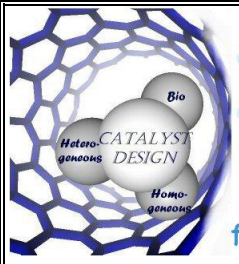

IDECAT

Integrated Design of Catalytic Nanomaterials for a Sustainable Production

SIXTH FRAMEWORK PROGRAMME

CONTRACT N° : NMP3-CT-2005-011730 **ACRONYM :** IDECAT
TITLE : Integrated Design of Catalytic Nanomaterials for a Sustainable Production
Instrument : NoE ; **Thematic Priority** : NMP

Final

PUBLISHABLE SUMMARY REPORT

Final and 5th Period (Months 49th – 66th)

REPORTING PERIOD : from 1st April 2009 to 30th September 2010
Start Date of the project: 1st April 2005
Duration: 5 years (+ 6th months extension)

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Date of issue of this report : 15th November 2010
Revision: Final

Research funded by THE COMMISSION OF THE EUROPEAN COMMUNITIES
Contract No: NMP3-CT-2005-011730

1. Executive Summary

IDECAT (Integrated Design of Catalytic Nanomaterials for a Sustainable Production) is a Network of Excellence (NoE) dedicated to catalysis and designed to strengthen scientific and technological excellence on this specific research topic through the durable integration of the research capacities of the participants. They aim was to overcome the fragmentation of European research in this area by:

- gathering the critical mass of resources
- gathering the expertise needed to provide European leadership

IDECAT objective was also to spread excellence beyond the boundaries of its partnership.

IDECAT main objective was to realize the conditions for perpetuation and development of the cooperation in the form of a self-sustaining *Durable Integration Structure* (DIS). The intended long-term impact was to create an efficient organization operating at the European level, which can reduce duplication of research effort and, by facilitating joint planning and resource sharing, overcoming inadequacies faced by individual institutes in terms of human resources, expertise, equipment and infrastructure. The DIS should also help to break down traditional barriers between the scientific disciplines.

To accomplish this ambitious research goal, IDECAT plan was based on the scientific excellence of its individual participants and on the creation of an effective path to incentive a durable integration at the researcher level as first step to realize then the integration at the institutional level.

The IDECAT organization and structure was thus finalized to the creation of a DIS (ERIC - *European Research Institute on Catalysis*) and to the conditions to enable the integration of network researchers, by developing a set of integrated activities organized in five major areas:

- a Joint Programme of Integration (JPI)
- a Joint Programme of Research (JPR)
- a Joint Programme of Spreading of Excellence (JPS)
- a Joint Programme for science and technology transfer (JPT)
- a Joint programme for management and administration transfer (JPMA).

The specific IDECAT objective is to integrate excellent European research groups in the area of the development of high-performance and conceptually innovative catalytic nanomaterials for industry and for Europe sustainable future. In fact, overcoming fragmentation in this area due to separate scientific communities (heterogeneous, homogeneous, and bio-catalysis) and coherently integrate their effort is a critical objective of ERA, because catalysis science and technology is one of the driving elements for Europe competitiveness and sustainability.

IDECAT integrates into a more general strategy of restructuring/ reshaping the catalysis research in Europe and focuses its research actions on the following areas:

(i) the synthesis and mastering of nano-objects, the materials of the future for catalysis, integrating the concepts which are also common to other nanotechnologies,
(ii) the integrated design of catalytic nanomaterials to achieve their non-evolutionary and knowledge-based development.

IDECAT gathers the main European research Institutions (37 laboratories from 17 Institutions) in the broad field of catalysis (from homogeneous to heterogeneous and bio-catalysis) to create the critical mass and the multi-disciplinary competences necessary to

design the next-generation catalysts and catalytic processes/technologies to promote sustainability.

The broad range of expertise ranges from the synthesis and mastering of nano-objects, the bridging between homo– hetero– and bio-catalysis and theory and modeling, surface science, and kinetic/applied catalysis as well, to the Integrated design of catalytic nanomaterials.

In terms of expected Deliverables and Milestones, they were all fulfilled and no particular deviation has to be remarked.

The major activities over the full duration of the NoE were the following:

- ***Jointly Programme of Integration - JPI (WPs 1-4)***

WP1 - Establishment of juridical structure

The catalysis thematic area in Europe represents a community of about 10.000 active researchers in the various sections of this multi- and trans-disciplinary scientific area. However, the European research is fragmented and has not reached the impact in the world marked appropriated to its potential, both in terms of scientific advancements and their exploration (*Futures Programme Competitiveness Map*, 1999).

The Networks of Excellence have been created to overcome this fragmentation and their Milestone number 1 is the creation of a new way of cooperation: an organization which embodies a new way of collaboration, stable, innovative and self-sustainable – a so-called Durable Integrating Structure (DIS).

ERIC is the result of these efforts and, after a long and difficult gestation, has been created as an A.I.S.B.L. – a Non Profit International Association – under the law of Belgium, to offer a single reference point of expertise and know-how to Industry; ERIC promotes catalysis and serves as interface and platform to communicate industrial and societal needs in the field.

The experience in the NoE has built up a highly specialized but all-round expertise and thus, ERIC's know-how represents the State-of-the-Art and its excellence cannot be easily replicated.

This single entry point, can be reached by all kind of industries in Europe and represents an invaluable asset especially for SMEs, whose limited turnover does not allow heavy investments in R&D, the chance to have all the best Institutions and core competencies, usually spread around Europe, within reach is precious.

It is quite common for industries and SMEs to ask services to the laboratories of the local University but it is very rare that a complete range of techniques, from project to prototype for example, can be performed by a single University or Institution.

With ERIC, the quality and wideness of the expertise available among its Members make this task within the grasp of most Small Medium Enterprises just contacting only one organization.

Furthermore, most of the SMEs cannot really protect their IP and this intellectual asset is often put at stake. ERIC is active as well in scouting, IP implementation and protection.

As an additional activity, ERIC also promotes the public understanding of Catalysis and an awareness of its implications especially in the areas of Environment, Energy, healthcare and biomedicine. In this respect, ERIC is very active in organising conferences, workshops and schools on one side, and, on the other, in its relationship with local governments to give its expertise in their energy and innovation policy.

ERIC has created a “Companies Guild” that aims to build a close cooperation among the DIS and Industries, As yet ERIC has been contacted by the most prominent chemical industries to be part of this “club” such as: TOTAL, LINDE, BASF and SASOL.

The progress of ERIC is following a strategic plan that has been outlined by the General Assembly and the Board of Directors through the following main actions:

- Development and sharing of a common vision of ERIC research and training opportunities
- Definition of a Roadmap to achieve the ERIC common vision
- Annual definition of the common research projects
- Organisation of a permanent virtual lab and ruling the common use of research infrastructures
- Definition and operation of integrated education and training programmes

For its Members and linked Institutions, ERIC represents the mean to reach a large number of scientific/industrial users and potential partners/clients.

Gender Issues

Promotion of gender equality in science was an important aspect of IDECAT. A Gender Action Plan was written at the beginning of the project and was updated annually. Specific activities were organized to increase leadership skills of female researchers and to give information about gender equality. A survey study conducted on the effect of gender on the careers of IDECAT researchers gave valuable information about the equality situation among academic catalysis researchers in Europe.

WP2 - e-IDECAT

The objective of the WP2 was to establish an electronic platform for the network to facilitate gathering and sharing information among partners on the one hand and to allow better management of the Joint Programme of Activities on the other hand. It has also served as an electronic interface to outside the network. Next to that, some activities concerning e-learning have been foreseen.

The worpackage has been initially organized in five tasks, which have been active in particular reporting periods and have been continuously updated when necessary.

Task 2.1 *Web-site* – has been created and improved within the duration of the project. The web-site is organized into a public accessible area which is a front-end for external communications and a private area requiring authorised login which is an essential component to facilitate intra-network exchange of information. The web-site is available at http://idecat.unime.it/ and is hosted by INSTM. After successful incorporation of the durable integration structure ERIC, the **eric-aisbl.org** domain has been registered and the ERIC web-site has been under construction.

Task 2.2 *Strengthen intra-net communication* – to improve data exchange and reporting, use of common software packages, templates and procedures has been recommended, however it was realised that full implementation of this system was only possible once the private area of the web-site would be operational. Upon opening the private area of the website, a number of actions have been undertaken to improve intra-net communication:

(1) a set of manuals containing guidelines on standardised practical aspects of data exchange and reporting have been prepared and published,

(2) a common format of IDECAT documents has been introduced and made available for the partners,
(3) a database of IDECAT equipment and best practices has been published and updated regularly,
(4) a database of available PhD and post-doc positions to facilitate and increase mobility within IDECAT has been created and updated regularly;
(5) FP7 Roadmaps on how and when to apply for funding were prepared and updated;
(6) information on conferences, workshops, summer schools etc. has been made available on the web-site.

In order to create an e-working group (subtask 4) an evaluation has been made of the possibility to use software produced by Microsoft such as Groove and SharePoint Portal Server that allow working simultaneously on the files on the desktop of the team members. However, the cost is considered too high as compared to the advantages offered by the use of these systems. Similar considerations were made about systems for on-line conferences (subtask 3). The most cost effective solution was found to be the use of the Skype software.

Task 2.3 *Public information on IDECAT progress* - in order to promote the visibility of catalysis to society, the public area of the IDECAT website, containing non-confidential information on the NoE, was created and extended and its contents has been integrated within the duration of the project. Events organized in the framework of IDECAT were advertised in the public area of the IDECAT website through graphics with high visual impact, addition of flyers, programmes and circulars to download, web links and e-mail contacts.
Moreover, the edition of an e-Newsletter has been started and is being continued. The e-Newsletter contains general information on the network and highlights the most interesting events and achievements of the Network.

Task 2.4 *e-Learning* - in order to develop a joint master and PhD curricula as well as a Virtual School on catalysis, the development of a system for e-learning was found necessary. To develop experience in e-learning, the construction of an e-learning platform has been started on a small scale. The first e-learning initiative was the electronic course on homogenous catalysis based on the book “Homogenous Catalysis: Understanding the Art” by Piet van Leeuwen. The e-learning platform has been initiated and further developed and optimized. The action has involved several IDECAT partners: CNRS Lyon, USTAN, NRSC Amsterdam and NRSC Eindhoven. In the course of the project some further initiatives have been implemented, i.e.(1) a web-based course "Characterization of solid catalytic materials" prepared by Aalto University School of Science and Technology (former HUT) and held during the spring term of 2010; (2) a number of web-site presentations and e-learning courses have been organized by FHI (Berlin).

Task 2.5 *Open-archive*. In order to promote public and free access to IDECAT publications, the creation of an open archive of non-confidential publications and documents, respecting the copyrights was foreseen. In the course of the project, however, interim evaluation indicated difficulties in implantation of this target due to resistance of publishers in the creation of the open archive and the Task was suspended.

WP3 - Pooling of equipment and best practices

WP3 was focused to analysis and development of the structure and synthesis procedures of the structured catalysts on a nano- and subnano-scale targeted for highly selective eco-efficient chemical processes and processes for energy production. This requires application of a combination of high number of techniques analyzing the catalyst structure, its development during their preparation and catalytic processes, of adsorbed reaction

intermediates and functioning of the active site entities, and highly experienced staff, not available in each laboratory.

During IDECAT the individual laboratories developed best practices in several selected techniques closely related to their research field as well as in catalyst preparation. Now they are equipped with the corresponding equipments/expertise and synthesis/processing of the catalysts. The techniques put together at IDECAT range from those used in material synthesis itself, in spectral and diffraction analysis of catalysts up to analysis of the interactions between the catalysts and reactants. Such complex insight is supplemented by theoretical (molecular and statistical) approaches and general understanding of the catalyst structure, its function and of the catalytic processes themselves. This is a base for development of the highly sophisticated and efficient catalyst structures.

The possibility given at IDECAT of purchase of common large equipment infrastructures was *not* identified as a priority. Materials and catalysis is a highly complex and interdisciplinary area requiring not only one type of equipment, but a number of equipments giving analysis of the structure of materials from different viewpoints.

To manage exploring of the equipment and expertise for collaboration of IDECAT Partners the ***List on Best Practice, Technique and Expertise in IDECAT*** was collected and continuously upgraded. It is available with all details at the webpage of IDECAT (www.idecat.org). This List is operated by the ***Data-base on Best Practice, Technique and Expertise in IDECAT*** *(*www.idecat.com) and provides easy and quick listing of the methodology, techniques and Partner laboratories. The Data-base is available for IDECAT Partners and will be available for the ERIC/ERIC+, and will also serve to industrial associates of ERIC/ERIC+ and other potential applicants. The List is organized as:

(i) summary and critical evaluation of the individual groups of common approaches, techniques and knowledge

(ii) detail description of the individual techniques and expertise offered at IDECAT Partners, including references and contact addresses for: high level standard spectroscopic and diffraction techniques, imaging techniques, EXAFS, XANES, synchrotron powered techniques, catalyst preparation, reaction, sorption techniques, in-situ (operando) FTIR, UV-Vis, Raman spectroscopy, quantum chemical, Monte Carlo, reaction kinetic model calculations.

The ***IDECAT Best Practice on Catalyst Preparation*** is given on the webpage (www.idecat.org). This provides an outline for the best approaches for the preparation of the various structured-typed catalysts.

Harmonization of the individual techniques for structure analysis of selected types of catalysts, identification of the active sites and their functioning in catalytic reactions was achieved. Such harmonization in each case of the catalyst should be done with specific respect to the types of the structured catalysts and their application in chemical processes.

The present ***Common research platform*** has been built for the IDECAT Partners and industrial cooperating companies. The Network developed approaches of simultaneous application and harmonization of a number of relevant spectral, diffraction and imaging techniques for studies of catalysts structured on a nano- up to a subnano-scale and on a molecular level, and made broader the contacts between experimentalists and those carrying out modelling and high-level (ab initio) quantum chemical, statistical and reaction kinetic analysis studies. These achievements using simultaneously high-tech equipments and knowledge, up to conditions of the catalyst operating at the reaction, and modelling of the structure on a molecular level represent a decisive step ahead in understanding of the synthesis of catalysts as well as the corresponding catalytic processes. The present high

general demands of the industry and society on the activity and selectivity of the catalytic processes can only be achieved by such level of structural and reactivity studies.

The equipment, expertise and the knowledge at individual laboratories is used for mutual collaboration among Partner groups. It will be further employed within ***ERIC/ERIC+ and associated industrial Partners.*** This is an imperative for carrying out successful research in material synthesis and its processing in highly selective and efficient catalytic processes within ERIC.

Beside to develop technique and expertise to carry out research on structural chemistry and catalysis, the specific purpose of WP3 ***is training post-docs, PhD and researchers*** from the Partners as well as from the industry and other academic institutions, and providing consultations and services to governmental as well private institutions.

WP4 - Continuing Education and Mobility

The major activities over the full duration of the NoE were devoted to encourage exchange of personnel within IDECAT and improve effectiveness of the research by transferring the knowledge across partners through mobility. Reorganization of the research activities, by relocation of part of the staffs when necessary was also part of these activities.

The activities can be schematically divided in two main tasks:

(1) Continuing education of the network personnel, through workshops, courses and training activities,

(2) Staff mobility and exchanges of PhD students and Post-doc involved nearly all the partners and all the research work-lines (WP5-WP8) along the overall project.

Mobility was strongly connected with continuing education and training in any field of interest for catalysis, ranging from theory (molecular modeling) to practice (industrial reactors) in order to educate young researchers and PhD students with multi-disciplinary culture on molecular, bio and solid catalysts.

The presence of the network allowed a broader knowledge among all members on the availability of experiment set up and or specific skills, in order to accelerate the growth of knowledge in specific fields. The training of PhDs and staff includes short and longer term mobility, access to network resources and expertise, workshops/schools and e-learning support and is composed of a sub-set of activities focused on (i) providing specific skills and knowledge for research, communication and presentation of results, (ii) emphasizing multi- and cross-disciplinary approaches of catalysis and (iii) strengthening integration by personal relationships and access to specific expertise, equipment.

It is very relevant to underline that joint PhD activities started and the recognition of a specific title for PhD students “growth within IDECAT” was defined.

“IDECAT PhD”:
- PhD student should stay at least 10 weeks at another node
- at least one member of IDECAT NoE should be in PhD thesis commission
- PhD student should participate to IDECAT activity (school, workshop, congress…)

- ***Jointly programme of research activities – JPR (WPs 5-8)***

To guarantee constant scientific discussion not only among the partners involved in the same collaboration, but also among groups involved in collaborations belonging to same task, several dedicated scientific meetings within each WP or Task were organized. This provided high flexibility and dynamicity, with continuous reorganization and definition of new tasks and

strategies. The success of the integration realized within WPs is evidenced not only by the level of participation in the above mentioned meetings by also by the following indicators:

- number of short and medium-long stages of researchers/PhD students involved in WPs collaborations in other IDECAT laboratories,
- number of samples and best practices exchanged among IDECAT partners involved in WPs collaborations,
- number of scientific publications and communications emerging from WPs activities.

WP5 - Creating and mastering nano-objects and nano-organisation

25 jointly executed research projects (see Table 1) were established in WP5 in the macro areas corresponding to the three tasks indicated below:

Task 5.1 - Nanoporous materials as tailored reaction space.

Task 5.2 - Nanofibrous materials as catalysts and supports.

Task 5.3 - Chemically nanostructured and functionalized materials.

To enhance the level of interaction among partners and across tasks meetings and thematic workshops were periodically organized. The level of participation was beyond expectation and a very stimulating discussion and exchange of ideas/expertise was developed. Those activities gave to the research carried out in WP5 a very flexible and dynamic asset, as inferred by the mobility of researches and students among IDECAT laboratories and by the exchange of materials, best practices and ideas.

The output was the publication of several papers in top journals and the presentation of the research results obtained in WP5 in national and international conferences. Networking in WP5 has created a very strong integration among centers of excellence, which will certainly last after IDECAT.

WP6 Creating and designing new multifunctional molecular, enzymatic and supported catalysts

Lasting collaborations have been developed involving all of the participants in bilateral and multilateral research projects, which would not have been developed without IDECAT funding.

All participating laboratories have been involved in receiving and sending researchers from / to other participating laboratories

- 63 Joint publications have appeared;
- 256 Other publications have been produced as a result of IDECAT sponsored projects;
- 5 Patents have been filed;
- 23 Meetings or Conferences have been organized.

NANOHOST an EC ITN, which was conceived and worked up through WP6 and mainly contains participants from IDECAT has been funded by the EC.

WP7 - Bridging the gap in multi-disciplinary approaches

In the past five years, WP7 has launched several core activities:

Task 7.1 *Multidisciplinary approach to catalysis research.*

This has involved all partners of IDECAT, and it was divided in 4 sub-research projects:

- Subtask 7.1.1: Understanding heterogeneous polymerization and metathesis catalysts.
- Subtask 7.1.2: Understanding heterogeneous oxidation catalysts.
- Subtask 7.1.3: Understanding catalysts for hydrocarbon conversion and formation.
- Subtask 7.1.4:Understanding surfaces of catalysts.

Task 7.2 *Setting-up think tanks in bio-catalysis and nano-designed catalysis*.

- Biocatalysis report 2008-2009
- A number of mutual short visits have been organized;
- At least 3 longer visits (equal or more than 3 months)
- A master course "Biocatalysis" has been organized in Delft (NRSC Delft) (January 2009).
- The IDECAT conference series (high-level Gordon-type conference) was created and occurred every year since 2007.

WP8 - Eco-processes and sustainable energy and production.

The activity of the Contractor Research Units spanned over a wide range of subjects, in the field of the sustainable and sound exploitation of natural raw materials and energy resources. The main achievements can be summarized in four main sections, as indicated below, and each of which composed many specific research projects involving several partners.

Task 8.1 - *Application of catalytic technologies for environment protection and remediation*

CNR, ICSC, INSTM, TUM, and GE were involved in particular in this Task with various activities ranging from catalysts for automotive applications to photocatalysis and to HDN conversion. 6 joint publications and 12 presentations to congresses have been made in the reporting period.

Task 8.2 - *Chemical process intensification and improvement of safety and eco-compatibility*

CNR, TUM, EPFL were involved in particular on activities related to the development of new catalysts for selective oxidation. The IDECAT Winter School: “Advanced course on Catalysis: from molecule to reactor design” was realized in the frame of the activties. 8 joint publications, 2 patents and 15 presentations to congresses have been made in the reporting period. One researcher of CNR sped a period of three months to another node of the network (CSIC).

Task 8.3 - *Clean fuels and sustainable energy use and production*

CNR, INSTM, CNRS, TUM and EPFL were involved in particular on a broad range of activities ranging from the preparation of novel catalysts to direct alcohol fuel cells (DAFC) or electrolyzers, membrane for H2 separation, and catalytic processes for biomass conversion. 39 joint publications, 2 patents and 28 presentations to congresses have been made in the reporting period. Two PhD students spend 6 months each in another node of the lab.

Task 8.4 - *Bio- and bio/chemical catalytic processes*

KUL and CNR were involved especially on the conversion of polyol biomass to chemicals, conversion of trioses to alkyl lactate and lactic acid, and H_2 production using bacteria. 4 joint publications, 1 patents and 12 presentations to congresses have been made in the reporting period.

- ***Jointly programme of spreading of excellence – JPS (WPs 9-11)***

WP9 - Dissemination of Knowledge

The main objective of Workpackage 9 has been to promote the dissemination of science results and, in general, knowledge of the science of Catalysis to i) companies and SME's and ii) to the scientific community. A number of tools for achieving this goal were conceived in the early stage of the project: Direct communication with companies at different levels, organization of specific events by the partners, publication of science papers describing the results of the Joint Programme of Research, and general reference works in Catalysis (reviews, edited books, book chapters, etc). These activities have contributed to largely increase the visibility of the Network to the companies and to the Catalysis community in general. The setup of the periodic IDECAT Conference on Catalysis, as an activity inspired in the celebrated Gordon Conferences can be cited as a paramount example of the dissemination effort of this Network.

One of the main features of IDECAT has been the intense interaction with the private sector. This has had a deep effect on the activities gathered under WP9 and made necessary a close interaction between WP9 and WP12. The intensity of these interactions has grown along the IDECAT funding period, ending up in the successful setup of several large research projects by IDECAT and industrial partners. The setup of a series of events specifically designed to promote the interaction between companies and academic research groups stands among the most remarkable results of WP9 on this regard. The "Industry-Academia Partnerships on Catalysis" workshops, held in Seville, Zaragoza and Berlin have served as a workbench to experiment with different approaches to improve the interaction between public and private sector researchers. Thus, in Seville the focus was on illustrating cases of such partnerships with short talks delivered from each side of the collaboration, while in Zaragoza, an attempt was made to promote the interaction by means of a Brokerage event, and in Berlin high level presentations of top research from industry and academia was presented with a symposium format including poster sessions.

Another important task of WP9 has been the continuous monitoring of the dissemination activity of IDECAT. This has been a difficult goal due to the size of the consortium and the wide variety of scientific activities developed within. However improvement of the monitoring performance has run parallel to the growing integration of the different teams. Efficient mechanisms have been developed to collect information, e. g., via the IDECAT webpage, or by means of specially designed WP9 forms distributed to the partners. The results of this monitoring effort have been collected in the successive WP9 reports, as well as in the IDECAT Newsletter, elaborated as a part of the WP9 activity and periodically published in the webpage and distributed by e-mail. The Newsletter collects both factual information on the progress of the network and scientific news related to the joint research activity or relevant in general for the Catalysis community. As a final statement on the performance of this monitoring, the following figures can be cited. Along its 5-years funding period, the IDECAT consortium has produced over 120 joint research papers, a similar number of high-level reviews and reference works, and more than 100 open dissemination events open to the industrial and scientific communities. It has been estimated that grossly 6000 people have been involved in the organization, delivering and attending this large dissemination activity.

WP10 - Teaching IDECAT

Education of PhD students and dissemination of knowledge are the main concern of WP 10. As in the previous periods, different courses, workshops, summer schools and conferences were organized by the IDECAT partners.

Over 100 courses and lectures were delivered to PhD students by the IDECAT members during the project. In addition, more than 50 book chapter and tutorial reviews, and various books useful for the education of PhD and Master student were published.

Of specific relevance was the design and preparation of IDECAT textbook on Catalysis, that is in publication by Wiley-VCH,that will serve as a basis for PhD education on catalysis in Europe and for the creation of dedicated curricula on catalysis. The book, edited by Beller, Renken and van Santen, is centred on the idea of a new integrated approach to catalysis, which integrated basic and applied science (from molecular modeling to reactor design) and which offers also an integrated approach to hetero-, homo- and bio-catalysis.

In the framework of the second topic, over 50 workshops and summer schools were organized for academic and industrial participants. Examples are the IDECAT Advanced course on catalysis: “From Molecular to Reactor Design” which attracted more than 80 PhD students (17 members contributed to course), the 2nd editions of the IDECAT Summer school on Computational Catalysis, the Summer school “Catalytic Reaction Engineering and process intensification”, the Summer School Nano designed-catalysts: from molecules to industrial processes, the IDECAT training workshop: MicroBio-Reactors in R&D for Fine Chemicals and Pharmaceutical Production, the IDECAT Winter School: Advanced Course on Catalysis: From Molecular to Reactor Design. In the specific reporting period, 7 summer schools and educational specific activities and various other workshops with the participation of various PhD students were organized. Various educational video activities were also made.

To be mentioned also the activities within the Initial Training Network NANOHOST, which is leaded and involves IDECAT members, and which training activities are well integrated and coordinated with those of IDECAT. In addition, IDECAT participated to the organization of the last Summer School organized by the European Federation of Catalysis Societies (EFCATS). Various other training and educational activities were made in collaboration with other scientific societies or organizations.

The dissemination of knowledge was accomplished by several high level publications and book chapters demonstrating the multidisciplinary approach to catalysis.

WP11 - Promotion of Science

The most important activities have been the strong involvement of IDECAT members in ongoing and continuing events for the promotion of science. Our report (“The Promotion of Catalysis through Europe”) on the effect of these activities shows a positive correlation between participation by school students in active events and the number of students entering a degree programme in chemistry. This is a very important finding. There are large scale galas and festivals of science, which individually may reach 2000-3000 people, and taken over the Network may reach 20000 per year or approaching 100,000 over the period of the contract. Over time, this will make a marked contribution to the enthusiasm for young scientists for a career in catalysis for a sustainable society. Questionnaires at individual festivals show a very positive response to the events from the general public in terms of improved understanding and enjoyment. This in turn improves the socio-political environment for policy changes that are seen necessary

A key innovation has been the establishing of set piece events in which very prominent scientists from academia and industry have face-to-face discussions with high school students and members of the public. This has been carried out by several institutions, including Krakow, Rennes and Southampton, but the archetype has been created by the series entitled "Tomorrow… towards a selected chemistry", which has now run 4 times. This was an exciting and successful format, which used the services of a professional and well-known media presenter to facilitate the discussion. Interactive video links were established internationally. This is a very challenging process which required detailed planning in order to achieve good quality 2-way audio and video communications between several sites (from Lyon to Toulouse (CLRS), Southampton (US), Ghent (GE) and Eindhoven (NRSC) with real-time French-English translations. At each of the remote there were local groups of school and college students. As well as increasing the numbers and range of nationalities involved, those at the remote sites also had the opportunity to question the panel interactively. Use of electronic voting pads allowed all to see the distribution of views on the topics of key interest. These were memorable events for all concerned and the permanent legacy is encapsulated in video recordings.

The Network has given an additional impetus to the creation of new material to promote the understanding of catalysis and its crucial role in the sustainability of our society. Good quality slideshow and video material has been created at several sites including HUT, INSTM, GE and US. INSTM's contribution of a multilingual animated movie on nanotechnology is to be freely available (http://cordis.europa.eu/nanotechnology), Ghent's a movie entitled "Chemistry for Today and Tomorrow", and an animated film explaining catalysis (US) will be made freely available in autumn 2010. Other lecture- demonstration materials have gathered and made freely available, for example video of sustainable chemistry and "how to do it" guides for school teachers (on http://www.soton.ac.uk/chemistry/IDECAT/index.html and http://www.southampton.ac.uk/chemistry/schoolsoutreach/schoolsoutreach.shtml.). These materials have significantly added to the resources available to the community for promoting catalysis and nanoscience to the wider public.

It is evident that these materials are being taken up and used to promote the teaching of the principles and operation of catalysis across Europe. Making available the resources developed across the Network should be an ongoing activity. The principles and the effectiveness of the approach have been established through the activities within IDECAT.

- ***Joint programme for science and technology transfer – JPT (WP12)***

WP12 - Technology Transfer to industry

The objective of WP12 is to transfer knowledge generated by IDECAT to the industry in order to contribute to the innovative capacity of the European chemical industry and to generate and valorize knowledge as a strategic means for a competitive Europe. The success of IDECAT in this respect is clear from the involvement of 33 companies in the IDECAT industrial board. These partners have substantially contributed to the formulation of academia-industry research proposals. Also a large number of SME have been involved in IDECAT activities.

The Industrial Liaison Office has been a key instrument in the knowledge transfer between the academic and the industrial partners. Important tools to facilitate the knowledge transfer are the Industrial Board meetings, workshops between academia and industry, booklets describing the research expertises and instrumentation of the IDECAT nodes and the SMEs involved in IDECAT and the IDECAT recruitment service.

Key success indicators of this WP are the large number of chemical industries and SMEs involved in IDECAT (the number has steadily grown during the IDECAT period), the many contacts between industry and academia (a.o. via annual academia-industry workshops), new patents filed by individual IDECAT partners in bilateral research contracts and the large number (>100) of PhD students and postdocs trained within IDECAT that have found positions in industry.

The work in WP12 has been divided in 4 tasks.

Task 12.1 – *Managing Intellectual Property Rights (IPR)*

An important activity within this task has been the creation of a patent databank. Patent brokerage events have been organized to bring these patents to the attention of the IDECAT industrial board members.

Booklets were created and constantly updated with the research expertise of the IDECAT nodes. A booklet giving an overview of the many SMEs involved is also available for industrial members.

These databases and booklets make IDECAT transparent to companies in their search for knowledge.

Task 12.2 - *Efficient transfer of knowledge to companies and SMEs*

The IDECAT Industrial Board meetings have become a forum between academia and industry, generating many ideas for cooperative proposals. A number of large cooperative proposals has been prepared and submitted to the FP7 NMP programme. Among the many successful ones including ITNs, the Large Collaborative Projects NEXT-GTL and INCAS have resulted in intense collaboration between academia and industry. In these projects, management is taken up by ERIC.

Together with WPs 4 and 9, the IDECAT Recruitment Service has been professionalized. This facilitates the access of PhDs and post-docs to academic and industrial positions. Besides dissemination of open positions, a booklet of CV's of PhDs and post-docs is available to industry.

Task 12.3 – *IP's, STREPs and research contracts*

During industrial board meetings ideas have been generated for the formulation of academia-industry proposals. Two Large Collaborative Projects, namely INCAS and NEXT-GTL, have been approved in the FP7 NMP programme involving several industrial members, SMEs and academic nodes within IDECAT.

Task 12.4 – *Monitoring performance in technology transfer*

The performance was monitored continuously by the Industrial Liaison Office. Booklets for knowledge transfer between academia and SMEs to industry have been regularly updated. The IDECAT nodes have organized many courses open to PhD students and post-docs. Very often, industrial experts were involved in these courses, providing a broader perspective to the participants. IDECAT industrial partners consult academic partners on a regular basis; these contacts are in general of confidential nature.

- ***Joint programme for management and administration transfer - JPMA***

WP13 - Strategic Management (13.1) and Administrative Structure (13.2).

The activity in this WP was to perform all activities of and in support to the strategic management of the network, e.g. the activities of and in support to the Decision-making Bodies and Advisory Boards. The management support action (secretariat, organization of the meetings and project reviews, prepare documents and draft of the plans, communications, implement and record decisions, etc.) has been realized.

During the five years year, the efficient platform for the management of the IDECAT virtual laboratory has been established. The start of management for IDECAT DIS (ERIC) has to be also mentioned.