	58%
	3.02.02 Glass	30	Foggia University	295	9.8	23%
	3.02.03 Paper/Wood	209	Federal University of Vicosa	2004	9.6	68%
	3.02.04 Other Materials	185	Spanish National Research Council	2709	14.6	59%
	3.03 Hybrid Systems	59	Spanish National Research Council	568	9.6	81%
	3.04 Nanomaterials	131	Spanish National Research Council	1772	13.5	91%
4. Manufacturing Process	4.01 Blow Molding	6	Tianjin University of Science & Technology	42	7.0	67%
	4.02 Injection Molding	3	Multiple	2	0.7	33%
	4.03 Extrusion	75	Univ Salerno	527	7.0	80%
	4.04 Lamination	327	Spanish National Research Council	3779	11.6	63%
	4.05 Coating	374	Foggia University	4952	13.2	72%
	4.06 3D Printing	13	Univ Massachusetts	160	12.3	77%
	4.07 Other Processes	890	Ghent University	12158	13.7	58%
5. Format	5.01 Built-in/Embedded	52	Multiple	565	10.9	73%
	5.02 Coating and Edible Film	28	Spanish National Research Council	128	4.6	100%
	5.03 Insert/Packet/Sachet/Patch/Tablet	14	Georgia Inst Technol	86	6.1	71%
	5.04 Marinade and Flavoring	19	Univ Suleyman Demirel	393	20.7	42%
	5.05 Label/Printable/Graphics	32	Univ Chongqing Jiao Tong	316	9.9	78%
	5.06 Interaction between Product and Shelf/Environment	38	US Dept. of Agriculture	507	13.3	58%
	5.07 Lid/Cap	8	Multiple	138	17.3	38%
	5.08 Secondary & Tertiary Packaging	11	Kyungnam University	19	1.7	73%
	5.09 Other Formats	30	Multiple	189	6.3	73%

This analysis makes for insightful reading. There are many entities that are prominent or have shown interest in many of the technology categories. The **Spanish National Research Council** (Spain) leads more categories that any other entity across multiple facets of technology related to function / technical features, applicant areas and materials.

There are technologies represented that have achieved 100% of its Literature published since 2009. Categories that fit these criteria have low total publication numbers; however they are still shown to be recent. Technology that match this criteria includes **UV blockage** (category 1.01.04.01), **corrosion inhibition** (category 1.01.07), **near field communication** (category 1.03.02.01), **electronic article surveillance** (category 1.03.03), **augmented reality** (category 1.03.05) and **resalable features** (category 1.04.04) in relation to the function or technical feature. **Medical devices** (category 2.10) in relation to the application area and **coating and edible films** (category 5.02) relating to the specific technology format. As these technologies are recent, it may be worth further investigation to assess the viability of them in terms of commercialisation or integration into current processes and procedures for **Meat & Livestock Australia** before they become fully realised by competitors.

Citation impact shows the extent that a publication within a technology has been cited by other publications therefore providing insight into the perceived interest and importance of literature published within that technology field. Understanding this, we can see there are a number of technologies which have high citation impact values. The highest recorded value (87.0) was given to **chemical properties** materials technology (category 3.01.08.02). This technology may have low levels of activity (1 publication) however due to the high citation impact, it can be said that the technology involved is of a high and innovative quality.

CROSS TECHNOLOGY CHARTS

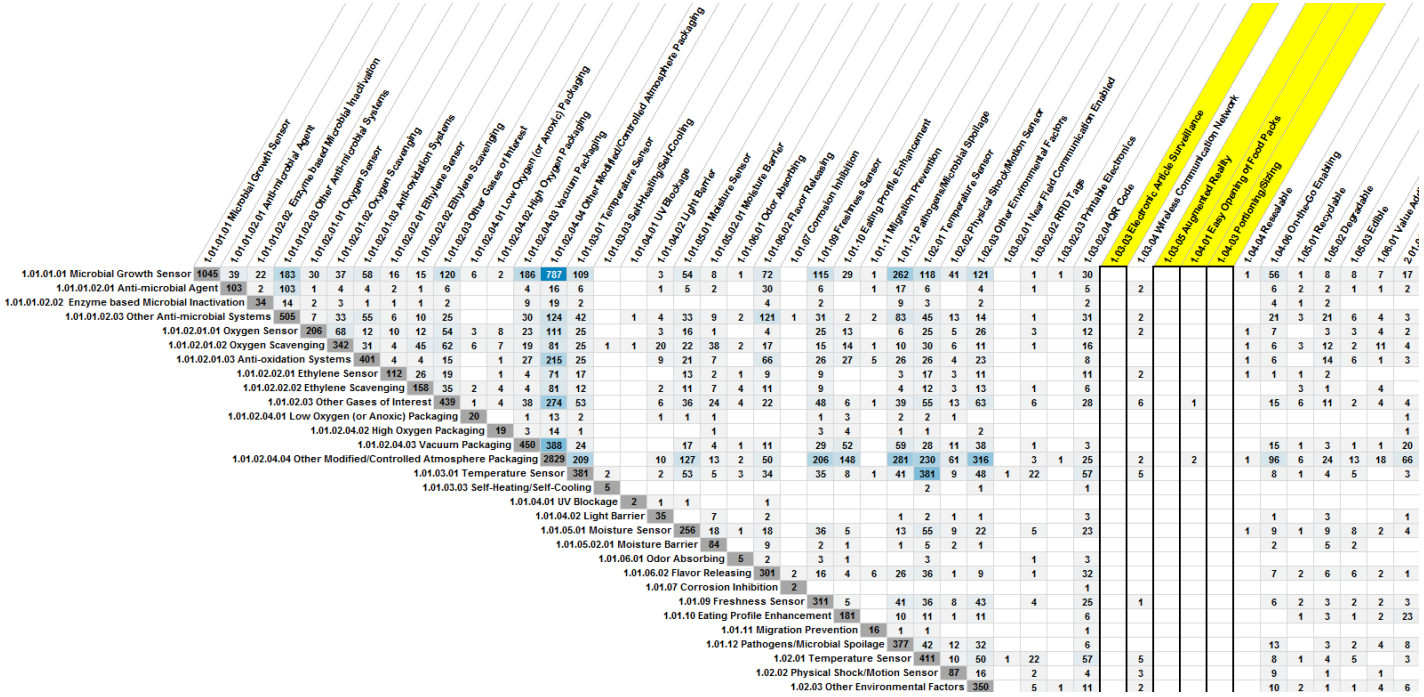
The matrix shown below in a partial view on the next page highlights a sample section of the cross-correlation of all technical categories in the data set, with the heat-map showing highly correlated categories. The matrix suggests there could be a “technology gap” (areas in a lighter shade of blue or white) in technology areas where there is little or no activity, but where **Meat & Livestock Australia** experts may consider having potential. Please note that due to the number of technology categories and large size of the cross technology chart, the full table has not been placed in the report. Due to its size, the full cross technology table can be viewed in the corresponding excel work file under the tab **‘Technology Analysis – Matrices’.**

A good method of navigating a cross technology chart is to focus on technology areas where there is there is little or no activity. These technology areas will highlight where these is potential opportunity to innovate. In terms of literature publications, if there is a technology which is crowded (many publications), these charts will help highlight who has better expertise in relation to a sub-technology and who may be best to conduct further investigations on for potential partnership or licensing opportunities.

In general, areas of high literature publication usually represent a low interest of perceived commercialisation opportunity. A low indication of activity in literature publications could equate to more interest in patent strategy and commercialisation for that technology area or potentially a lack of interest in the technology in general due to a deficiency of expertise, low perceived need or budgetary requirements needed for research and development.

There appear to be multiple areas of low activity relating to this category. Some examples include **electronic article surveillance** (category 1.03.03), **augmented reality** (category 1.03.05), **easy opening of food packs** (category 1.04.01) and **portioning / sizing** (category 1.04.03).

Literature Cross Technology Chart (partial chart example)



HIGH IMPACT PUBLICATIONS

Below is a list of top 'high impact' publications identified within the collection. Older documents however have had more opportunity to be cited. To compensate for this fact, age-weighted frequencies (average citations per year) have been calculated. Further investigation of these high impact literature publications may be warranted by **Meat & Livestock Australia.** The complete list can be viewed within the corresponding excel worksheet.

High Cited Publications	Age-Weighted Citation
Plat-E: an efficient and stable system for transient packaging of retroviruses	**60.69**
Univ Tokyo	
Publication Year - 2000	
Times Cited - 971	
Tailor-made polyelectrolyte microcapsules: From multilayers to smart containers	**57.00**
Capsulut Nanosci AG| Max Planck Inst Colloids & Interfaces	
Publication Year - 2004	
Times Cited - 684	
Bio-nanocomposites for food packaging applications	**41.33**
Univ Michigan State| Univ Mokpo Natl| Univ Pusan Natl	
Publication Year - 2013	
Times Cited - 124	
Strength and barrier properties of MFC films	**26.57**
NTNU| Paper & Fibre Res Inst PFI	
Publication Year - 2009	
Times Cited - 186	
Extending and measuring the quality of fresh-cut fruit and vegetables: a review	**26.33**
Dublin Inst Technol| Univ Politecn Valencia	
Publication Year - 2007	
Times Cited - 237	
Chitosan: antimicrobial activity, interactions with food components and applicability as a coating on fruit and vegetables	**23.33**
State Univ Ghent	
Publication Year - 2004	
Times Cited - 280	
Food packaging based on polymer nanomaterials	**23.20**
CNR Natl Res Council Italy	
Publication Year - 2011	
Times Cited - 116	
Antimicrobial food packaging in meat industry	**22.71**
Expt Stn Food Preserving Ind	
Publication Year - 2002	
Times Cited - 318	
Natural biopolymer-based nanocomposite films for packaging applications	**22.00**
Univ Michigan State| Univ Mokpo Natl	
Publication Year - 2007	
Times Cited - 198	
Where is MAP Going? A review and future potential of modified atmosphere packaging for meat	**21.00**
Univ Louisiana State	
Publication Year - 2008	
Times Cited - 168	
Antimicrobial activity of whey protein based edible films incorporated with oregano, rosemary and garlic essential oils	**20.60**
Univ Suleyman Demirel	
Publication Year - 2006	
Times Cited - 206	

APPENDIX A – DATA COLLECTION

DATA COLLECTION STRATEGY

The patent collection was developed using the full patent content on Thomson Innovation®, which included the Derwent World Patent Index® (DWPI). The use of the patent content on Thomson Innovation ensures a comprehensive collection. The patent collections were normalised on the DWPI database structure to allow for accurate analysis. The Literature collection was also developed using the full content literature coverage on Thomson Innovation®, which includes Web of Science, Conference proceedings, Current Contents Connect and Inspec.

Data de-duplication was performed to remove literature references with identical accession numbers. Additionally, literature references with identical titles were subjected to preliminary screening to identify and eliminate redundant references. The net result of this step is unique literature references in the dataset.

Entity names were cleaned and unified to the extent possible so that known subsidiaries and merger and acquisition entities were grouped under a single company name for a more accurate view of the entities holdings.

Specifically, the search process returned a set of **12930** screened DWPI inventions. There were a total of **4441** literature results returned from the search process.

WHAT IS NOT INCLUDED?

The search strategies employed identified **12930** patented inventions and **4441** literature publications. There may have been other inventions developed which may not have been protected by patent or published as papers in journals. The inventors may have chosen to pursue the developments without patent protection or publishing literature. They may have chosen their ideas to be protected by trade secrets, which by their nature are not publically accessible.

DATA COUNTING DEFINITION

The DWPI database is structure around “patent families”[1].

Each related patent application and granted patent is added to the DWPI family record as it is [published. This being the case, all counts of records in the project refer to patent families or inventions, and not to individual patent documents. For example, United States granted, United States application and European application patent for a single invention family is counted in aggregate as “1” in all the analyses in this report unless otherwise noted.

This provided a more accurate measure of the level of inventive activity from an entity within the technical space, and a truer picture of the overall level of innovation across the field as a whole

COUNTS AND TOTALS, SCIENTIFIC PAPERS

The Web of Science database is formed around individual papers, articles, review studies and editorials published in its source journals.

Each record is therefore a unique article in the body of scientific literature. The date the journal containing the article was published is used throughout the report in all timelines and charts.

TIMELINES AND DATES

As each DWPI record contain potentially many individual application and publication events, this report utilises the earliest known priority filing date for each patent family. The tables and charts included in the report use these dates unless otherwise noted.

The patent and literature data in the collection had an earlier priority date of at least **1995**. Because of the way the data was collected, there is some data in the report that has an earliest priority date earlier that **1995**. To the extent possible, this data was removed from the analysis but it may remain in some of the aggregate findings.

[1] A single patent only provides a statutory monopoly for the patent technology within the legal jurisdiction of the authority that granted the patent. This means that inventors must file applications for a patent in each jurisdiction where they foresee a need for protection.

APPENDIX B – BACKGROUND ON CONSULTANT

Nick Solomon, based in Melbourne (Australia), delivers research and analysis projects and solutions using advanced statistical analysis of scientific and technical data sources and primary patent, trademark, literature and business type information. The reports are designed to provide intelligence on technical or competitive trends to senior client executives and decision makers.

Nick's responsibilities also include providing expert insight and best practice knowledge on Thomson Reuters' products and services, assessing customer requirements and trainer and education specialist for the Australian and New Zealand territories on various IP databases and solutions.

In an earlier role, Nick managed Information Services of an Australian Intellectual Property Law firm for 10 years, where he became familiar with all aspects of the Intellectual Property field and analytics associated. Prior to this, Nick worked in research at the Commonwealth Scientific Industrial Research Organisation (CSIRO) and as an IP Administrator for a Co-operative research center.

Nick joined Thomson Reuters in 2013 and has a Bachelor of Applied Science Biochemistry / Chemistry from Swinburne University and a Diploma in Business / Management.