

A patent survey case: How could technological forecasting help cosmetic chemists with product innovation?

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Synopsis

Patents represent a free and open source of data for studying innovation and forecasting technological trends. Thus, we suggest that new discussions about the role of patent information are needed. To illustrate the relevance of this issue, we performed a survey of patents involving skin care products, which were granted by the United States Patent and Trademark Office (USPTO) between 2006 and 2010, to identify opportunities for innovation and technological trends. We quantified the use of technologies in 333 patents. We plotted a life cycle of technologies related to natural ingredients. We also determined the cross impact of the technologies identified. We observed technologies related to processes applied to cosmetics (2.2%), functional packaging and applicators (2.9%), excipients and active compounds (21.5%), and cosmetic preparations (73.5%). Further, 21.6% of the patents were related to the use of natural ingredients. Several opportunities for innovation were discussed throughout this paper, for example, the use of peptides as active compounds or intracellular carriers (only 3.9% of the technologies in cosmetic preparations). We also observed technological cross impacts that suggested a trend toward multifunctional cosmetics, among others. Patent surveys may help researchers with product innovation because they allow us to identify available and unexplored technologies and turn them into whole new concepts.

INTRODUCTION

A few decades ago, in 1953, Cifelli Jr. (1) published a paper in this journal discussing the need of scientific tests to support the claims of cosmetic patents. From that time on, the cosmetic industry has acquired considerable knowledge on how to prepare a patent application. In fact, a great deal has evolved in the cosmetic industry and the need of scientific data to support claims is already common sense. Therefore, it is time for new discussions about the role of patents in this sector. Following, we present some mottos to study and discuss patent information.

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In different technological fields, some authors have studied patent information with the purpose of (a) estimating the market value of a company (2), (b) monitoring convergence between different industries (3), (c) developing strategies for technology management (4), (d) plotting technological life cycles (5), (e) identifying new businesses (6), (f) assessing R&D efficiency (7), (g) benchmarking companies (8), and (h) determining the technological impact of one technology over another (9), among others. Obviously, patent analysis represents a broad field of research. On the other hand, we could barely find scientific patent analysis specifically devised for the cosmetic industry.

A peculiarity of the data reported in granted patents is that they are not found elsewhere before the occasion of patent application. This is one reason why patents represent a unique source of information to develop innovative thinking (8). Furthermore, patents are so closely related to the life cycle of technologies, that it is possible to study innovation and technological trends through patent information. For example, when a technology is in process of development, fundamental scientific and technological issues have to be solved and risks must be taken in order to achieve an innovation. Therefore, the number of patent applications is low and increases slowly. Afterward, as technological and market uncertainties fade, many innovations based on the initial technology are developed and the number of patent applications increases. Then, the technology reaches its maturity period, and the number of patents decline, though some incremental innovations may remain constant (5).

Certainly, patents play the role of providing scientific and technical information. In fact, one study showed that in most areas of chemistry, patents are a rich source of first publications (10). Moreover, this study shows that only 7% of the polymers patented in 1980 (1980–2003) were ulteriorly published in non-patent literature and that 43% of all polymers developed that year were published only in patents (10). This scenario suggests that patent information is more dynamic than non-patent literature, although it is not well explored.

In this context, our objective was to perform a survey of patents related to skin care products, which were granted by the United States Patent and Trademark Office (USPTO) between 2006 and 2010, to identify opportunities for innovation as well as technological trends.

METHODS

DATA COLLECTION

In this survey, we used the search tools available on the homepage of the USPTO to collect data (11). We searched patents granted during the period of January 1, 2006 to December 31, 2010, which contained the words “cosmetic” or “cosmetics” in their title. This search procedure resulted in a total of 1036 patents. Afterward, we read and analyzed the patents, selecting only those that claimed for application in skin care products. Consequently, we excluded patents related only to manufacturing processes, ornamental designs, or other types of products. This filtering procedure resulted in a total of 335 patents (32.3% of the initial number). We limited this survey to skin care products because there is a common expectation of even more efficient products in this area, once they are capable of, for example (a) reducing the risk of acquiring age-related skin diseases; (b) preserving against the effects of UVA and UVB radiations; (c) avoiding the urge for cosmetic surgeries; (d) reducing the psychosocial impact of aging on the human being; and (e) keeping a youthful and healthy aspect.

PATENT CLASSIFICATION AND QUANTIFICATION

After selecting the patents, we went on to analyze them considering the International Patent Classification (IPC) system established by the Strasbourg Agreement (12). The IPC is an international agreement on how to systematically classify patentable technologies and inventions. We used the IPC internet publication version 2011.01 to browse for IPC code definitions (13). The Appendix presents a list of some IPC codes and their meanings. Further, simply for didactic and practical purposes, we proposed a categorization of the IPC codes observed in our patent sample. This categorization is based on the use and similarity of the IPC codes. Table I presents the categories proposed and the families of IPC codes related to them.

Table I
Categorization of the IPC Codes Observed in this Study

Categories	IPC codes included ^a
Cosmetic preparations	
General cosmetic or toilet preparations	A61K 8
Preparations characterized by a special physical form	A61K 9
Preparations containing organic active compounds	A61K 31
Preparations containing inorganic active compounds	A61K 33
Preparations containing natural ingredients	A61K 36
Preparations containing peptides	A61K 38
Make-up preparations	A61Q 1
Hair care preparations	A61Q 5 and A61Q 7
Sun care and other barrier preparations	A61Q 17
Skin care preparations	A61Q 19
Others	A61K 6, A61K 35, A61K 39, A61K 47, A61L 9, A61Q 3, and A61Q 15
Excipients and active compounds	
Preservatives	A01N
Non-heterocyclic organic compounds	C07C
Heterocyclic organic compounds	C07D
Sugar derivatives	C07H
Peptides	C07K
Other macromolecular compounds	C08B, C08F, C08G, and C08L
Detergents	C11D
Others	A61P, B32B, B60C, C01B, C07F, C07G, C08J, and C08K
Functional packaging and applicators	A45D, A46B, A47L, A61F, A61H, A61J, B43K, B43M, B65B, B65D, B67D, F25D, and G01F
Processes applied to cosmetics	A23B, A23C, A23J, A23L, B01J, B05D, C11B, C12N, and C12P

^aSubclasses were omitted. For further information on IPC codes, see Appendix or visit <http://www.wipo.int/ipcpub>.

Once each IPC code was established to have a different meaning and to represent an individual technology or a group of technologies, we proceeded with their quantification and interpretation. Out of the sample of 335 patents, two patents were not classified according to the IPC system, therefore, we excluded them. Some patents presented more than one IPC code and some codes were repeated in different patents. Then, we found a total of 341 different IPC codes or a total of 876 IPC codes if repetitions were considered. Thus, we presented the quantification results as a percentage of the total frequency of IPC codes ($n = 876$ codes). We also presented a life cycle of technologies related to natural ingredients, whether the technology is primarily related ($n = 45$ patents) or generally related ($n = 72$ patents).

CROSS-IMPACT ANALYSIS

Cross-impact analysis is a mathematical model based on the theory of probability that allows us to determine the influence of one event over another (9,14). In this survey, we employed the cross-impact analysis to calculate the impact index of a certain technology "A" over a certain technology "B." We considered each IPC code as a technology of interest and calculated the conditional probability between different codes. We followed the method proposed by Choi *et al.* (9), adapted from Blanning and Reinig's (14), which uses patent classification systems to quantitatively estimate the impact index of technology A on B. The impact index was calculated according to equation 1 (9).

$$\text{Impact}(A,B) = p(B|A) = n(A \cap B)/n(A) \quad (1)$$

In equation 1, the term " $n(A \cap B)$ " represents the total number of patents included both in technology A and B and the term " $n(A)$ " represents the total number of patents included in technology A. The impact index score ranges from 0 to 1. The closer the impact index is to 1, the higher the impact of technology A on B (9). For the purpose of this survey, we set the threshold value at 0.5. We classified the impact scores as low (if equal or lower than 0.5 for both technologies), unidirectional (if higher than 0.5 for only one technology), or bidirectional (if higher than 0.5 for both technologies). In this analysis, we excluded the technologies observed only once to avoid occasional misleading impacts ($n = 109$ codes, 32% of the number of codes).

RESULTS AND DISCUSSION

THE CATEGORIZATION OF IPC CODES

We proposed the categories presented in Table I especially for the sample of patents of this survey. Possibly, a different patent sample would require different categories due to the complexity of the IPC system. Further, we proposed the categories based on our assumptions of the technologies and of the organization of IPC codes, but other authors would likely compose them differently. Nonetheless, these categories allowed us to perform a better analysis of the information available in the patents. Figure 1 presents the distribution of the technologies observed in the patents, according to the main categories defined in Table I. In the next sections, we will comment on the results for each category.

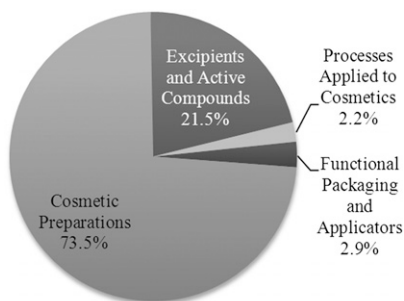


Figure 1. Distribution (%) of the technologies in the main categories proposed. $n = 876$ codes.

PROCESSES APPLIED TO COSMETICS

Patent literature is highly specialized in the many uses of compounds, although preparations and processes are also published (10). However, it is also reported that the chemical industry will less likely disclose detailed descriptions of processes, whether in patent or non-patent literature (10). In this case, industrial secrecy is usually the first choice to protect intellectual property. For these reasons, we decided to focus on products instead of processes.

Even though we filtered for skin care products only, some patents presented claims for the processes involved with the core innovation (Figure 1). In general, the processes we observed are commonly applied to cosmetics, whether or not adapted from food and pharmaceutical technologies. One example in this category was the use of technology C12P 21/04, i.e., the preparation of cyclic or bridged peptides or polypeptides, to describe the bond of a self cell-penetrating Tat peptide to a human parathyroid hormone-derived peptide in order to offer a slimming agent superior cell-penetration properties (15).

FUNCTIONAL PACKAGING AND APPLICATORS

Other elements liable to innovation in skin care products are packaging and applicators. Besides ornamental design, it is possible to devise these elements to perform functional roles. Considering the results of this survey (Figure 1), we can observe that such technologies are still only slightly explored. In fact, even in non-patent literature, we could barely find information on this issue. Certainly, functional packaging and applicators represent an opportunity for innovation and cosmetic chemists should work along with designers to elucidate possible approaches.

At first glance, some technologies observed and included in this category might not seem applicable to skin care products. However, further analysis of the patent contents might illustrate the function of such technologies in cosmetics. For instance, technology class F25D, i.e., cooling or freezing apparatus, has no immediate relation to cosmetic products. But subclass F25D 3/00, i.e., devices using other cold materials or devices using cold-storage bodies, was observed in a patent of a cooling device with the aim of locally improving the skin penetration of a cosmetic product (16). Another similar case was the application of technology B43K 7/10, i.e., arrangements for feeding ink to ball-point pens, in a roll-on dispenser to control liquid flow and to offer more equivalent doses (17).

In general, technologies in this category are related to the following functions: (a) avoiding oxidation or deterioration of cosmetic preparations (18), (b) avoiding microbial contamination

(19), (c) cooling or heating cosmetic preparations to improve performance (16,20), (d) dispensing precise doses (17,18), (e) ensuring full use of the product (21), and (f) providing additional benefits to enhance consumer experience (16,22). One example of how packaging and applicators could enhance consumer experience is the association of a massage device with a shower formulation in a single container (22).

EXCIPIENTS AND ACTIVE COMPOUNDS

Figure 2A presents the distribution of technologies in the category of excipients and active compounds, and Table I relates the IPC codes to the subcategories proposed. We observed that the subcategory of preservatives (A01N) was the most explored. If we consider that technology A01N 65/00 represents the naturally derived preservatives, 25% of the preservatives were obtained from natural products. Though technology A01N 65/00 refers to preservatives, in some of these patents, the compound of interest presented additional functions. For example, one patent proposes the addition of an orange peel glycolic extract to a self-tanning cosmetic containing dihydroxyacetone to make the tan look particularly natural (23).

The subcategories of non-heterocyclic compounds (C07C) and heterocyclic compounds (C07D) combined, in their turn, represented 26.1% of the technologies related to excipients and active compounds. Sometimes, however, these technologies are not specific and it is difficult to interpret what exactly the compound of interest is. For example, technology C07C 69/76 stands for esters of carboxylic acids having an esterified carboxyl group bound to a carbon atom of a six-membered aromatic ring and technology C07D 317/08 stands for heterocyclic compounds containing five-membered rings having oxygen atoms in positions 1 and 3 as the only hetero atoms in the rings. In these two cases, there are a considerable number of substances that match the definition. An illustration of such cases would be the use of several amide, sulphonamide, or carbamate derivatives

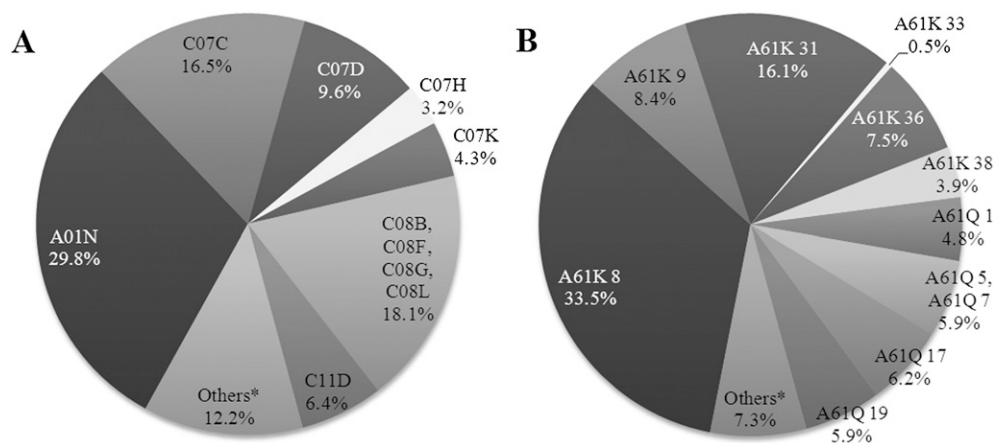


Figure 2. Distribution (%) of the IPC codes in the categories (A) of excipients and active compounds and (B) of cosmetic preparations. (A) $n = 188$ codes. *Others comprise A61P, B32B, B60C, C01B, C07F, C07G, C08J, and C08K. (B) $n = 644$ codes. *Others comprise A61K 6, A61K 35, A61K 39, A61K 47, A61L 9, A61Q 3, and A61Q 15. For further information on IPC codes, see Appendix or visit <http://www.wipo.int/ipcpub>.

of the cyanoacrylic acid as new uncolored and photostable broad-UVA screening agents, which were described only by technology C07C 255/00, i.e., carboxylic acid nitriles (24).

We also observed a considerable use of the subcategory of other macromolecular compounds, which is comprised by technologies C08B, C08F, C08G, and C08L, i.e., polysaccharides and derivatives (such as chitosan-thio-amidine), polymers obtained by reaction of C–C unsaturated bonds (such as polyethylene and acrylates), polymers obtained otherwise (such as siloxanes), and compositions thereof (such as blends of acrylates and siloxanes), respectively. In general, the use of polymers in this patent sample was related to the following purposes: (a) improving sensory properties (25), (b) granting higher adhesion to the skin (26), (c) improving resistance to pH (27) and to electrolytes (28), (d) increasing (29) or reducing (30) the gelling power, (e) promoting powder surface treatments (31), (f) encapsulating (32), and (g) replacing surfactants in surfactant-free formulations (27), among others. Even though these functions may be well-characterized in non-patent literature, such as the use of polymers as surfactants (33), patent literature provides updated information on economically viable uses of polymers and may lead formulation practitioners through a competitive market.

Another issue we know from non-patent literature is that blends of synthetic and natural polymers may originate a new class of materials with unique mechanical properties and biocompatibility, if compared with those of neat polymers (34). One example from patent literature is the association of alginate, poly(vinyl alcohol), and carboxymethylcellulose in concentrations that reduce wrinkles by improving adhesion to the skin and promoting a tightening effect, without the uncomfortable feeling of stretching out the skin (35).

In addition, some patents related to excipients and active compounds suggest the development of cosmetics using ingredients originally employed in other industries. For example, one patent proposed some cosmetic preparations containing a volatile branched polysiloxane originally used in the production of tires, which was described by technology B60C 1/00 (tires characterized by the chemical composition or physical arrangement, or a mixture of the composition), among others (36). Probably, there are several ingredients employed in other industries, which are promising for use in innovative cosmetics.

COSMETIC PREPARATIONS

Figure 2B presents the distribution of technologies in the category of cosmetic preparations, and Table I relates the IPC codes to the subcategories proposed. We observed that the subcategories of general cosmetic or toilet preparations (A61K 8) and of preparations characterized by a special physical form (A61K 9) accounted for 41.9% of the technologies observed in the category of cosmetic preparations. However, if we consider the definition of these technologies, we might conclude that they should be present somehow in every patent of a cosmetic preparation. For instance, the definition of subclass A61K 8/02 is considerably broad, i.e., cosmetic or toilet preparations characterized by a special physical form. Indeed, the non-specific subclasses A61K 8/00, A61K 8/02, and A61K 8/18 (see Appendix) accounted for 23.1%, 32.9%, and 7.8% of the technologies related to general preparations (A61K 8), respectively.

A similar situation is observed for the subcategory of preparations characterized by a special physical form (A61K 9). For instance, subclass A61K 9/00 (medicinal preparations characterized by a special physical form) accounted for 25.9% of the technologies related to this subcategory (A61K 9). Perhaps, one might say that class A61K 9 should not be related to cosmetic preparations once its definition consists of medicinal preparations

characterized by a special physical form. However, in a patent, sometimes the core innovation is also claimed to be useful for pharmaceutical, nutritional, or other purposes. Besides, subclasses A61K 8/02 to A61K 8/14 that are related to cosmetic or toilet preparations characterized by a special physical form (see Appendix) may be rather limited for some cosmetic preparations.

Although these subcategories (A61K 8 and A61K 9) may not be so detailed, we managed to extract more specific information. In the subcategory of general preparations (A61K 8), we observed that 4.2% of the technologies present in this sample were related to preparations containing inorganic compounds, 13.4% to preparations containing organic compounds, and 9.3% to preparations containing macromolecular compounds. In the subcategory of preparations characterized by a special physical form (A61K 9), in turn, we observed that 16.7% of the technologies present in this sample were related to dispersions or emulsions, 33.3% to powders and 9.3% to preparations in capsules. One example of preparation in powder is an extemporaneous preparation containing propionyl L-carnitine glycinate hydrochloride for cellulite treatment, which is reconstituted to a gel form on the occasion of the application, using or not using special containers. This preparation has the advantage of not containing preservatives (37).

Other subcategories related to class A61K were preparations containing organic active compounds (A61K 31) and preparations containing inorganic active compounds (A61K 33). We confirmed a larger use of organic active compounds compared to inorganic compounds. Throughout this article, we present some examples of the use of organic compounds in patented cosmetic preparations. However, one example of preparations containing an inorganic active compound is the use of volcanic water with adequate amounts of iron, potassium, sodium, magnesium, calcium, silicon dioxide, phosphorus, selenium, and zinc to remineralize the skin (38).

We also observed preparations containing natural ingredients (A61K 36). If we consider the total of patents analyzed (333 patents), 13.5% were related to the use of naturally derived products based on technologies A61K 36 and A01N 65/00. However, there were cases of patents related to natural products that were classified with codes that are not primarily related to natural ingredients. For example, technology A61K 31/56, which refers to compounds containing cyclopenta[a]hydrophenanthrene ring systems, was the only technology used to describe the use of an extract of *Ajuga turkestanica* able to regulate aquaporins and provide a hydrating effect (39). Also, we observed that another 8.1% of patents were related to natural ingredients but were classified with codes not primarily related to the quality of natural ingredients. Figure 3 presents the life cycle of the technologies related to natural ingredients in order to complement these data. From a general perspective, if we consider all technologies, we can observe that the number of patents related to natural ingredients has increased over time. However, the use of primarily related technologies (A61K 36 and A01N 65/00) has been rather stable in the last four years.

In addition, we observed preparations containing peptides (A61K 38), in which the peptide was usually responsible for the biological activity or for the intracellular delivery of active compounds. We present an example of the use of peptides when the category of processes applied to cosmetics is discussed (15). Peptides have been increasingly used in cosmeceuticals once they are inherent to some cutaneous biological processes, such as the modulation of cell proliferation, cell migration, inflammation, angiogenesis, melanogenesis, and

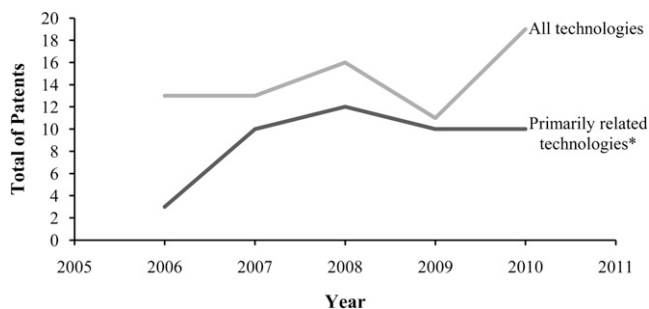


Figure 3. Life cycle of technologies related to natural ingredients. $n = 45$ patents for primarily related technologies and $n = 72$ patents for all technologies. *Series A61K 36 and technology A01N 65/00 only. For further information on IPC codes, see Appendix or visit <http://www.wipo.int/ipcpub>.

protein synthesis or regulation (40). Therefore, peptides represent another underexplored opportunity for innovation in product development.

The last subcategories of cosmetic preparations are those related to class A61Q. Besides preparations for skin care (A61Q 19), we also observed makeup preparations (A61Q 1), hair care preparations (A61Q 5 and 7), and barrier preparations (A61Q 17), such as sun care products or insect repellents, among others. The fact that we found other technologies other than skin care suggests that some innovations are multifunctional. For example, one patented preparation refers to the combined use of an organosiloxane and a derivative of cyclohexanetricarboxamide to improve transfer resistance in a makeup preparation containing skin care active compounds, among others (41). In fact, this result suggests that there is a trend toward multifunctional cosmetics, for example, color cosmetics designed not only to enhance or alter appearance, but also to protect and hydrate.

Before discussing the technological cross impact, we will present some considerations regarding delivery systems. Even though there are specific IPC classes to describe some delivery system, such as technology A61K 9/127 (liposomes), we observed patents related to these systems without an obvious classification code. For example, technology A61F 13/00 (bandages, dressings, and absorbent pads) was used to describe the use of patch or plaster supports in preparations containing aquatic animals named stinging cells (cnidocytes) or capsules (cnidocysts), which promote transdermal delivery of active compounds (42). Other delivery systems observed were nanocapsules, microcapsules, cyclodextrins, liposomes, and hydrogels. However, only 5.1% of the patents were related to delivery systems. Therefore, such technologies represent an underexplored opportunity for innovation with many possibilities of application. Another possible application of these technologies is not their use as delivery systems but as a means of preserving the active compound, for instance, the use of cyclodextrins to stabilize vitamin F against oxidative decomposition (43).

TECHNOLOGICAL CROSS IMPACT

According to the literature, identifying the relationship and impact between technologies can provide insight for technological strategies (9). For example, a company may substantially decide on which technology to invest, research, or use based on a cross-impact analysis. Further, estimating the impact of one technology over another also provides information

on technological trends for product development. Generally, it is not easy to obtain information related to the use of technologies; however, patents represent a free and open source of data for studying and evaluating cross impacts.

Figure 4 presents some technological pairs identified in this survey and their respective impacts. According to previous reports (9), we classified the technological pairs in three groups: low impact, unidirectional impact, and bidirectional impact. First, the technological pairs classified as low impact can be considered independent of other technologies and, therefore, are not discussed further. Second, in the cases of technological pairs with unidirectional impact, one technology influences the other, but not vice versa. Third, bidirectional impact technologies influence and are influenced by the paired technology. Following, we will present and comment some of the unidirectional and bidirectional technological pairs identified.

Some of the unidirectional impacts observed are not meaningful from the perspective of product development. First, for example, we observed a considerable number of unidirectional

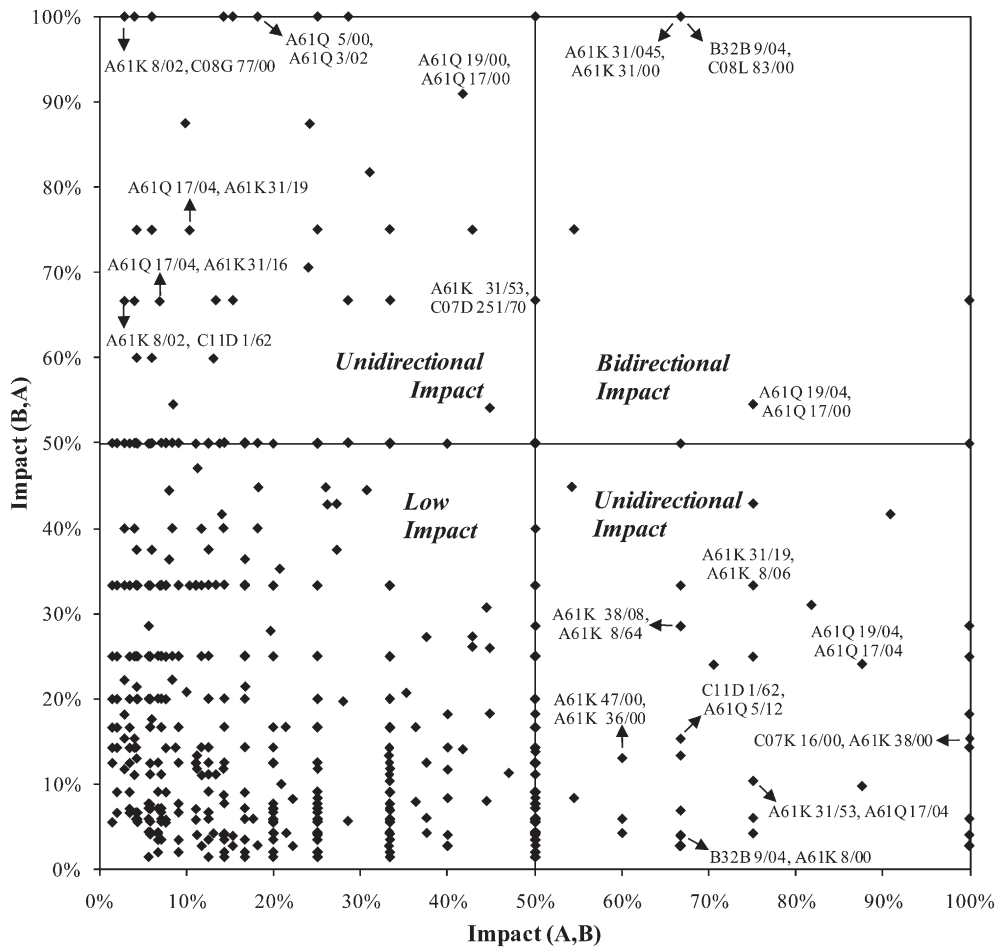


Figure 4. Technological pairs and their cross impact. A specular image is obtained if one traces a diagonal line from the upper right to the lower left. Some technological pairs (A, B) were identified. $n = 109$ technologies. For further information on IPC codes, see Appendix or visit: <http://www.wipo.int/ipcpub>.

impacts between technologies in the same class, such as the impacts between technologies A61K 8/00 and A61K 8/18 (impacts A, B = 0.24 and B, A = 0.71) or A61K 31/00 and A61K 31/045 (Figure 4). Such impacts only mean that innovations related to cosmetic or toilet preparations (A61K 8/00) are strongly characterized by their composition (A61K 8/18). Second, we observed unidirectional impacts between cosmetic preparations characterized by a special physical form (A61K 8/02) and types of cosmetic preparations, such as anti-perspirants and body deodorants (A61Q 15/00; impacts A, B = 0.04 and B, A = 0.60) or tanning skin care preparations (A61Q 19/04; impacts A, B = 0.10 and B, A = 0.87). Third, we observed some unidirectional impacts of specific excipients and active compounds over their relative cosmetic preparations. For example, whenever monoclonal or polyclonal immunoglobulins (C07K 16/00) were employed, there was a preparation containing peptides (A61K 38/00; Figure 4). In general, these impacts are rather obvious and vaguely meaningful for the formulation practitioner. For that reason, some of those cases were not identified in Figure 4. Therefore, it is necessary that one skilled in cosmetic technologies identifies and interprets the meaningful technological impacts so that patent information becomes useful for product innovation.

In fact, we observed some unidirectional technological impacts with relevant information for cosmetic chemists. For instance, the impact of technology A61K 47/00 (medicinal preparations characterized by the non-active ingredients used) over technology A61K 36/00 (medicinal preparations of undetermined constitution containing naturally derived ingredients). This impact means that in 60% of the patents classified as A61K 47/00, the ingredient that characterized the innovation was originally natural. This result reflects the relevance of naturally derived ingredients as an alternative to innovate in cosmetic preparations.

Another unidirectional impact observed was the influence of technology A61Q 3/02 (manicure or pedicure preparations for nail coatings) on technology A61Q 5/00 (preparations for hair care). This impact is explained by the use of the same film-forming polymers in preparations for nail coatings as well as for eyelash mascaras, in which the polymers are supposed to offer resistance for fragile nails or lengthening effects for eyelashes (44). Such patents also claimed for skin care activity. The relationship between these two technologies elucidates the possibility of using one specific new raw material in many different new products to better explore either the resources or the innovative capability.

In relation to bidirectional impacts, we observed the influence of technology C08L 83/00 (compositions of silicon-derived macromolecular compounds) on technology B32B 9/04 (layered products comprising a substance as the main or only constituent of a layer, such as surface-treated particles). This impact is related to the use of silicone polymers of different solubility, either crosslinked or not, to improve particle dispersibility in a silicone liquid medium. These polymers could be used to treat the surface of pigments, clays, and other minerals; to improve the stability of the final dispersion; to offer higher adhesion to the skin; and to enhance transfer resistance (26), among others. This data reflects the relevance of silicone polymers in particle surface treatment.

Finally, we observed a bidirectional impact between technologies A61Q 19/04 (skin care preparations for chemically tanning the skin) and A61Q 17/00 (barrier preparations, like sun care preparations). This impact was also supported by the unidirectional impacts between technologies A61Q 19/04 and A61Q 17/04 (topical preparations for affording protection against sunlight or other radiations) or technologies A61Q

19/00 (skin care preparations) and A61Q 17/00 (see Appendix). This result reinforces the suggestion of a trend toward multifunctional skin care cosmetics. In other words, a single skin care product should be designed not only to treat the skin (hydrating, cleansing, bleaching, renewing, etc.) but also to protect it from the harmful effects of sunlight.

CONCLUSIONS

This work proposed new discussions about the role of patent information in the cosmetic industry and presented some directions. We verified that patents are relevant sources of information for technological forecasting and for the development of cosmetics. We also showed that patent surveys may help both researchers from academia and industry with the development of innovative cosmetics and raw materials, either because they allow us to identify unexplored technological fields or because they allow us to identify available technologies and turn them into whole new concepts. Besides, patent statistics available in the literature may provide inputs for laboratorial data banks of patented products and technologies. Further, we indicated that life cycle curves and technological cross impacts are useful tools for determining technological trends in the cosmetic industry. In terms of innovation, identifying a trend first, means being one step closer to the new blockbuster or breakthrough.

Several opportunities for product innovation were highlighted and illustrated throughout this paper; however, some limitations must be considered. First, the short sampling period (five years) does not allow us to develop a solid technological life cycle, although we managed to analyze individual patents more deeply, in order to obtain specific information. Second, the IPC system has some intrinsic limitations, such as: (a) it does not offer classes exactly corresponding to a particular product-related technology and (b) it allows patent examiners to classify their patents based on their own assumptions of the IPC system. In order to avoid misleading interpretation of the results, we read and analyzed each patent in our sample. However, this work would be considerably exhausting for larger samples. In that case, it is possible to turn to patent analysis software or web search tools, such as Derwent database.

This work also raised opportunities for future studies. First, patent surveys considering more specific samples, such as the use of siloxane derivatives in cosmetics, could be conducted. Second, different technological classification systems should be proposed in order to avoid previous limitations and to aid in patent analysis. Finally, patent studies may accomplish different purposes other than the one employed in this paper.

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Appendix
List of IPC Codes cited in this Paper, and their Meanings

Code	Description
<i>Section A</i>	<i>Human Necessities</i>
A01N	Preservation of bodies of humans or animals or plants or parts thereof; biocides, e.g., as disinfectants, as pesticides, or as herbicides; pest repellants or attractants; plant growth regulators.
A01N 65/00	Biocides, pest repellants, or attractants, or plant growth regulators containing material from algae, lichens, bryophyta, multicellular fungi or plants, or extracts thereof.
A23	Foods or foodstuffs; their treatment, not covered by other classes.
A23B	Preserving, e.g., by canning, meat, fish, eggs, fruit, vegetables, edible seeds; chemical ripening of fruit or vegetables; the preserved, ripened, or canned products.
A23C	Dairy products, e.g., milk, butter, cheese; milk or cheese substitutes; making thereof.
A23J	Protein compositions for foodstuffs; working-up proteins for foodstuffs; phosphatide compositions for foodstuffs.
A23L	Foods, foodstuffs, or non-alcoholic beverages, not covered by subclasses A21D or A23B-A23J; their preparation or treatment, e.g., cooking, modification of nutritive qualities, physical treatment; preservation of foods or foodstuffs, in general.
A45	Hand or travelling articles.
A45D	Hairdressing or shaving equipment; manicuring or other cosmetic treatment.
A46	Brushware.
A46B	Brushes.
A47	Furniture; domestic articles or appliances; coffee mills; spice mills; suction cleaners in general.
A47L	Domestic washing or cleaning; suction cleaners in general.
A61	Medical or veterinary science; hygiene.
A61F	Filters implantable into blood vessels; prostheses; devices providing patency to, or preventing collapsing of, tubular structures of the body, e.g., stents; orthopedic, nursing or contraceptive devices; fomentation; treatment or protection of eyes or ears; bandages, dressings or absorbent pads; first-aid kits.
A61F 13/00	Bandages or dressings; absorbent pads.
A61H	Physical therapy apparatus, e.g., devices for locating or stimulating reflex points in the body; artificial respiration; massage; bathing devices for special therapeutic or hygienic purposes or specific parts of the body.
A61J	Containers specially adapted for medical or pharmaceutical purposes; devices or methods specially adapted for bringing pharmaceutical products into particular physical or administering forms; devices for administering food or medicines orally; baby comforters; devices for receiving spittle.
A61K	Preparations for medical, dental, or toilet purposes.
A61K 6	Preparations for dentistry.
A61K 8	Cosmetics or similar toilet preparations.
A61K 8/02	Characterized by special physical form.
A61K 8/03	Liquid compositions with two or more distinct layers.

(Continued)

Appendix
Continued

Code	Description
A61K 8/04	Dispersions; emulsions.
A61K 8/06	Emulsions.
A61K 8/11	Encapsulated compositions.
A61K 8/14	Liposomes.
A61K 8/18	Characterized by the composition.
A61K 8/64	Proteins, peptides, derivatives or degradation products thereof.
A61K 8/72	Containing organic macromolecular compounds.
A61K 9	Medicinal preparations characterized by special physical form.
A61K 9/127	Liposomes.
A61K 31	Medicinal preparations containing organic active ingredients.
A61K 31/045	Hydroxy compounds, e.g., alcohols; salts thereof, e.g., alcoholates.
A61K 31/16	Amides, e.g., hydroxamic acids.
A61K 31/19	Carboxylic acids, e.g., valproic acid.
A61K 31/53	Heterocyclic compounds having six-membered rings with three nitrogens as the only ring hetero atoms, e.g., chlorazaniol, melamine.
A61K 33	Medicinal preparations containing inorganic active ingredients.
A61K 35	Medicinal preparations containing material or reaction products thereof with undetermined constitution.
A61K 36	Medicinal preparations of undetermined constitution containing material from algae, lichens, fungi, or plants, or derivatives thereof, e.g., traditional herbal medicines.
A61K 38	Medicinal preparations containing peptides.
A61K 38/08	Peptides having 5 to 11 amino acids.
A61K 39	Medicinal preparations containing antigens or antibodies.
A61K 47	Medicinal preparations characterized by the non-active ingredients used.
A61L	Methods or apparatus for sterilizing materials or objects in general; disinfection, sterilization, or deodorization of air; chemical aspects of bandages, dressings, absorbent pads, or surgical articles; materials for bandages, dressings, absorbent pads, or surgical articles.
A61L 9	Compositions for disinfection, sterilization, or deodorization of air.
A61P	Specific therapeutic activity of chemical compounds or medicinal preparations.
A61Q	Specific use of cosmetics or similar toilet preparations.
A61Q 1	Makeup preparations, body powders, preparations for removing make up.
A61Q 3	Manicure or pedicure preparations.
A61Q 3/02	Nail coatings.
A61Q 5	Preparations for care of the hair.
A61Q 5/12	Preparations containing hair conditioners.
A61Q 7	Preparations for affecting hair growth.
A61Q 15	Anti-perspirants or body deodorants.
A61Q 17	Barrier preparations; Preparations brought into direct contact with the skin for affording protection against external influences, e.g., sunlight, X-rays or other harmful rays, corrosive materials, bacteria, or insect stings.
A61Q 17/04	Topical preparations for affording protection against sunlight or other radiation; topical sun tanning preparations.

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Appendix
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Code	Description
A61Q 19	Preparations for care of the skin.
A61Q 19/04	Preparations for chemically tanning the skin.
<i>Section B</i>	<i>Performing operations; transporting.</i>
B01	Physical or chemical processes or apparatus in general.
B01J	Chemical or physical processes, e.g., catalysis, colloid chemistry; their relevant apparatus.
B05	Spraying or atomizing in general; applying liquids or other fluent materials to surfaces, in general.
B05D	Processes for applying liquids or other fluent materials to surfaces, in general.
B32	Layered products.
B32B	Layered products, i.e. products built-up of strata of flat or non-flat, e.g., cellular or honeycomb, form.
B32B 9/04	Comprising such substance as the main or only constituent of a layer, next to another layer of a specific substance.
B43	Writing or drawing implements; bureau accessories.
B43K	Implements for writing or drawing.
B43K 7/10	Arrangements for feeding the ink to ball-point pens.
B43M	Bureau accessories not otherwise provided for.
B60	Vehicles in general.
B60C	Vehicle tires; tire inflation; tire changing; connecting valves to inflatable elastic bodies in general; devices or arrangements related to tires.
B60C 1/00	Tires characterized by the chemical composition or the physical arrangement or mixture of the composition.
B65	Conveying, packing, storing, handling thin or filamentary material.
B65B	Machines, apparatus, or devices for, or methods of, packaging articles or materials; unpacking.
B65D	Containers for storage or transport of articles or materials, e.g., bags, barrels, bottles, boxes, cans, cartons, drums, jars, tanks, hoppers, forwarding containers; accessories, closures, or fittings therefore; packaging elements; packages.
B67	Opening or closing bottles, jars or similar containers; liquid handling.
B67D	Dispensing, delivering, or transferring liquids, not otherwise provided for.
<i>Section C</i>	<i>Chemistry; metallurgy.</i>
C01	Inorganic chemistry.
C01B	Non-metallic elements; compounds thereof.
C07	Organic chemistry.
C07C	Acyclic or carbocyclic compounds.
C07C 69/76	Esters of carboxylic acids having an esterified carboxyl group bound to a carbon atom of a six-membered aromatic ring.
C07D	Heterocyclic compounds.
C07D 251/70	Other substituted melamines.
C07D 317/08	Heterocyclic compounds containing five-membered rings having oxygen atoms in positions 1 and 3 as the only ring hetero atoms.

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Appendix
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Code	Description
C07F	Acyclic, carbocyclic, or heterocyclic compounds containing elements other than carbon, hydrogen, halogen, oxygen, nitrogen, sulfur, selenium, or tellurium.
C07G	Compounds of unknown constitution.
C07H	Sugars; derivatives thereof; nucleosides; nucleotides; nucleic acids.
C07K	Peptides.
C07K 16/00	Immunoglobulins, e.g., monoclonal or polyclonal antibodies.
C08	Organic macromolecular compounds; their preparation or chemical working-up; compositions based thereon.
C08B	Polysaccharides; derivatives thereof.
C08F	Macromolecular compounds obtained by reactions only involving carbon-to-carbon unsaturated bonds.
C08G	Macromolecular compounds obtained otherwise than by reactions only involving carbon-to-carbon unsaturated bonds.
C08G 77/00	Macromolecular compounds obtained by reactions forming in the main chain of the macromolecule a linkage containing silicon, with or without sulfur, nitrogen, oxygen, or carbon.
C08J	Working-up; general processes of compounding; after-treatment not covered by subclasses C08B, C08C, C08F, C08G, or C08H.
C08K	Use of inorganic or non-macromolecular organic substances as compounding ingredients.
C08L	Compositions of macromolecular compounds.
C08L 63/00	Compositions of macromolecular compounds obtained by reactions forming in the main chain of the macromolecule a linkage containing silicon with or without sulfur, nitrogen, oxygen, or carbon only; compositions of derivatives of such polymers.
C11B	Producing, e.g., by pressing raw materials or by extraction from waste materials, refining or preserving fats, fatty substances, e.g., lanolin, fatty oils or waxes; essential oils; perfumes.
C11D	Detergent compositions; use of single substances as detergents; soap or soap-making; resin soaps; recovery of glycerol.
C11D 1/62	Quaternary ammonium compounds.
C12N	Micro-organisms or enzymes; compositions thereof; propagating, preserving, or maintaining micro-organisms; mutation or genetic engineering; culture media.
C12P	Fermentation or enzyme-using processes to synthesize a desired chemical compound or composition or to separate optical isomers from a racemic mixture.
C12P 21/04	Preparations of cyclic or bridged peptides or polypeptides.
<i>Section F</i>	<i>Mechanical engineering; lighting; heating; weapons; blasting.</i>
F25	Refrigeration or cooling; combined heating and refrigeration systems; heat pump systems; manufacture or storage of ice; liquefaction or solidification of gases.
F25D	Refrigerators; cold rooms; ice-boxes; cooling or freezing apparatus not covered by any other subclass.
F25D 3/00	Devices using other cold materials; devices using cold-storage bodies.

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Appendix
Continued

Code	Description
<i>Section G</i>	<i>Physics.</i>
G01	Measuring; testing.
G01F	Measuring volume, volume flow, mass flow, or liquid level; metering by volume.
G01F 11/00	Measuring the volume flow or mass flow of fluid or fluent solid material wherein the fluid passes through the meter in a continuous flow.

Source: WIPO (13). For further information on IPC codes visit <http://www.wipo.int/ipcpub>.

