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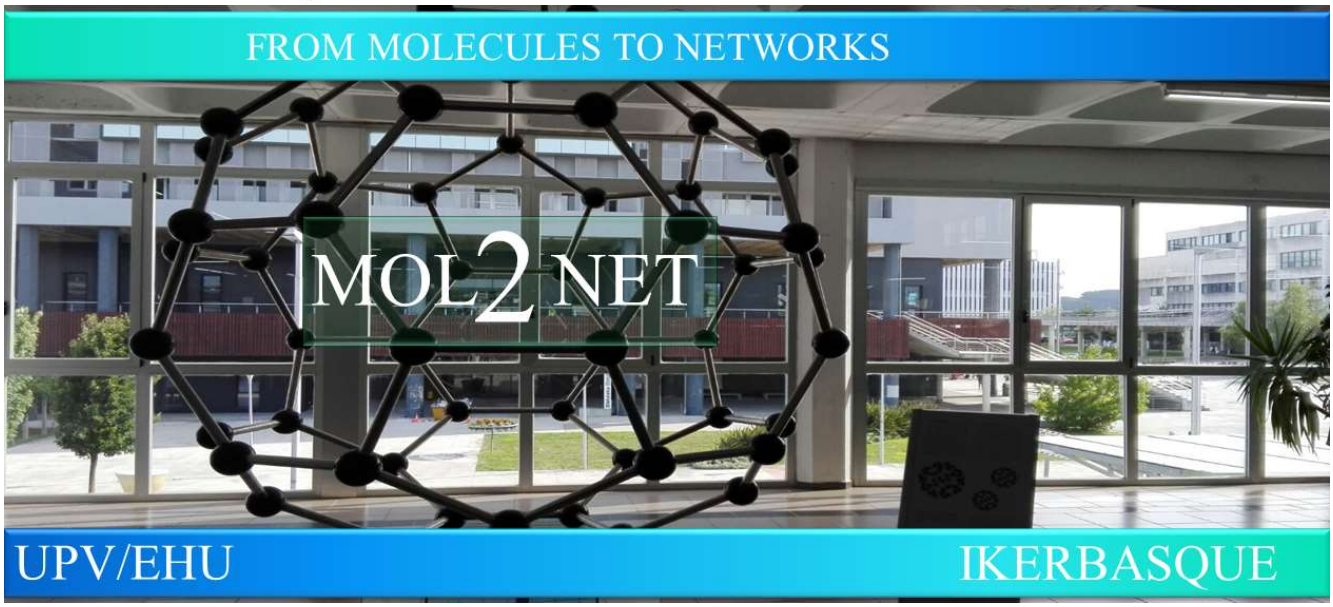
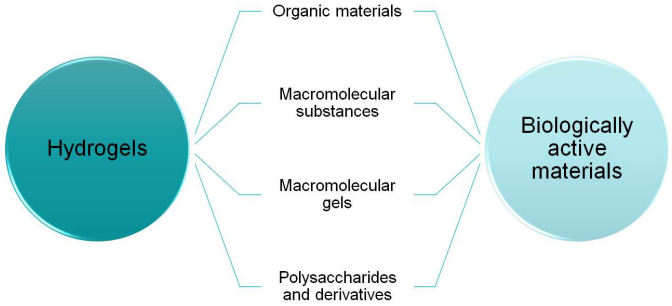


The International Patent Classification: Case of hydrogels

ChaymaaHachimiAlaoui[1,2], *Ahmed Fatimi* [1,2*]

[1]*Department of Chemistry, Polydisciplinary Faculty of Beni-Mellal (FPBM), Sultan Moulay Slimane University (USMS), P.O.BOX 592 Mghila, Beni-Mellal 23000, Morocco*
[2]*ERSIC, Polydisciplinary Faculty of Beni-Mellal (FPBM), Sultan Moulay Slimane University (USMS), P.O.BOX 592 Mghila, Beni-Mellal 23000, Morocco*
[*]*a.fatimi@usms.ma*

Graphical Abstract



Abstract.

This overview concerns the International Patent Classification of hydrogels. More specifically, this study presents the state of the art by introducing what has been innovated and patented in relation to hydrogelsthrough the PCT global system.A detailed analysis is then given regarding publication years, patent classifications, and jurisdictions.

Keywords:*hydrogels; invention; PCT, patent classification.*

Introduction

Recently, hydrogels have acquired an increasing interest from researchers due to their advantageous properties and various applications. Hydrogels are commonly known as crosslinked polymeric materials in the form of three-dimensional (3D) networks rich in hydrophilic functional groups [1]. They can give rise to their ability to absorb water, solvents, and biological fluids up to a thousand times their own dry weight without being dissolved and preserving their physical structure as a result of chemical and physical crosslinking in their structure[2]. Moreover, these materials are able to control the diffusion process and respond to specific environmental stimuli such as changes in ionic strength, pH, and/or temperature, and they have the affinity to trap chemical and biological species [3].The main synthesis methods for hydrogels are copolymerization and crosslinking free radical polymerization, in which three integral parts have been involved, namely: monomer, initiator, and crosslinking agent, that will give these materials the main characteristic of insolubility in water [3,4].

Research on hydrogels is developing rapidly through the innovation and improvement of polymers, chemical synthesis, and methods of preparation, formulation, and fabrication processes, as well as applications [5-7]. Moreover, research in the field of hydrogels has been actively growing for the past couple of decades[8]. This is also evident from the increase in the number of patent applications filed each year worldwide in this area [9].

This overview concerns the International Patent Classification (IPC) of hydrogels. The state of the art is presented by introducing what has been innovated and patented in relation to hydrogels through the Patent Cooperation Treaty (PCT), which is a global system for filing patent applications administered by the World Intellectual Property Organization (WIPO) [10].A detailed analysis is then given regarding publication years, jurisdictions, and patent classifications.

Materials and Methods

This study is based on the Patentscope search service of the WIPO [11]. During the search, the IPC code of hydrogels (i.e., A61L27/52) wasused, and patents were searched according to title, abstract, and claims. The search was then filtered to include only international patent publications through the PCT with a publication date until December 31st, 2021.

Results

Based on definitions of the terms used generally in the world of patent information, publication is the step when the patent document (patent application, granted patent, etc.) is made available to the public, to which a publication number and a publication date have been assigned by a patent authority. In other words, the publication date is the date on which a patent document is published, thereby making it part of the state of the art [12].Figure 1presents the publication years of resultant patents for hydrogels.

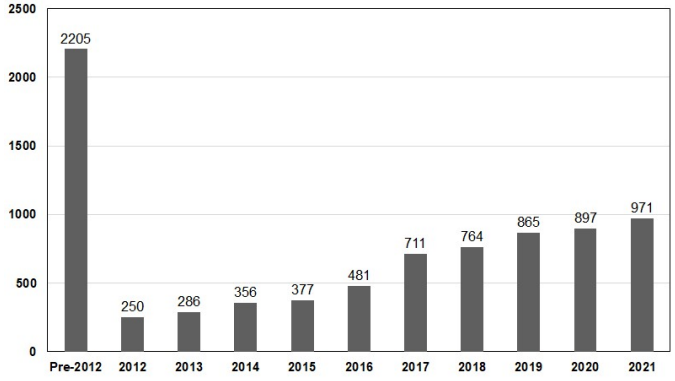


Figure 1. *Publication years of resultant patents for hydrogels*

An applicant, or first mentioned applicant in the case of joint applicants, can file an application for a patent at the appropriate patent office under whose jurisdiction he normally resides, has his domicile, has a place of business, or the place from where the invention actually originated [13]. If patent protection is sought in a number of countries worldwide, an applicant may consider filing an international application under the PCT global system [10]. Figure 2presents the top 10 jurisdictions of resultant patents for hydrogels.

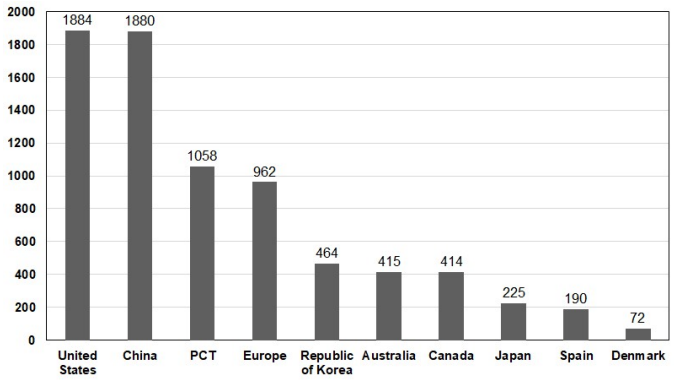


Figure 2. *Jurisdictions (top 10) of resultant patents for hydrogels*

The IPC is a hierarchical system in the form of codes, which divides all technology areas into a range of sections, classes, subclasses, groups, and subgroups. It is an international classification system that provides standard information to categorize inventions and evaluate their technological uniqueness [14].Table 1presents the top 10 IPC codes of resultant patents for hydrogels as well as a description of each IPC code.

Table 1.*Description and patent contribution of IPC codes(top 10) in relation to hydrogels*

IPC code	Description	Patents	%
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	8164	100
A61K	Preparations for medical, dental, or toilet purposes	2869	35
A61F	Filters implantable into blood vessels; prostheses; devices providing patency to, or preventing collapsing of, tubular structures of the body	1545	19
C08L	Compositions of macromolecular compounds	1539	19
C08J	Working-up; general processes of compounding; after-treatment	1328	16
C12N	Microorganisms or enzymes; compositions thereof; propagating, preserving, or maintaining microorganisms; mutation or genetic engineering; culture media	828	10
C08F	Macromolecular compounds obtained by reactions only involving carbon-to-carbon unsaturated bonds	639	8
C08B	Polysaccharides; derivatives thereof	562	7
A61P	Specific therapeutic activity of chemical compounds or medicinal preparations	548	7
C08G	Macromolecular compounds obtained otherwise than by reactions only involving carbon-to-carbon unsaturated bonds	446	5

Conclusions

This study concerned only the International Patent Classification of hydrogels until 2021. During our search, we found 8184 patent documents. The United States was ranked first with 1884 patent documents, followed by China with 1880 patent documents. The innovation and improvement of hydrogels are concerned with raw materials (synthetic and natural polymers), synthesis and methods of preparation, as well as formulations and fabrication processes. Based on the patent classification codes, all filled patents and most inventions are intended for methods or apparatus for sterilizing materials and compositions of macromolecular compounds, as well as preparations for medical, dental, or toilet purposes. According to knowledge clusters and expert driving factors, research based on specific therapeutic activity of chemical compounds or medicinal preparations is concentrated in the majority of patents.

References

1. Chin, S.F.; Jong, S.J.; Yeo, Y.J. Optimization of cellulose-based hydrogel synthesis using response surface methodology. *Biointerface Research in Applied Chemistry* **2022**, *12*, 7136-7146, doi:10.33263/briac126.71367146.
2. Kaur, R.; Sharma, R.; Chahal, G.K. Synthesis of lignin-based hydrogels and their applications in agriculture: A review. *Chemical Papers* **2021**, *75*, 4465-4478, doi:10.1007/s11696-021-01712-w.
3. Rico-García, D.; Ruiz-Rubio, L.; Pérez-Alvarez, L.; Hernández-Olmos, S.L.; Guerrero-Ramírez, G.L.; Vilas-Vilela, J.L. Lignin-Based Hydrogels: Synthesis and Applications. *Polymers* **2020**, *12*, 81, doi:10.3390/polym12010081.
4. Ahmed, E.M. Hydrogel: Preparation, characterization, and applications: A review. *Journal of Advanced Research* **2015**, *6*, 105-121, doi:10.1016/j.jare.2013.07.006.
5. Fatimi, A. Hydrogel-based bioinks for three-dimensional bioprinting: Patent analysis. *Materials Proceedings* **2021**, *7*, 3, doi:10.3390/IOCPS2021-11239.
6. Fatimi, A. Patentability of hydrogels as biocompatible coatings for medical device biofabrication. *Proceedings of the 7th Conference on Molecular, Biomedical & Computational Sciences and Engineering* **2021**, doi:10.3390/mol2net-07-10885.
7. Fatimi, A.; Okoro, O.; Shavandi, A. Biopolymer-based hydrogels for three-dimensional bioprinting. *Materials Proceedings* **2021**, Accepted, doi:10.3390/IOCPS2021-11284.
8. Fatimi, A.; Okoro, O.V.; Podstawczyk, D.; Siminska-Stanny, J.; Shavandi, A. Natural Hydrogel-Based Bio-Inks for 3D Bioprinting in Tissue Engineering: A Review. *Gels* **2022**, *8*, 179.
9. Fatimi, A. Development and innovation on hydrogels in the world: A scientific overview based on patent applications. *Proceedings of the 7th Conference on Molecular, Biomedical & Computational Sciences and Engineering* **2021**, doi:10.3390/mol2net-07-10884.
10. World Intellectual Property Organization. Summary of the Patent Cooperation Treaty (PCT) (1970). Available online: https://www.wipo.int/treaties/en/registration/pct/summary_pct.html (accessed on March 10, 2022).
11. World Intellectual Property Organization. The Patentscope. Available online: https://patentscope.wipo.int (accessed on March 10, 2022).
12. Fatimi, A. Seaweed-based biofertilizers: A patent analysis. *Recent patents on biotechnology* **2022**, doi:10.2174/1872208316666220128105056.
13. Intellectual Property India. Jurisdiction of Patent Offices. Available online: https://ipindia.gov.in/jurisdiction-of-patent-offices.htm (accessed on February 10, 2022).
14. World Intellectual Property Organization. IPC Publication. Available online: https://www.wipo.int/classifications/ipc/ipcpub, IPCPUB v9.1 (accessed on February 10, 2022).