

# Chemical research in the Catalan Countries: a brief quantitative assessment of the agents, resources, and results

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**Resum.** Aquest treball descriu la recerca en química desenvolupada durant el decenni 2000-2009 als territoris de llengua i cultura catalanes, especialment a l'euroregió formada per Catalunya, les Illes Balears i el País Valencià. L'article presenta l'evolució de la recerca en química en relació amb l'activitat científica total d'aquests territoris i d'altres del seu entorn. El treball és enfocat a la globalitat del cicle de la producció científica, estructurat en quatre apartats: entitats actores, recursos humans implicats, recursos econòmics invertits i resultats obtinguts (en forma d'articles, tesis doctorals i patents).

**Paraules clau:** química · recerca · Catalunya · País Valencià · Illes Balears

**Summary.** This work describes the chemical research developed during the ten year period 2000–2009 in the territories of Catalan language and culture, especially in the euroregion formed by Catalonia, the Balearic Islands, and the Valencian Country (Valencian Community). The article presents the evolution of chemical research in relation to the total scientific activity of these territories and of others in their proximity. The work is focused on the global scientific production cycle, as structured in four sections: entities, human resources involved, economic resources invested, and results obtained (in the form of articles, doctoral theses, and patents).

**Keywords:** chemistry · research · Catalonia · Valencian Country · Balearic Islands

## Abbreviations

BAC	Bibliometry and Science Evaluation Group
BOE	Official Spanish Gazette
CERCA	Research Centers of Catalonia
CSIC	Spanish National Research Council
ECRN	European Chemical Regions Network
EDP	Full-time equivalent (FTP)
EPO	European Patent Office
EU-27	European Union
FP	Framework Programme
FPI	Training Research Personnel program
FPU	Training University Lecturers program
GDP	Gross Domestic Product
ICREA	Catalan Institution for Research and Advanced Studies
INE	National Statistics Institute
IQS	Chemical Institute of Sarrià
JCI	Juan de la Cierva program
MERIDIÀ	Measurement of Research, Development and Innovation
MICINN	Ministry of Science and Innovation

OEPM	Spanish Patent and Trademark Office
OR-IEC	Observatory for Research of the Institute for Catalan Studies
PDI	Teaching and research staff
R&D	Research and Development
R&D&I	Research, Development, and Innovation
RYC	Ramón y Cajal program
SCI-E	Science Citation Index Expanded
URL	Ramon Llull University

## Introduction

The geographical scope of this study of chemistry research is essentially the euroregion formed by the territories of Catalan language, also known as the Catalan Countries. As a linguistic term, *Catalan Countries* is used in a similar fashion to the English anglosphere, the French francophonie, the Portuguese lusophonie or the Spanish hispanophone territories. The study focuses on the Catalan Countries found in the Spanish state, specifically, on Catalonia, the Balearic Islands, and the Valencian Country (Valencian Community), either individually or as a group. These countries are the most important from demographic and territorial points of view and each has an autonomous political administrative status (Autonomous Community). The study also makes comparisons, where appropriate, with Spain (which includes the Catalan Countries) and with the Eu-

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ropean Union (EU-27). In the framework of the Spanish state, the three regions mentioned account for 29.2% of the population and 30.8% of the GDP at market prices (year 2009).

Of the three mentioned territories, Catalonia is the most important country, demographically, territorially, and economically. Some 25% of Spanish chemical companies are found in Catalonia, and they account for 37.5% of Spain's employment in the chemical sector. Currently, the companies based in Catalonia contribute 50% of the chemical activity taking place in the Spain, which makes Catalan chemical production higher than that of Sweden, Denmark, or Austria. Catalonia has an industrial chemistry past that goes back to the end of the 18th century. Today, based on the high concentration of chemical companies, Catalonia is part of the European Chemical Regions Network (ECRN).

The temporal scope of this article mainly covers the decade 2000–2009, varying slightly according to the available data for each section. In addition, the tables are in natural years or academic years. The content scope is mainly chemical research. Nonetheless, in certain indicators, other related specialties have been taken into account, such as, chemical engineering, nanoscience, and pharmacy. It is important to emphasize the problems with assigning research data in chemistry, given the diversity of the classifications of the sources consulted: areas of knowledge of university professors, the assigned codes to the economic activity of the companies, fields of the research articles, codes for patent applications, etc.

With regard to the methodology, a mostly quantitative perspective has been adopted, combined with qualitative assessments. The sources used were quite heterogeneous, which has led to significant difficulties in locating, unifying, and comparing information. Official bulletins, statistical data, websites of public administrations, bibliometric and patent databases, university proceedings, administration plans and reports, etc. have been consulted. In large part, this task has been possible due to the information collected by the Observatory for Research of the Institute for Catalan Studies (OR-IEC), through its web portal MERIDIÀ (Measurement of Research, Development and Innovation) [<http://meridia.iec.cat>] [4].

The work considers the globality of the scientific production cycle, especially the public sector, and is structured in four sections: entities (1), human resources involved (2), economic resources invested (3), and results obtained (4). The final section consists of the conclusions that can be drawn based on an analysis of the data (5).

## 1. Entities

The most important public research entities in the territorial field studied are universities. The Vives Network is an association that strengthens the ties among the universities of Catalonia, Balearic Islands, Valencian Country, Northern Catalonia (the territory that corresponds approximately to the modern French *département* of the Pyrénées-Orientales), and Andorra as well as other territories with strong cultural, geographical, historical, and linguistic bonds. The aim of this association is to create a

university network that enables the coordination of teaching, research, and cultural activities, as well as the promotion and normalization of the Catalan language. To date, the Vives Network includes 21 universities that comprise a group of more than 440,000 people: 400,000 students, 30,000 teachers, and 10,000 administrative staff and professionals.

The main components of higher education (universities and their departments) of Catalonia, the Balearic Islands, and the Valencian Country that regularly work in chemistry or chemical engineering or that have part of their researchers officially ascribed to these areas are indicated in Table 1. Entities that use concepts and methods from chemistry but not exclusively or which include chemistry as part of a multidisciplinary way (for example, departments of biomedical research), are not included. Thus, research in chemistry and chemical engineering is present in 40 departments of 15 university institutions.

Table 2 lists other research institutions. Two are integrated in the Research Centers of Catalonia (CERCA) of the Autonomous Government of Catalonia, and three depend on the Spanish National Research Council (CSIC). The CSIC is a network of research centers of the Spanish state administration.

Within entities listed in Tables 1 and 2 are research groups in chemistry and chemical engineering (Table 3) recognized and/or financed by the Autonomous Governments of Catalonia (92 groups, year 2009), and of the Balearic Islands (3 groups, year 2006). There are no similar data for the Valencian Country. Based on the names of the research groups that make up Table 3, the keywords describing the chemical research currently being carried out in these territories can be readily extracted.

With regard to applied research and technological transfer, TECNIO was created by ACCIÓ (an agency of the Autonomous Government of Catalonia), with the aim of bringing together the main Catalan expert players in this field. The chemical technologies section includes 24 of the 97 current members of TECNIO (Table 4).

In Catalonia, there is a powerful chemical and pharmaceutical industry, which generated 5645.2 million Euros, and thus 42.8% of the GDP in this sector in the Spanish State (National Statistics Institute, INE, data from the year 2007). The figures for the Valencian Country and the Balearic Islands are more modest (8.4% and 0.1%, respectively). In Catalonia, the 1050 mostly small and medium-sized chemical generate 137,000 direct jobs [3,8].

## 2. Human resources

In 2007–2008, the teaching and research staff (PDI) of public universities associated with the areas of chemistry and chemical engineering comprised, respectively, 862 and 364 professors (Table 5). Approximately 27% of the Spanish PDI for these areas works in the Catalan Countries and they have experienced a cumulative growth of almost 19% since 1999–2000. However, compared with the total PDI of the Catalan language and culture territories, the trend in chemistry has been slightly downwards while in chemical engineering, it has remained unchanged, mirroring the pattern in Spain.

**Table 1.** Universities and departments (2009)

## a) Catalonia

University	Department
Autonomous University of Barcelona (UAB)	Department of Chemical Engineering
	Department of Chemistry
Pompeu Fabra University (UPF)	Department of Experimental and Health Sciences (Analytical and Organic Chemistry Area)
Ramon Llull University (URL) – Chemical Institute of Sarrià (IQS)	Department of Chemical Engineering
	Department of Analytical Chemistry
	Department of Organic Chemistry
Rovira i Virgili University (URV)	Department of Chemical Engineering
	Department of Inorganic and Physical Chemistry
	Department of Analytical Chemistry and Organic Chemistry
Technical University of Catalonia (UPC)	Department of Chemical Engineering
University of Barcelona (UB)	Department of Chemical Engineering
	Department of Pharmacology and Therapeutic Chemistry (Organic Chemistry Area)
	Department of Physicochemistry (Physical Chemistry Area)
	Department of Physical Chemistry
	Department of Organic Chemistry
	Department of Inorganic Chemistry
	Department of Analytical Chemistry
University of Girona (UdG) <sup>a</sup>	Department of Chemical and Agricultural Engineering and Agrifood Technology
	Department of Chemistry
University of Lleida (UdL)	Department of Chemistry

## b) Balearic Islands

University	Department
University of the Balearic Islands (UIB)	Department of Chemistry

## c) Valencian Country

University	Department
Cardenal Herrera University CEU (UCH-CEU)	Department of Chemistry, Biochemistry and Molecular Biology
Jaume I University (UJI)	Department of Chemical Engineering
	Department of Inorganic and Organic Chemistry
	Department of Physical and Analytical Chemistry
Miguel Hernández University (UMH)	Department of Agrochemistry and Environment (Physical Chemistry and Chemical Engineering Areas)
	Department of Pharmacology, Pediatrics and Organic Chemistry (Inorganic and Organic Chemistry Areas)

University	Department
Technical University of Valencia (UPV)	Department of Chemical and Nuclear Engineering
	Department of Textile and Paper Engineering (Physical Chemistry Area)
	Department of Chemistry
University of Alacant <sup>b</sup> (UA)	Department of Chemical Engineering
	Department of Analytical Chemistry, Nutrition and Bromatology (Analytical Chemistry Area)
	Department of Physical Chemistry
	Department of Inorganic Chemistry
University de Valencia (UV)	Department of Organic Chemistry
	Department of Chemical Engineering
	Department of Analytical Chemistry
	Department of Physical Chemistry
University de Valencia (UV)	Department of Inorganic Chemistry
	Department of Organic Chemistry
	Department of Physical Chemistry
	Department of Analytical Chemistry

Source: Own work.

<sup>a</sup> Sp. Gerona

<sup>b</sup> Sp. Alicante

**Table 2.** Research institutes (2009)

Institute	Entity	City	URL
Catalan Institute of Nanotechnology (ICN) <sup>a</sup>	CERCA	Bellaterra	<a href="http://www.nanocat.org">http://www.nanocat.org</a>
Institute of Chemical Research of Catalonia (ICIQ)	CERCA	Tarragona	<a href="http://www.iciq.es">http://www.iciq.es</a>
Institute of Advanced Chemistry of Catalonia (IQAC)	CSIC	Barcelona	<a href="http://www.iqac.csic.es">http://www.iqac.csic.es</a>
Institute of Applied Molecular Chemistry (IQMA)	UPV	Valencia	<a href="http://iqma.webs.upv.es">http://iqma.webs.upv.es</a>
Institute of Chemical Technology (ITQ)	CSIC, UPV	Valencia	<a href="http://www.upv.es/itq">http://www.upv.es/itq</a>
Institute of Computational Chemistry (IQC)	UdG	Girona <sup>b</sup>	<a href="http://iqc.udg.es/">http://iqc.udg.es/</a>
Institute of Electrochemistry (IUE)	UA	Alacant <sup>c</sup>	<a href="http://www.ua.es/Institutoe/iue/index.html">http://www.ua.es/Institutoe/iue/index.html</a>
Institute of Materials Science of Barcelona (ICMAB)	CSIC	Bellaterra	<a href="http://www.icmab.es">http://www.icmab.es</a>
Institute of Organic Synthesis (ISO)	UA	Alacant <sup>c</sup>	<a href="http://iso.ua.es/va">http://iso.ua.es/va</a>
Institute of Theoretical and Computational Chemistry (IQTUB)	UB	Barcelona	<a href="http://www.iqtc.ub.es">http://www.iqtc.ub.es</a>
University Institute of Chemical Process Engineering (IIPQ)	UA	Alacant <sup>c</sup>	<a href="http://www.ua.es/Institutoe/iipq/index.html">http://www.ua.es/Institutoe/iipq/index.html</a>

Source: Own work.

<sup>a</sup> Together with the CSIC, the ICN promotes the Research Center on Nanoscience and Nanotechnology (CIN2, <http://www.cin2.es>).

<sup>b</sup> Sp. Gerona

<sup>c</sup> Sp. Alicante

**Table 3.** Recognized research groups

## a) Catalonia (2009)

Code	Group	Entity	Institute/Department
2009 SGR 1152	Preparation of Nanostructured Thin-Films Based on Organic and Inorganic Materials	CSIC	Research Center on Nanoscience and Nanotechnology(CIN2)
2009 SGR 605	Laboratory of Nanostructured Materials for Photovoltaic Energy (NANOEF)	CSIC	Research Center on Nanoscience and Nanotechnology(CIN2)
2009 SGR 171	Nanostructured Functional Materials (NANOSFUN)	CSIC	Research Center on Nanoscience and Nanotechnology(CIN2)
2009 SGR 126	Advanced Characterization and Nanostructuring of Materials (CANEM)	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 158	Chirality in Surfaces and Molecular Machines	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 376	Magnetic Materials and Functional Oxides (MAGIFOX)	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 50	Laboratory of Solid-State Chemistry	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 558	Optoelectronic and Surface Properties of Nanostructured Materials	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 770	Superconducting Materials and Large Scale Nanostructuring	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 516	Molecular Nanoscience and Organic Materials (NANOMOL)	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 666	Molecular Simulation	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 279	Inorganic Synthesis and Catalysis	CSIC	Institute of Materials Science of Barcelona (ICMAB)
2009 SGR 1343	Applied Molecular Receptors Group (AMRG)	CSIC	Institute of Advanced Chemistry of Catalonia (IQAC)
2009 SGR 1212	Physical Chemistry and Vesicular Structuring of Bacterial Lipids and Biopolymers	CSIC	Institute of Advanced Chemistry of Catalonia (IQAC)
2009 SGR 1472	Theoretical and Computational Chemistry	CSIC	Institute of Advanced Chemistry of Catalonia (IQAC)
2009 SGR 1331	Surfactants and Sustainable Chemistry	CSIC	Institute of Advanced Chemistry of Catalonia (IQAC)
2009 SGR 961	Surfactants	CSIC	Institute of Advanced Chemistry of Catalonia (IQAC)
2009 SGR 871	Unit of Chemical Ecology (UCE)	CSIC	Institute of Advanced Chemistry of Catalonia (IQAC)
2009 SGR 1072	Research Unit on Bioactive Molecules (RUBAM)	CSIC	Institute of Advanced Chemistry of Catalonia (IQAC)
2009 SGR 726	Research Group of Dr Rubén Martín	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 47	Organometallic Chemistry in Organic Synthesis	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 461	Laboratory for Heterogeneous Catalysis	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 259	Computational Modeling of Homogeneous and Heterogeneous Catalysis	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 69	Redox Catalysis	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 207	Laboratory of Optoelectronic Materials and Devices	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 686	Multidisciplinary Supramolecular Chemistry	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 623	Research in Modular Catalytic Systems (SICAM)	ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)
2009 SGR 150	Phononic and Photonic Nanostructures	ICN	Catalan Institute of Nanotechnology (ICN)
2009 SGR 776	Inorganic Nanoparticles	ICN	Catalan Institute of Nanotechnology (ICN)
2009 SGR 76	Nanobioelectronics and Biosensors	ICN	Catalan Institute of Nanotechnology (ICN)
2009 SGR 109	Nuclear Magnetic Resonance and Supramolecular Structures	UAB	Department of Chemistry
2009 SGR 1470	Applied Chemometrics (GQA)	UAB	Department of Chemistry
2009 SGR 638	Theoretical Studies on Activation of Biomolecules	UAB	Department of Chemistry
2009 SGR 1319	Stereoselective Organic Synthesis	UAB	Department of Chemistry

Code	Group	Entity	Institute/Department
2009 SGR 1084	Electrochemistry, Photochemistry and Organic Reactivity (GEFRO)	UAB	Department of Chemistry
2009 SGR 409	Dynamics and Mechanisms of Chemical and Biochemical Reactions	UAB	Department of Chemistry
2009 SGR 663	Centre for Separation Techniques in Chemistry	UAB	Department of Chemistry
2009 SGR 453	Photocatalysis and Green Chemistry	UAB	Department of Chemistry
2009 SGR 733	Synthesis, Structure and Chemical Reactivity (SERQ)	UAB	Department of Chemistry
2009 SGR 68	Synthesis and Modeling of Systems with Transition Metals	UAB	Department of Chemistry
2009 SGR 323	Sensors and Biosensors (GSB)	UAB	Department of Chemistry
2009 SGR 1441	Studies on Organic and Organometallic Chemistry (GEQOOM)	UAB	Department of Chemistry
2009 SGR 984	Laboratory of Materials and Environmental Electrochemistry	UB	Department of Physical Chemistry
2009 SGR 17	Dynamics of Chemical Reactions (Gdrq)	UB	Department of Physical Chemistry
2009 SGR 1041	Computational Materials Science Laboratory (CMSL)	UB	Department of Physical Chemistry
2009 SGR 1203	Structure of Molecular Materials (Gem2)	UB	Department of Physical Chemistry
2009 SGR 949	ELECTRODEP	UB	Department of Physical Chemistry
2009 SGR 1055	Self-Organized Complexity and Self-Assembling Materials (SOC&SAM)	UB	Department of Physical Chemistry
2009 SGR 881	Chirality Emergence, Amplification and Transfer (CHEAT)	UB	Department of Organic Chemistry
2009 SGR 208	Synthesis and Structure of Biomolecules	UB	Department of Organic Chemistry
2009 SGR 825	Stereoselective Synthesis of Antitumoral and Antiviral Agents (SSAAA)	UB	Department of Organic Chemistry
2009 SGR 1164	Organometallic Chemistry	UB	Department of Inorganic Chemistry
2009 SGR 674	Advanced Inorganic Materials and Catalysis	UB	Department of Inorganic Chemistry
2009 SGR 1454	Magnetic Interactions and Molecular Magnetism	UB	Department of Inorganic Chemistry
2009 SGR 1064	Magnetism and Functional Molecules (GMMF)	UB	Department of Inorganic Chemistry
2009 SGR 1459	Electronic Structure	UB	Department of Inorganic Chemistry
2009 SGR 986	Physico-chemical Characterization and Biological Activity Estimation of Bioactive Compounds	UB	Department of Analytical Chemistry
2009 SGR 1325	Analytical Chemistry. Analysis of contaminants	UB	Department of Analytical Chemistry
2009 SGR 1188	Quality in the Determination of Priority Contaminant and Evaluation of their behavior (QÜESTRAM)	UB	Department of Analytical Chemistry
2009 SGR 45	Development and Transference of Multivariant Resolution Chemometric Methodologies	UB	Department of Analytical Chemistry
2009 SGR 1423	Analysis and Behavior of Drugs in Food and the Environment	UB	Department of Analytical Chemistry
2009 SGR 1110	Bioanalysis	UB	Department of Analytical Chemistry
2009 SGR 229	Applied Catalysis and Kinetics	UB	Department of Chemical Engineering
2009 SGR 1466	Advanced Engineering of Oxidation Processes	UB	Department of Chemical Engineering
2009 SGR 416	Separation Processes, Membranes and Polymers	UB	Department of Chemical Engineering
2009 SGR 182	Innovation Laboratory in Processes and Products of Organic Synthesis (LIPPSO)	UdG	Department of Chemistry
2009 SGR 1495	Analytical and Environmental Chemistry (QAA)	UdG	Department of Chemistry
2009 SGR 528	Theoretical Chemistry and Modeling, and Molecular Engineering (QTMEM)	UdG	Department of Chemistry
2009 SGR 631	Bioinspired Redox Catalysis (CREBIO)	UdG	Department of Chemistry

Code	Group	Entity	Institute/Department
2009 SGR 620	Laboratory of Chemical and Environmental Engineering (LEQUIA)	UdG	Department of Chemical and Agricultural Engineering and Agrifood Technology
2009 SGR 622	Laboratory of Paper Engineering and Polymeric Materials (LEPAMAP)	UdG	Department of Chemical and Agricultural Engineering and Agrifood Technology
2009 SGR 465	Physical Chemistry of Macromolecular Systems of Environmental Interest	UdL	Department of Chemistry
2009 SGR 1208	Macromolecular Chemistry	UPC	Department of Chemical Engineering
2009 SGR 1402	Molecular and Industrial Biotechnology (GBMI)	UPC	Department of Chemical Engineering
2009 SGR 905	Separation Processes and Treatment of Industrial Waste	UPC	Department of Chemical Engineering
2009 SGR 1469	Advanced Industrial Polymers and Technological Biopolymers	UPC	Department of Chemical Engineering
2009 SGR 1118	Centre of Technological Risk Studies (CERTEC)	UPC	Department of Chemical Engineering
2009 SGR 365	Food and Environmental Security (IQS-SAMA)	URL	Department of Analytical Chemistry
2009 SGR 82	Biological Chemistry and Biotechnology (GQBB)	URL	Department of Organic Chemistry and Biochemistry
2009 SGR 332	Molecular Engineering (GEM)	URL	Department of Organic Chemistry and Biochemistry
2009 SGR 1238	Catalytic Materials	URV	Department of Chemical Engineering
2009 SGR 1529	Transport Phenomena (FET)	URV	Department of Chemical Engineering
2009 SGR 882	Molecular Simulation: Complex Systems, Interfaces and Polymers	URV	Department of Chemical Engineering
2009 SGR 865	Chemical Reaction Engineering and Process Intensification	URV	Department of Chemical Engineering
2009 SGR 139	INTERFIBIO: Research in the Physico-Biological Interface	URV	Department of Chemical Engineering
2009 SGR 237	Structured Systems Engineering for Energy, Materials and Chemistry (SYSTEMIC)	URV	Department of Chemical Engineering
2009 SGR 116	Organometallics i Heterogeneous Catalysis	URV	Department of Physical and Inorganic Chemistry
2009 SGR 462	Quantum Chemistry (QQ)	URV	Department of Physical and Inorganic Chemistry
2009 SGR 746	Organic Synthesis	URV	Department of Analytical Chemistry and Organic Chemistry
2009 SGR 270	Chemometrics, Qualimetrics and Nanosensors	URV	Department of Analytical Chemistry and Organic Chemistry
2009 SGR 223	Chromatography and Environmental Applications	URV	Department of Analytical Chemistry and Organic Chemistry
2009 SGR 1550	Polymers	URV	Department of Analytical Chemistry and Organic Chemistry

Source: Own work, from data published by the Resolution of 3 July 2009 of the President of the Executive Committee on Research Grants, which settles the call for funding to support activities of research groups for 2009 (SGR-DGR). A total of 1296 grants were awarded.

#### b) Balearic Islands (2006)

Code	Group	Entity	Department
PCTIB-2005GC1-ORC10	Molecular Reactivity and Drug Design	UIB	Department of Chemistry
PCTIB-2005GC1-ORC15	Bioinorganic and Bioorganic Chemistry	UIB	Department of Chemistry
PCTIB-2005GC3-ORC03	Ambient Analytical Chemistry, Automation and the Environment	UIB	Department of Chemistry

Source: Own work, from data published by the Government of the Balearic Islands (Resolution of the Minister of Economy, Finance and Innovation on 6 October, 2006, granting aid to support competitive research groups). A total of 39 grants awarded.



Territory	Indicator	1999– 2000	2000– 2001	2001– 2002	2002– 2003	2003– 2004	2004– 2005	2005– 2006	2006– 2007	2007– 2008
Valencian Country	PDI total	825	870	914	973	988	998	1004	1043	1072
	% Chemistry out of total PDI	4.4%	4.1%	3.9%	3.9%	3.7%	3.8%	3.8%	3.7%	3.8%
	% Chemical Engineering out of total PDI	–	–	–	–	–	–	–	–	–
	Chemistry	326	330	334	331	373	353	370	355	376
	Chemical Engineering	115	117	121	123	130	133	134	132	141
Catalan Countries	PDI total	8152	8475	8985	9240	9910	10,046	10,377	10,560	10,805
	% Chemistry out of total PDI	4.0%	3.9%	3.7%	3.6%	3.8%	3.5%	3.6%	3.4%	3.5%
	% Chemical Engineering out of total PDI	1.4%	1.4%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%	1.3%
	Chemistry	728	755	768	796	818	788	821	812	862
	Chemical Engineering	305	310	327	347	368	359	357	361	364
Spain	PDI total	20,686	21,398	22,430	23,229	24,154	24,338	25,079	25,751	26,411
	% Chemistry out of total PDI	3.5%	3.5%	3.4%	3.4%	3.4%	3.2%	3.3%	3.2%	3.3%
	% Chemical Engineering out of total PDI	1.5%	1.4%	1.5%	1.5%	1.5%	1.5%	1.4%	1.4%	1.4%
	Chemistry	3066	3126	3154	3174	3137	3165	3153	3205	3285
	Chemical Engineering	1090	1142	1182	1208	1252	1287	1271	1287	1332
	PDI total	79,779	82,902	84,645	86,676	88,222	91,059	91,810	95,489	98,303
	% Chemistry out of total PDI	3.8%	3.8%	3.7%	3.7%	3.6%	3.5%	3.4%	3.4%	3.3%
	% Chemical Engineering out of total PDI	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.4%	1.3%	1.4%

Source: Own work, data from the INE and the Commissioner of University and Research (CUR), in addition to the university reports.

Note 1: Chemistry includes the areas of knowledge of Analytical Chemistry (code 750), Physical Chemistry (code 755), Inorganic Chemistry (code 760) and Organic Chemistry (code 765). Chemical Engineering contains only this knowledge area code (555).

Note 2: Catalonia does not include data from the PDI category of assistant.

Note 3: In the Valencian Country, the data of the University of Alacant (years 1999–2000 and 2000–2001), the Technical University of Catalonia (years 1999–2000 and 2000–2001) and Jaume I University (from the academic year 2004–2005 until 2007–2008) are not available. In all these cases, the data recorded are from the year before or after.

Unfortunately, there is not enough solid data on private universities, some of which are carrying out high-quality research in chemistry, such as the Chemical Institute of Sarrià (IQS) of Ramon Llull University (URL) [<http://www.iqs.url.es>].

Despite the difficulties in obtaining reliable information on the institutions not linked exclusively with universities, there is a clear upward trend in the number of researchers they employ (Table 6).

With regard to public initiatives to finance the hiring of researchers in universities and research institutions, worthy of mention are the Catalan Institution for Research and Advanced Studies (ICREA) of the Autonomous Government of Catalonia and Spanish programs aimed at attracting talent: Ramón y Cajal (RYC) and Juan de la Cierva (JCI), both of the Ministry of Science and Innovation (MICINN). Thus, in the period 2001–2008, these actions led to the incorporation of 261 researchers specialized in chemistry, with 12.1% of these awards going to the Catalan Countries (Table 7).

As for scholarships and grants for researchers in training, the Spanish government promotes two major subprograms:

Training University Lecturers (FPU) and Training Research Personnel (FPI). Of the 4842 new predoctoral internships granted in the period 2000–2008 in the Catalan Countries (Table 8), 11.1% (538) corresponded to chemistry. Moreover, the recruitment of postgraduate students to this field is increasing in both absolute and relative terms. Further analysis was not possible due to the lack of accurate data corresponding to the predoctoral positions of the autonomic administrations, universities, and research institutes.

In the private sector, according to estimates from the data of the INE [6], the personnel employed in R&D in chemical and pharmaceutical companies represented 19.3% of the total personnel for R&D in Catalonia (year 2004), with 3964 workers as full-time equivalents (EDP).

### 3. Financial resources

Public financing of research is structured in multi-annual plans. In the decade 2000–2009, the EU-27 launched three Frame-

**Table 6.** Research staff of non-university institutions (2000–2008)

Entity	Institute	2000	2001	2002	2003	2004	2005	2006	2007	2008
CSIC	Chemical and Environmental Research Institute of Barcelona J. Pascual Vila (IIQAB)	46	47	47	46	49	n/a	26	26	n/a
	Institute of Chemical Technology (ITQ)	8	11	11	13	14	15	17	20	n/a
	Institute of Materials Science of Barcelona (ICMAB)	30	33	38	39	40	40	43	41	n/a
	Research Center on Nanoscience and Nanotechnology (CIN2)	-	-	-	-	-	-	-	8	n/a
ICIQ	Institute of Advanced Chemistry of Catalonia (ICIQ)	n/a	n/a	n/a	n/a	n/a	n/a	52	79	81

Source: Own work, based on the memoirs of the CSIC and ICIQ.

Note 1: The data of the CSIC centers are cumulative (not available for Chemistry alone) and include only the categories of Research Professor, Research Scientist, and Associate Scientist. In 2007, the CIN2 was created and the IIQAB was divided into the Institute of Advanced Chemistry of Catalonia (IQAC) and the Institute for Environmental Diagnostics and Water Research (IDAEA).

**Table 7.** Researchers hired by public programs (2001–2008)

Program	Territory	Indicator	2001	2002	2003	2004	2005	2006	2007	2008	Total
ICREA	Catalonia	Chemistry	0	0	2	4	5	6	5	3	25
		Total	11	25	32	17	52	49	32	29	247
		% Chemistry	0.0%	0.0%	6.3%	23.5%	9.6%	12.2%	15.6%	10.3%	10.1%
RYC	Catalonia	Chemistry	20	15	16	5	6	11	3	7	83
		Total	195	151	177	65	62	73	65	65	853
		% Chemistry	10.3%	9.9%	9.0%	7.7%	9.7%	15.1%	4.6%	10.8%	9.7%
	Balearic Islands	Chemistry	0	0	2	2	0	0	1	0	5
		Total	7	2	9	10	2	6	3	2	41
		% Chemistry	0.0%	0.0%	22.2%	20.0%	0.0%	0.0%	33.3%	0.0%	12.2%
	Valencian Country	Chemistry	16	5	17	10	4	12	3	1	68
		Total	73	30	81	56	18	23	9	7	297
		% Chemistry	21.9%	16.7%	21.0%	17.9%	22.2%	52.2%	33.3%	14.3%	22.9%
JCI	Catalonia	Chemistry	-	-	-	7	7	10	14	12	50
		Total	-	-	-	103	93	118	125	107	546
		% Chemistry	-	-	-	6.8%	7.5%	8.5%	11.2%	11.2%	9.2%
	Balearic Islands	Chemistry	-	-	-	1	0	0	0	0	1
		Total	-	-	-	5	2	4	7	7	25
		% Chemistry	-	-	-	20.0%	0.0%	0.0%	0.0%	0.0%	4.0%
	Valencian Country	Chemistry	-	-	-	8	5	8	5	9	35
		Total	-	-	-	38	23	35	28	32	156
		% Chemistry	-	-	-	21.1%	21.7%	22.9%	17.9%	28.1%	22.4%
Total	Catalonia	Chemistry	20	15	18	16	18	27	22	22	158
		Total	206	176	209	185	207	240	222	201	1 646
		% Chemistry	9.7%	8.5%	8.6%	8.6%	8.7%	11.3%	9.9%	10.9%	9.6%
	Balearic Islands	Chemistry	0	0	2	3	0	0	1	0	0
		Total	7	2	9	15	4	10	10	9	66
		% Chemistry	0.0%	0.0%	22.2%	20.0%	0.0%	0.0%	10.0%	0.0%	0.0%
	Valencian Country	Chemistry	16	5	17	18	9	20	8	10	103
		Total	73	30	81	94	41	58	37	39	453
		% Chemistry	21.9%	16.7%	21.0%	19.1%	22.0%	34.5%	21.6%	25.6%	22.7%
	Catalan Countries	Chemistry	36	20	37	37	27	47	31	32	261
		Total	286	208	299	294	252	308	269	249	2 165
		% Chemistry	12.6%	9.6%	12.4%	12.6%	10.7%	15.3%	11.5%	12.9%	12.1%

Source: Own work, Resolutions from the BOE, MICINN and ICREA.

Note 1: The data show the number of researchers hired annually.

Note 2: ICREA and RyC Program began in 2001, while the JCI program was created in 2004.

**Table 8.** Scholarships and grants to researchers in training (2000–2008)

Program	Territory	Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total	
FPU	Catalonia	Chemistry	11	14	23	22	25	18	22	28	34	197	
		Total	136	139	198	188	194	208	233	220	234	1750	
		% Chemistry	8.1%	10.1%	11.6%	11.7%	12.9%	8.7%	9.4%	12.7%	14.5%	11.3%	
	Balearic Islands	Chemistry	1	2	2	1	0	0	0	0	0	2	8
		Total	6	5	7	3	6	4	3	3	6	9	49
		% Chemistry	16.7%	40.0%	28.6%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	22.2%	16.3%
	Valencian Country	Chemistry	9	14	17	10	15	9	10	10	17	16	117
		Total	103	110	110	90	96	122	103	103	119	104	957
		% Chemistry	8.7%	12.7%	15.5%	11.1%	15.6%	7.4%	9.7%	14.3%	15.4%	15.4%	12.2%
FPI	Catalonia	Chemistry	9	15	17	30	19	14	29	21	16	170	
		Total	76	123	157	211	188	203	214	254	244	1670	
		% Chemistry	11.8%	12.2%	10.8%	14.2%	10.1%	6.9%	13.6%	8.3%	6.6%	10.2%	
	Balearic Islands	Chemistry	n/a	n/a	n/a	n/a	n/a	1	0	0	0	2	3
		Total	n/a	n/a	n/a	n/a	n/a	7	12	12	12	10	41
		% Chemistry	n/a	n/a	n/a	n/a	n/a	14.3%	0.0%	0.0%	20.0%	7.3%	
	Valencian Country	Chemistry	n/a	n/a	n/a	n/a	n/a	9	3	15	16	16	43
		Total	n/a	n/a	n/a	n/a	n/a	92	89	100	94	375	
		% Chemistry	n/a	n/a	n/a	n/a	n/a	9.8%	3.4%	15.0%	17.0%	11.5%	
Total	Catalonia	Chemistry	20	29	40	52	44	32	51	49	50	367	
		Total	212	262	355	399	382	411	447	474	478	3420	
		% Chemistry	9.4%	11.1%	11.3%	13.0%	11.5%	7.8%	11.4%	10.3%	10.5%	10.7%	
	Balearic Islands	Chemistry	1	2	2	1	0	1	0	0	0	4	11
		Total	6	5	7	3	6	11	15	15	18	19	90
		% Chemistry	16.7%	40.0%	28.6%	33.3%	0.0%	9.1%	0.0%	0.0%	21.1%	12.2%	
	Valencian Country	Chemistry	9	14	17	10	15	18	13	13	32	32	160
		Total	103	110	110	90	96	214	192	219	198	1332	
		% Chemistry	8.7%	12.7%	15.5%	11.1%	15.6%	8.4%	6.8%	14.6%	16.2%	12.0%	
Catalan Countries	Chemistry	30	45	59	63	59	51	64	81	86	538		
	Total	321	377	472	492	484	636	654	711	695	4842		
	% Chemistry	9.3%	11.9%	12.5%	12.8%	12.2%	8.0%	9.8%	11.4%	12.4%	11.1%		

Source: Own work from the resolutions issued by the BOE and the MICINN.

Note 1: The data show the number of new four-year scholarships awarded annually.

Note 2: In the period 2000–2003 FPI data are not available for the Balearic Islands and the Valencian Country.

work Programmes (FP): the 5th FP (1998–2002); the 6th FP (2003–2006); and the 7th FP (2007–2013). The Spanish government has structured its scientific policies around successive editions of the National R&D&I Plan: 4th (2000–2003); 5th (2004–2007); and 6th (2008–2011). In addition, the Autonomous Governments of Catalonia, the Balearic Islands, and the Valencian Country have their own multi-year plans.

In the period 2000–2008, the OR-IEC database registered 217 participations in the FP projects of the EU-27 Catalan entities (public and private) specialized in chemistry (Table 9). This represents an average of 5.6% of the global participants in all areas, despite the oscillations reflecting the increased activity in the central years of each program. Unfortunately, there is no specific program dedicated to chemistry nor is detailed information on the amounts awarded available.

The National R&D&I Plan of the Spanish government finances (in the form of credits and/or grants) research projects and complementary actions executed by public and private entities. Under the National Chemical Science and Technology Program (2000–2007), the territories of Catalan language and culture obtained 742 awards, 26.9% of the Spanish total (Table 10). This translates into an annual average of 3.9% of the projects and actions of the Catalan Countries. In economic terms, 50.99 million Euros have been obtained in credits (40.7% of the Spanish overall, testifying to the weight of the Catalan industry) and 65.54 million Euros in grants (28.7%). However, these amounts are modest quantity if compared with the economic volume of the chemical industry. Table 11 indicates the Catalan companies with the highest European and Spanish public funding for R&D industrial projects.

With regard to the actions of autonomous governments, the last call for funding to support the activities of research groups based in the Autonomous Government of Catalonia recognized 92 groups in chemistry and chemical engineering (Table 3), of which 54 were financed with a total of 2.6 million Euros for the 5-year period 2009–2013. In terms of the number of groups and financing, chemistry accounted for 7.4% of the global concessions.

Compared to chemo-pharmaceutical companies, in 2004 the internal expenditure on R&D was approximately 376.4 million Euros [6], 27% of the total of the Catalan private sector (the expenditure for the year 2000 was 26.6%, with 226 million Euros [5]). There are also data on the relative R&D effort by the sector comprising high and medium to high technological content in Catalonia (2004–2007), in other words, the percentage of expenditure of R&D turnover (Fig. 1) [7]. This indicator shows that while the pharmaceutical industry ranked second, chemistry is far below.

In Table 11 the Catalan and Valencian companies with five or more research and industrial development projects partially funded by Spain and the EU-27 are shown.

#### 4. Results

This section describes the scientific and technological production (in the form of articles, doctoral theses, and patents) generated by the R&D agents, according to the human and financial resources invested. In some cases, only a qualitative assessment of the results was possible. In the period 2000–2008, the production of scientific articles indexed in the Science Citation Index Expanded (SCI-E, Thomson Reuters) database grew considerably in absolute terms (Table 12). Nonetheless, there was a sharp decline in chemistry articles relative to the global scientific

production of the territories. In addition, based on the number of PDI of the public universities (Table 5), each chemistry professor of the Catalan Countries published an average of two articles per year.

From a qualitative point of view, the average number of citations per article (C/A Chemistry) almost doubled during the period 2000–2008, with the Catalan territories indicators well above the Spanish ones. This observation is confirmed by a study of the Bibliometry and Science Evaluation Group (BAC) (Fig. 2). Thus, since 1993, the ratio of citations per document in Catalonia exceeds the Spanish, European, and world values.

From the 1999–2000 until the 2007–2008 academic years, 1469 doctoral theses in Chemistry were completed in Catalonia, the Balearic Islands, and the Valencian Country (Table 13). This figure represents 8% of the total of new doctorates in the Catalan Countries and is above the Spanish percentage (7.7%). In relation to the PDI of public universities in the Catalan Countries (Table 5), one thesis is completed annually per every five Chemistry lecturers.

In order to assess the technological production it is interesting to examine the statistics on patent applications published by the Spanish Patent and Trademark office (OEPM). Thus, in the period 2000–2008, Catalonia, the Balearic Islands, and the Valencian Country submitted 490 applications in the field of chemistry (6.8% of the total for these territories, Table 14), accounting for almost half of the 1041 Spanish patents in this area. Although since the year 2000, the absolute number of patents has doubled it is nonetheless low, particularly when compared to the weight of the industrial sector or the production of scientific articles. In addition, only a minority of patents can be ascribed to the public sector, which shows a weak technological transference to the productive sector [1,2].

Among the patent applications submitted to the European Patent Office (EPO), the data also show that there has been

**Table 9.** Participation in FP projects of the EU-27 (2000–2008)

Territory	Indicator	FP5			FP6				FP7		Total
		2000	2001	2002	2003	2004	2005	2006	2007	2008	
Catalonia	Chemistry	20	30	24	12	28	29	18	7	16	184
	Total	358	454	466	210	134	328	472	169	318	2909
	% Chemistry	5.6%	6.6%	5.2%	5.7%	20.9%	8.8%	3.8%	4.1%	5.0%	6.3%
Balearic Islands	Chemistry	0	1	0	0	0	0	0	0	0	1
	Total	5	15	21	3	16	21	15	8	4	108
	% Chemistry	0.0%	6.7%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.9%
Valencian Country	Chemistry	0	6	5	3	9	5	2	1	1	32
	Total	2	102	151	70	143	98	154	59	87	866
	% Chemistry	0.0%	5.9%	3.3%	4.3%	6.3%	5.1%	1.3%	1.7%	1.1%	3.7%
Catalan Countries	Chemistry	20	37	29	15	37	34	20	8	17	217
	Total	365	571	638	283	293	447	641	236	409	3883
	% Chemistry	5.5%	6.5%	4.5%	5.3%	12.6%	7.6%	3.1%	3.4%	4.2%	5.6%

Source: Own work from the CORDIS database (EU-27) and the Autonomous Government of Catalonia.

Note: The data show the number of shares of entities in the field of Chemistry in FP projects. In the same project more than one organization may intervene in the territories of Catalan language and culture.

**Table 10.** Research projects and complementary actions of the National R&D&I Plan (2000–2007)

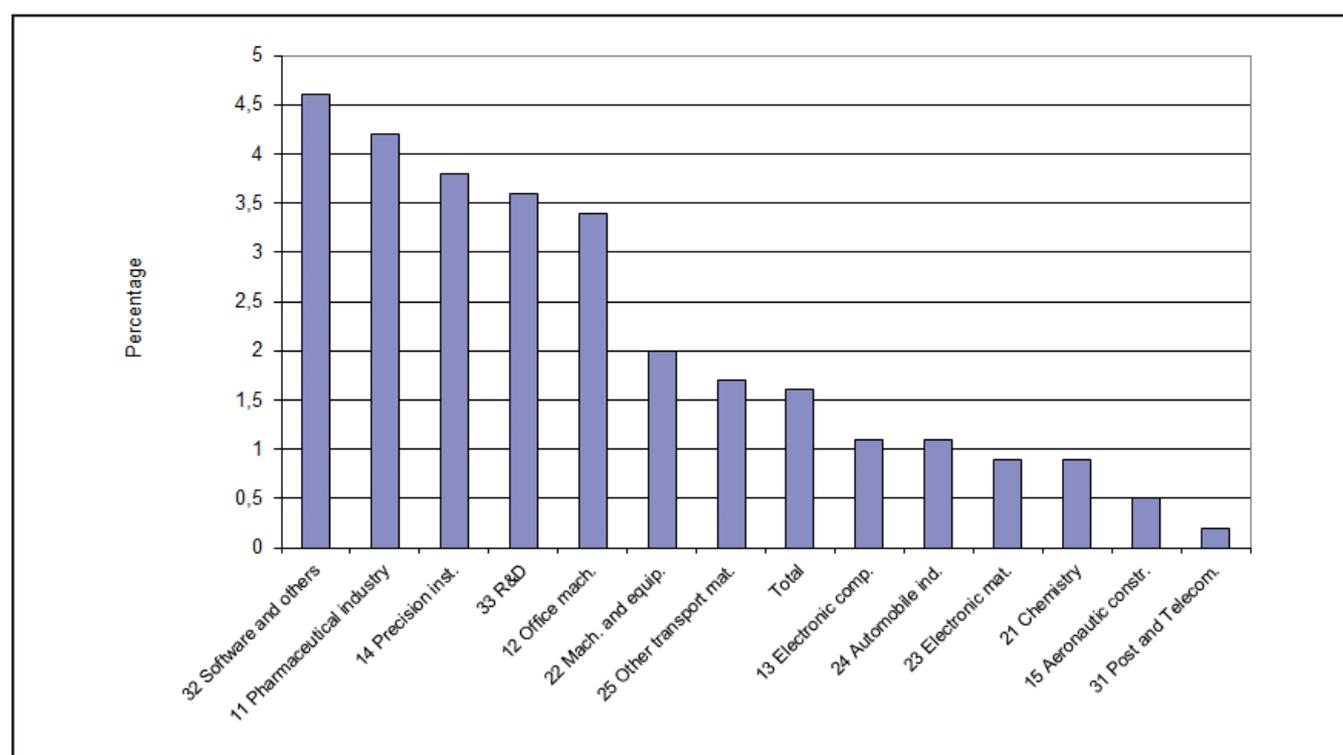
Territory	Indicator	4th National R&D&I Plan (2000–2003)			5th National R&D&I Plan (2004–2007)			Total		
		Activities	Credit	Grant	Activities	Credit	Grant	Activities	Credit	Grant
Catalonia	Chemistry	256	15.10	16.73	272	30.90	28.43	528	46.00	45.17
	Total	5887	392.64	344.08	7146	627.72	757.21	13,033	1020.36	1101.29
	% Chemistry	4.3%	3.8%	4.9%	3.8%	4.9%	3.8%	4.1%	4.5%	4.1%
Balearic Islands	Chemistry	7	0.00	0.54	10	0.00	1.00	17	0.00	1.54
	Total	338	23.37	14.58	322	12.24	20.97	660	35.60	35.55
	% Chemistry	2.1%	0.0%	3.7%	3.1%	0.0%	4.8%	2.6%	0.0%	4.3%
Valencian Country	Chemistry	79	3.62	6.18	118	1.37	12.65	197	4.99	18.83
	Total	2277	49.01	131.95	2969	101.21	262.83	5246	150.22	394.78
	% Chemistry	3.5%	7.4%	4.7%	4.0%	1.4%	4.8%	3.8%	3.3%	4.8%
Catalan Countries	Chemistry	342	18.72	23.45	400	32.27	42.09	742	50.99	65.54
	Total	8502	465.02	490.61	10,437	741.17	1041.00	18,939	1206.19	1531.62
	% Chemistry	4.0%	4.0%	4.8%	3.8%	4.4%	4.0%	3.9%	4.2%	4.3%
Spain	Chemistry	1349	32.11	89.17	1414	93.03	139.24	2763	125.14	228.41
	Total	26,236	1330.27	1497.63	33,330	2155.55	3364.28	59,566	3485.83	4861.92
	% Chemistry	5.1%	2.4%	6.0%	4.2%	4.3%	4.1%	4.6%	3.6%	4.7%

Source: Annual R&D Report (MICINN).

Note 1: In the period 2000–2003, chemistry includes the national programs General Promotion of Knowledge (Chemistry) and Process and Chemicals. The period 2004–2007 corresponds to the national program of Chemical Science and Technologies.

Note 2: Activities include research projects and complementary actions granted to public and private entities in the form of credits and/or grants.

Note 3: Credits and grants in millions of Euros.



**Fig. 1.** Relative R&D effort by sector of high and medium to high technological content (2004–2007). Source: ACC1Ó 2009, from data from the INE.

**Table 11.** Companies with the highest number of publicly funded research and industrial development projects (2000–2008)

Company	City	URL
Esmalglass, S.A.	Vila-real	<a href="http://www.esmalglass-itaca.com">http://www.esmalglass-itaca.com</a>
Fritta, S.L.	Onda	<a href="http://www.fritta.com">http://www.fritta.com</a>
Henkel Ibérica, S.A.	Barcelona	<a href="http://www.henkel.es">http://www.henkel.es</a>
Industrias Chemistrys del Vallès, S.A.	Mollet del Vallès	<a href="http://www.iqvagro.es">http://www.iqvagro.es</a>
Kao Corporation, S.A.	Barberà del Vallès	<a href="http://www.kaochemicals-eu.com">http://www.kaochemicals-eu.com</a>
Menadiona, S.L.	Barcelona	<a href="http://www.menadiona.com">http://www.menadiona.com</a>
Natura Bisse International, S.A.	Cerdanyola del Vallès	<a href="http://www.naturabisse.es">http://www.naturabisse.es</a>
Productos Concentrol, S.A.	Riudellots de la Selva	<a href="http://www.concentrol.com">http://www.concentrol.com</a>
Sociedad Anónima Reverte Productos Minerales	Barcelona	<a href="http://www.reverteminerals.com">http://www.reverteminerals.com</a>
Sociedad Española de Carburos Metálicos, S.A.	Barcelona	<a href="http://www.carburos.com">http://www.carburos.com</a>
Torrecid, S.A.	Alcora	<a href="http://www.torrecid.com">http://www.torrecid.com</a>
UBE Chemical Europe, S.A.	Castelló	<a href="http://www.ube.es">http://www.ube.es</a>
Vidres, S.A.	Vila-real	<a href="http://www.vidres.com">http://www.vidres.com</a>

Source: Own work, from the CORDIS database (EU-27) and the the Center for Industrial Technological Development (CDTI).

Note: Companies with 5 or more projects that have received public funding (2000–2008).

**Table 12.** Indexed articles in the SCI-E database (2000–2008)

Territory	Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008
Catalonia	Chemistry	774	849	799	850	921	1037	1207	1282	1328
	Total	4289	4462	4672	4870	5481	5903	6826	7566	8664
	% Chemistry	18.0%	19.0%	17.1%	17.5%	16.8%	17.6%	17.7%	16.9%	15.3%
	Citations Chemistry	3288	3673	3619	4240	5121	6466	7909	9073	n/a
	C/A Chemistry	4.25	4.33	4.53	4.99	5.56	6.24	6.55	7.08	n/a
Balearic Islands	Chemistry	31	43	41	50	44	53	45	42	50
	Total	237	307	338	330	401	401	407	447	542
	% Chemistry	13.1%	14.0%	12.1%	15.2%	11.0%	13.2%	11.1%	9.4%	9.2%
	Citations Chemistry	123	147	281	290	176	397	373	319	n/a
	C/A Chemistry	3.97	3.42	6.85	5.80	4.00	7.49	8.29	7.60	n/a
Valencian Country	Chemistry	479	558	550	507	631	696	712	771	781
	Total	2022	2233	2215	2403	2617	2835	3254	3668	3991
	% Chemistry	23.7%	25.0%	24.8%	21.1%	24.1%	24.6%	21.9%	21.0%	19.6%
	Citations Chemistry	1979	2641	3137	3158	3839	4391	4676	5202	n/a
	C/A Chemistry	4.13	4.73	5.70	6.23	6.08	6.31	6.57	6.75	n/a
Spain	Chemistry	3920	4027	4324	4202	4583	4984	5207	5533	5513
	Total	18,727	19,487	20,420	20,895	22,441	24,109	26,640	29,491	32,144
	% Chemistry	20.9%	20.7%	21.2%	20.1%	20.4%	20.7%	19.5%	18.8%	17.2%
	Citations Chemistry	15,257	15,850	17,816	19,119	23,066	26,619	29,942	33,830	n/a
	C/A Chemistry	3.89	3.94	4.12	4.55	5.03	5.34	5.75	6.11	n/a

Source: Own work from the Science Citation Index Expanded (SCI-E, Thomson Reuters) database.

Note 1: "Chemistry" and "Total" correspond to the number of items. "Citations Chemistry" presents the citations received in the year of publication of articles in Chemistry and two years later. "C/A Chemistry" is the ratio of citations received by articles of Chemistry.

Note 2: Aggregate data from the territories of Catalan language and culture are not presented since aggregates would have duplicated articles.

Note 3: Chemistry includes the following areas: Physics, Atomic, Molecular & Chemical; Chemistry, Analytical; Chemistry, Applied; Chemistry, Inorganic & Nuclear; Chemistry, Medicinal; Polymer Science; Chemistry, Multidisciplinary; Chemistry, Organic; Chemistry, Physical; Electrochemistry.

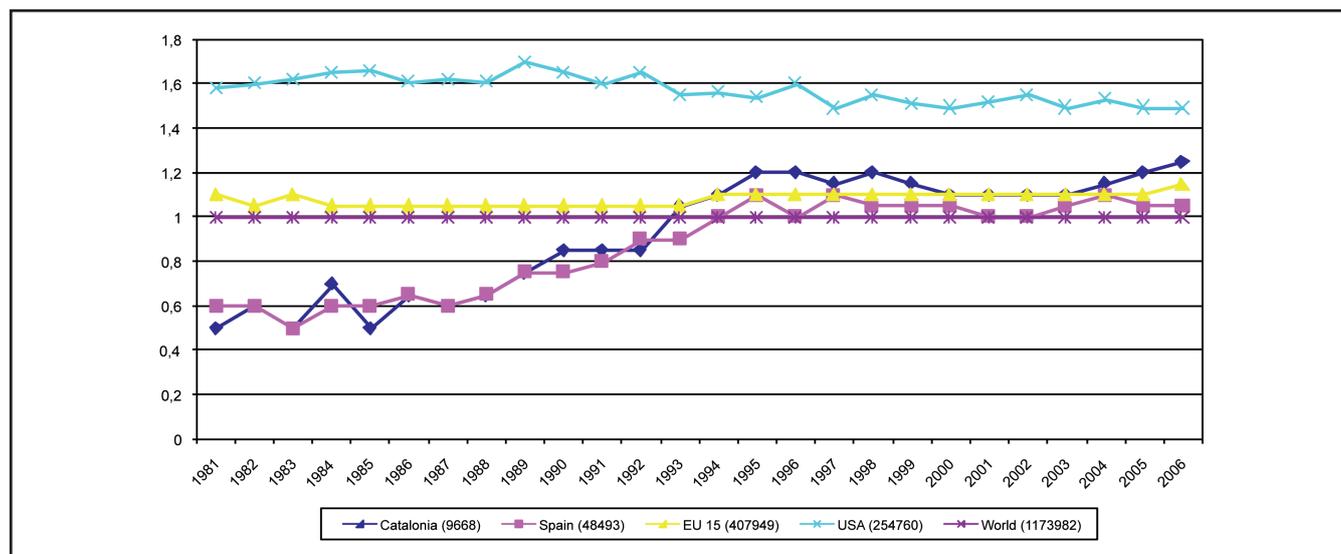
considerable growth (Table 15). In the period 2000–2006, the 357 chemistry-related patents represented 9.8% of the total patents of the Catalan Countries, a percentage higher than in the rest of Spain (8.1%) and the EU-27 (6.7%).

## 5. Conclusions

Public research in chemistry in Catalonia, the Balearic Islands, and the Valencian Country is carried out mainly in universities. It

follows the guidelines of a multi-level governance in which autonomous governments, the Spanish Government, and the European administration are involved. Most universities conduct research in chemistry, and to a lesser extent in chemical engineering.

Approximately 27% of the Spanish PDI in chemistry and chemical engineering work in the studied territories. Policies to attract teaching and research talent have proven sufficient to strengthen and complement the university staff and associated workforce. In these territories, 11.1% of the staff associated



**Fig. 2.** International Bibliometric Comparison - Chemistry (1981–2006). Source: BAC. Bibliometric characterization of the scientific production in Catalonia, 1996–2006 [<http://bibliometria.prbb.org/ncrcat06>]. Note: Annual evolution of the citations per document in the subject area according to certain territorial aggregates. The reference value (= 1) is the ratio of all documents in the world. Values >1 indicate that the number is greater than the world average of citations for a given document. Values <1 indicate that the number is lower than the world average.

**Table 13.** Doctoral theses (1999–2008)

Territory	Indicator	1999–2000	2000–2001	2001–2002	2002–2003	2003–2004	2004–2005	2005–2006	2006–2007	2007–2008	Total
Catalonia	Chemistry	93	109	117	105	97	99	112	155	105	992
	Total	1104	1094	1150	1189	1225	1268	1409	1394	1478	11,311
	% Chemistry	8.4%	10.0%	10.2%	8.8%	7.9%	7.8%	7.9%	11.1%	7.1%	8.8%
Balearic Islands	Chemistry	5	7	4	2	0	2	7	3	0	30
	Total	43	49	50	34	35	36	41	50	19	357
	% Chemistry	11.6%	14.3%	8.0%	5.9%	0.0%	5.6%	17.1%	6.0%	0.0%	8.4%
Valencian Country	Chemistry	34	51	42	57	58	65	40	54	46	447
	Total	652	713	777	689	780	889	633	723	774	6630
	% Chemistry	5.2%	7.2%	5.4%	8.3%	7.4%	7.3%	6.3%	7.5%	5.9%	6.7%
Catalan Countries	Chemistry	132	167	163	164	155	166	159	212	151	1469
	Total	1799	1856	1977	1912	2040	2193	2083	2167	2271	18,298
	% Chemistry	7.3%	9.0%	8.2%	8.6%	7.6%	7.6%	7.6%	9.8%	6.6%	8.0%
Spain	Chemistry	479	576	531	556	552	541	583	570	518	4906
	Total	6408	6380	6936	7467	8176	6902	7159	7150	7302	63,880
	% Chemistry	7.5%	9.0%	7.7%	7.4%	6.8%	7.8%	8.1%	8.0%	7.1%	7.7%

Source: INE.

**Table 14.** Applications of patents published by the OEPM (2000–2008)

Territory	Indicator	2000	2001	2002	2003	2004	2005	2006	2007	2008	Total
Catalonia	Chemistry	27	38	30	37	47	42	59	37	46	363
	Total	412	519	566	521	577	639	611	491	538	4874
	% Chemistry	6.6%	7.3%	5.3%	7.1%	8.1%	6.6%	9.7%	7.5%	8.6%	7.4%
Balearic Islands	Chemistry	0	0	0	1	0	1	0	1	1	4
	Total	16	15	15	21	21	15	13	18	18	152
	% Chemistry	0.0%	0.0%	0.0%	4.8%	0.0%	6.7%	0.0%	5.6%	5.6%	2.6%
Valencian Country	Chemistry	4	18	9	16	14	20	18	11	13	123
	Total	182	233	231	263	241	282	275	220	260	2187
	% Chemistry	2.2%	7.7%	3.9%	6.1%	5.8%	7.1%	6.5%	5.0%	5.0%	5.6%
Catalan Countries	Chemistry	31	56	39	54	61	63	77	49	60	490
	Total	610	767	812	805	839	936	899	729	816	7213
	% Chemistry	5.1%	7.3%	4.8%	6.7%	7.3%	6.7%	8.6%	6.7%	7.4%	6.8%
Spain	Chemistry	62	122	98	137	121	119	134	100	148	1041
	Total	1549	1879	1808	1966	1977	2084	2036	1948	2195	17,442
	% Chemistry	4.0%	6.5%	5.4%	7.0%	6.1%	5.7%	6.6%	5.1%	6.7%	6.0%

Source: Statistics of Industrial Property (OEPM).

Note: Classes from the International Patent Classification (IPC): C01 (Inorganic Chemistry), C02 (Water Treatment), C07 (Organic Chemistry), C08 (Organic Macromolecular Compounds).

**Table 15.** Applications of patents published by the EPO (2000–2006)

Territory	Indicator	2000	2001	2002	2003	2004	2005	2006	Total
Catalonia	Chemistry	21.32	24.93	22.9	29.21	56.71	77.43	80.63	313.13
	Total	327.17	348.44	383.32	393.11	477.96	494.46	511.64	2936.10
	% Chemistry	6.5%	7.2%	6.0%	7.4%	11.9%	15.7%	15.8%	10.7%
Balearic Islands	Chemistry	0	0.07	0	0	0	0.73	0.06	0.86
	Total	8.60	7.02	2.83	6.00	7.50	6.07	9.74	47.76
	% Chemistry	0.0%	1.0%	0.0%	0.0%	0.0%	12.0%	0.6%	1.8%
Valencian Country	Chemistry	4.57	6.41	4.99	3.38	11.14	7.79	5.08	43.36
	Total	83.37	89.56	94.17	82.06	118	112.64	88.11	667.91
	% Chemistry	5.5%	7.2%	5.3%	4.1%	9.4%	6.9%	5.8%	6.5%
Catalan Countries	Chemistry	25.89	31.41	27.89	32.59	67.85	85.95	85.77	357.35
	Total	419.14	445.02	480.32	481.17	603.46	613.17	609.49	3651.77
	% Chemistry	6.2%	7.1%	5.8%	6.8%	11.2%	14.0%	14.1%	9.8%
Spain	Chemistry	52.98	60.27	54.42	63.58	114.87	131.08	124.43	601.63
	Total	799.08	861.55	938.09	936.45	1210.65	1333.29	1322.97	7402.08
	% Chemistry	6.6%	7.0%	5.8%	6.8%	9.5%	9.8%	9.4%	8.1%
UE-27	Chemistry	3543.70	3236.31	3437.36	3387.70	3790.35	3772.75	3564.76	24,732.93
	Total	51,370.26	50,826.47	50,462.32	51,624.66	54,571.60	55,288.93	56,200.01	370,344.25
	% Chemistry	6.9%	6.4%	6.8%	6.6%	6.9%	6.8%	6.3%	6.7%

Source: Eurostat.

Note 1: Classes of the International Patent Classification (IPC): C01 (Inorganic Chemistry); C02 (Water treatment); C07 (Organic Chemistry); C08 (Organic Macromolecular Compounds).

Note 2: The regional data are published with 4–5 years of delay.

Note 3: The geographical distribution of applications is assigned according to country and region of residence of the inventor. To avoid duplicate counts, if an application has more than one inventor, this is divided equally between them and their countries of residence.

with the state initiative of predoctoral research is affiliated with programs in chemistry. The university sector in these regions also has been very active in obtaining competitive resources from state and European agencies for research in chemistry, receiving 26.9% of the projects financed by the Chemical Science and Technology Program of the Spanish Government.

The size and importance of the Catalan chemical and pharmaceutical industry (practically 50% of the Spanish one) underlines this country's relevance at the level of the studied area as well as at the state level. For example, it accounts for 19.3% of the territory's private personnel engaged in R&D. The pharmaceutical industry in Catalonia invests comparatively more in R&D than does the chemical industry.

Scientific production in the studied territories in the form of publications in specialized chemistry journals is significant and of high quality. Indeed, for Catalan chemistry research, the number of citations per article is higher than the European average. Few data are available in the Catalan Countries on a relatively low regarding chemistry patents as a function of the production of original research articles (even though they account for 47% of the Spanish total in this specialty). This may indicate that public research carried out in these territories has a poor rate of transfer to industry.

Despite the quality of research undertaken in the various fields of chemistry and the recent efforts of the public administrations, the flow of chemical knowledge towards industry in Catalonia, where the chemical industry is a traditional economic sector, is not sufficient. This finding indicates that, Catalan researchers in Chemistry provide a huge amount of knowledge to international channels without yielding a direct return to their country.

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## About the authors

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**Salvador Alegret** was appointed Professor of Analytical Chemistry at the Autonomous University of Barcelona (UAB), in 1991. In 1983, he founded the Group of Sensors and Biosensors (GSB) in the Department of Chemistry (UAB). The GSB is a pioneer in the field of chemical sensors and biosensors, both in Catalonia and in Spain. He has published more than 300 research papers

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