Proposal

Submitted for funding under IRIPA scheme

Phase II

NATIONAL CENTRE FOR CATALYSIS RESEARCH

Indian Institute of Technology - Madras

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Summary

The National Centre for Catalysis Research was established by the Department of Science and Technology in July 2006 at the Indian Institute of Technology-Madras, Chennai, with the following mandate:

- Developing qualified manpower in Catalysis through M.Tech., Ph.D. programmes
- Organizing special courses / workshops for persons from academia and the industry
- Pursuing research in frontier areas in Catalysis that will have a global impact
- Interacting with Indian and global industries to develop / improve catalytic technologies
- Collaborating with academic Institutions in India and abroad
- Involving in activities to improve Catalysis research in India

Ever since the Centre was formed, it has been actively involved in the above activities that have resulted in:

- Training of more than 300 persons at different levels in various aspects of Catalysis,
- Establishing facilities for carrying out advanced research in the area of Catalysis.
- More than 100 publications in journals, 9 patents, 18 books (14 of them printed versions) and more than 150 presentations
- Collaborations with many Indian and foreign universities
- Many collaborative research projects with industries

A detailed report on these activities and achievements is attached. A brief account of the proposed activities of NCCR for the next five years is outlined below:

1. **Focus on Man power development**

- In the last 5 years, manpower development in Catalysis has been substantial at various levels

Sr.No	Level	No
1	M.Tech	10
2	Ph. D-completed	16
3	Ph. D- in progress	14
4	PDF on rolls & trained	2+3
5	Research Associates	50
6	Orientation Course- in 5 years	200
7	Summer courses- every year	20
8	Capsule Course for Industry Summer Courses	10

- Man power development would continue to be one of the main tasks for NCCR

2. Introduce new fellowships

- To facilitate man power development it is proposed to introduce new Fellowships,
  - M.Tech-6 & Ph. D- 6

3. Initiation of research in new areas

- Reduction of carbon dioxide with water to yield fuels & chemicals
- Alternate routes for hydrogen generation
- New materials for hydrogen storage
- Design & fabrication of alternate electrodes for fuel cell
- Synthesis of new materials
- Bio-mass conversion- starting with platform chemicals

4. Strengthening NCCR Faculty

- Currently, NCCR has 4 Senior Faculty, 6 Adjunct faculty from IITM & 3 Adjunct faculty from Anna University.
- It is proposed to add three new Faculty members, who can initiate research in areas like lithium ion battery, clean fuels and bio-mass conversions

5. Expanding International collaborations

- International collaboration will be extended to other countries, especially with the Catalysis Centres, at North America, Africa and other Asian countries.
- Collaborations will be established with at least another 5-8 new Centres in Catalysis in the world in the next five years.

6. Collaborations with academic institutions

- MOU to be executed with 5 new Universities

7. Catalysis Data Centre

- The data base maintained by NCCR has become highly useful and sought after over the years by the scientists who teach research and practice catalysis, both in India & abroad.
- In order to make this data base more versatile, it is proposed to include in the data base the list of published papers, patents, and process technologies developed

In order to firmly establish NCCR as a house of knowledge and research in Catalysis at global level, its activities are to be continued and strengthened. It is now requested that the DST extend its financial support to the Centre for another five years. The proposed plan of activities and the budget required for the next five years are attached. Total budget estimate, as detailed in the proposal, works out to Rs.1252 Lakhs.

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1. National Centre for Catalysis Research

The National Centre for Catalysis Research (NCCR) was established by the Department of Science and Technology, Government of India in July 2006 with the following vision and mandate.

A. The Vision

To emerge as the premier National Centre for Catalysis focusing on:

- building human resource and knowledge capital
- establishing advanced R&D facilities
- initiating research programs in frontier areas
- cultivating vibrant partnership among the trinity of academy-research-industry.

B. The Mandate

- actively build human capacities and expertise manpower in the area of Catalysis through structured educational programs at various levels
- undertake advanced research in frontier areas of basic sciences relating to Catalysis: New materials, Energy conversion processes, Surface science & Theoretical science
- solicit support from industries for applied research in cutting-edge technology areas
- emerge as a knowledge center & store house of relevant information to user industries towards reliable problem solving, testing & training
- initiate collaborative research programs with universities, national and international institutes & laboratories

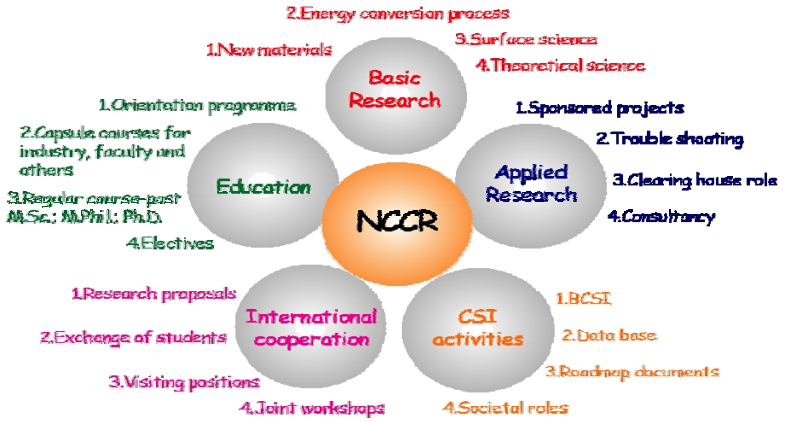

Fig.1. Pictorial representation of the principal activities of NCCR.

Since its inception, the Centre has been concentrating on successfully fulfilling these mandates. The major activities/contributions of the Centre in the last 5 years are summarized in the following pages.

2. Details of Activities: 2006 - 2011

A. INFRASTRUCTURE

In order to support educational and research activities of the Centre, laboratories (6000 sq. ft) equipped with requisite infrastructure and apparatus, seminar hall, office room & library and other facilities have been established. State of the art equipments required for preparation, comprehensive characterization and performance evaluation of catalysts have been set up at a cost of Rs 18 crores. List of the facilities available at NCCR is given in Annexure 1. During the last five years the Centre has established well- equipped laboratory facilities with a range of analytical and spectroscopic instruments and catalytic reactors which can be employed for carrying out research in frontier areas in this field. The use of the facilities of the Centre has been extended to various academic and industrial organizations.

B. EDUCATIONAL PROGRAMMES

i. M Tech Programme

NCCR has introduced an ***M Tech programme in Catalysis Technology***, in the year 2009 and the first batch of ***5 students*** would be completing by June, 2011. This is a specialized M Tech programme, designed to cover all aspects of the science, engineering and technology of Catalysis, which can cater to the human resource requirements of the Indian Chemical Industry. ***In 2010-11 academic sessions 5 more students have joined***.

ii. Ph D Programme

A total of 16 persons have obtained their Ph D degree during this five year period. Six Ph D students are presently registered at IIT-Madras under the guidance of NCCR faculty.

Ten scholars of various institutions are carrying out their research in NCCR and are being guided by the NCCR faculty. The students are registered at Anna University (four), Madras Christian College, Tambaram, Bharathidasan University and Thiagarajar College, Madurai. 30 candidates have been trained in the Centre as project associates, PDFs and in various other capacities in the last five years.

iii. Orientation Course

NCCR has organized the ***Orientation Course for research scholars*** from all over the country in the field of Catalysis during the last 5 years. Each year 35-40 students attended this course conducted during Nov-Dec. This a unique course for preparing the students for research in this interdisciplinary area & has been hailed by the participants. The ***Eleventh Course*** (the first course was started in 1999 at Chemistry Dept., IIT-M) was held in the month of Nov-Dec 2010.

The Centre has also brought out successfully three well received monographs originating from this course. ***Five such Orientation Courses have been held since 2006- Total students trained during the last 5 years ~ 200***

iv. Other Post-graduate Courses

a. 3 Weeks course in Catalysis for Post graduate students & research scholars in Tezpur University, Tezpur was held twice in September 2008 & November 2009.
b. 2 Days Pre-school in Thermal methods, Spectroscopic Methods in Catalysis, Theoretical Aspects of Catalysis and Analytical Techniques in Catalysis have been conducted at IMMT, Bhubaneswar, NCL, Pune, Gauhati University and at Department of Chemistry, Anna University,Chennai in the last four years.
c. 2 Days capsule course in Experiments in Chemistry and Biology for Staff & Students of Madurai Thiagarajar College at Madurai during 2010.
d. 2 Days Course in Spectroscopic Methods for Staff & Students of Madurai Thiagarajar College at NCCR, IIT-Madras, Chennai, 24 - 25 October 2010.
e. Fundamentals of Catalysis- One semester Course at Anna University, Chennai during 2007-2008, for M Phil / Ph D students (Two Times).
f. Industrial Catalysis- One semester Course at Anna University, Chennai during 2007-2008 for M.Sc. (Applied Chemistry) students (Two times).

v. Capsule Courses - For Industry

a. Capsule Course on all aspects of Catalysis to R&D Engineers from M/s Nagarjuna Fertilizer Co Ltd., for 1 week, during Sept 2009
b. A special one day course on catalysis, zeolites and characterization technique, with particular reference to deNOx systems was offered to a group of employees of General Motors, Bangalore on 9th September 2008.
c. A special one day course on “Technology appreciation programme of IIT-Madras” for 15 participants from industry during Dec. 2006.

vi. Special Courses

Summer Courses on Analytical methods, Spectral interpretation, Photo-catalysis, Photo-electrochemical processes, Fuel cells & Hydrogen storage were conducted periodically during the last four years for graduate/ PG & research students from IITM and other Institutes in the city

vii. Courses for School Children

Summer school for school children from the city covering recent developments in science has been held during the last 5 years

viii. Seminars / Workshops Organized

- Three-day Indo-Hungarian Workshop on **"Future frontiers in Catalysis"** during 16-18 February 2010.
- Four-day 20th National Symposium on "**Catalysis for Energy Conversion and Conservation of Environment"** during 19-22 December 2010.
- Regular research scholars meet with Anna and Madras Universities once in every six months.
- Annual day meet of the Centre in the last week of July every year - Meeting of all research Scholars of the Centre - Four such meetings have been arranged so far.

ix. Other Educational Activities:

- M Sc and M Tech students from other institutions have carried out their final semester projects in NCCR. (12 students)
- In addition regular stream of students (and teachers) sponsored by Indian Academy of Sciences (seven) and UGC (four) for summer fellowships.
- The Centre has also hosted foreign students from University of Nevada, University Queensland and other places for a period 3 weeks to three months.

C. BASIC RESEARCH

1. Nano-porous Materials

Since its inception, NCCR has developed a series of ordered/disordered nano-porous materials including silica (IITM-56), alumina (HSAI-100), carbons (NCCR-1 & NCCR-56), and transition metal oxides (TMON-75) for use as catalysts or catalyst support for a variety of reactions.

a. Ordered Nano-porous Carbons

Porous carbon materials have extensively been employed in variety of applications including gas separation, water purification, catalyst supports, hydrogen storage, and electrodes for batteries and fuel cells. However, the controlled fabrication of ordered nano porous carbon arrays remains a synthetic challenge to scientists. On the other hand, the resulting materials possess exotic properties that have been extensively exploited in the material research in the form of nano wire, nano tube and nano cage. They are typically produced using nano porous hard (silica) and soft (block polymers) templates, e.g., CMK, NCCR, OMC, FDU, etc. These carbons possess high surface area, large pore volume and enhanced meso porosity that is desirable for electro catalyst support materials.

It is expected that the traditional systems for energy conversion would be partly replaced by fuel cells in a medium/long term. The most investigated fuel cells are polymeric electrolyte membrane fuel cells using methanol as possible combustible fuel. The commonly used electro-catalyst, both for cathode and anode, is platinum supported on a variety of carbons. However, it is necessary to obtain a more effective catalyst, both in catalytic performance and electronic conductivity. To achieve a higher efficiency of the electro-catalyst, platinum has to be well dispersed on the support thereby a reduction is achieved in active metal content; in addition sintering problems can also be avoided. Nano porous carbons, designated as CMK-3 or NCCR-1, are excellent candidates for such purpose as these catalyst systems (Pt/CMK-3; Pt/NCCR-1) give promising electro-catalytic activity for methanol oxidation.

It can be seen from Table 1 that Pt/NCCR-1 exhibits higher activity than that of the catalyst prepared using commercial carbon (Pt/CDX-975) or commercial Pt/E-TEK catalyst. As stated earlier, the enhanced activity is due to the better dispersion and utilization of the Pt catalyst, which originate, respectively, from a higher surface area, large pore volume and oxy-functional groups present in the carbon materials. The study also demonstrates that optimized carbon supports not only exhibit higher current density and low activity loss but also can offer significant cost savings by lowering the extent of catalyst loading.

Table 1: Measured activity for methanol oxidation at 0.7 V.

Electrocatalyst†	Current density (mA/cm^2)	Activity loss after 3 h (%)
Pt/ NCCR-1‡	69.6	8.0
Pt/ CMK-3‡	93.2	28.0
Pt/CDX-975§	48.2	61.0
Pt/E-TEK¶	47.6	47.0

†20 wt % platinum on carbon; ‡Nanoporous carbon; §Commercial carbon; ¶Commercial catalyst.

b. Hydrogen Storage Materials

The ordered nanoporous carbons obtained via the template carbonization method, viz., CMK-3, NCCR-1, FDU-17, etc. are attractive for hydrogen storage purpose. These carbon materials exhibit enhanced and reversible hydrogen storage capacities. For example, a hydrogen uptake capacity of 2.7 wt% for CMK-3 at 77 K and 45 bar pressure and 1.9 wt% for NCCR-1 at 77 K and 25 bar pressure was achieved. These results suggest that chemisorptions or other chemical storage methods should be combined with physisorption if carbon materials are to be considered for hydrogen storage application.

c. Ordered Nano-porous Silica

Ordered nanoporous molecular sieves are special class of materials with ordered arrays of uniform pores, high surface areas, and large pore volumes. These periodic surfactant-mediated silica/silica-based materials, designated as MCM-41, MCM-48, SBA-15, SBA-3, etc., are promising for variety of applications including catalysis, adsorption and separation processes. Two most common types involve SBA-15 and MCM-41 that have ordered structures consisting of uniform nanopores. The former possesses larger pores, thicker walls and higher thermal stability as compared to the latter. Therefore, it is of interest to make materials with a combination of moderate pore size and thicker wall structure. The desired characteristics were made possible with the advent of oligomeric alkyl poly ethylene oxide (Brij-56) surfactant template, resulting in a novel silicate material, designated as IITM-56, with a (moderate) pore size of 35 Å and a wall thickness of 24 Å.

d. Ordered Nano-porous Titania

High surface area nanoporous titanium dioxides (TMON-75) have been synthesized using non-ioninc surfactant by hydrothermal treatment. The calcined catalyst possessed mesoporous framework with anatase structure and showed photo-catalytic activity about 60% higher than that of commercial TiO_2 (Degussa P25).

e. High Surface Area Alumina

High surface area alumina, (γ-alumina (HSAI-100) the range 300-400 m^2/g were successfully prepared and characterized. Silicotungstic acid supported on γ-alumina showed 99 % glycerol conversion with a maximum acrolein selectivity of 54 % for more than 20 h. On the other hand, Cu/ZnO supported on γ-alumina exhibited a 55% glycerol conversion with maximum 1, 2-propane diol selectivity of 88%.

f. Carbon Material from Natural Sources

Many hidden treasures of nature have not yet been exploited fully by mankind. Carbon materials are one such age old materials employed for the benefit of mankind in diverse ways though not to its full potential. Activated carbon materials are being used for electrode (super capacitor and fuel cell) fabrication, water purification, hydrogen storage and for the removal of toxic chemicals from water and air. The applications of carbon materials to mankind are diverse. Owing to the great utility and urgent demand for such carbon materials, has been made significant progress in evolving methods for producing micro porous high specific surface area carbon materials with interesting properties and applications from un-conventional carbon precursors like Calotripis gigantean, Borassus flabellifera, Limonia acidissima and Ipomoea carnea. Such an attempt is necessary from economical as well as environment view points. The carbon materials have been successfully used for the fabrication of fuel cell electrode materials, designing adsorbents for the sorption of mercury and some typical dye compounds like methylene blue. Commercially available activated carbon materials like Calgon carbon, adsorbent carbon and several others have also been tailored for the removal of organo sulphur compounds for diesel (adsorptive desulphurization).

2. Catalysis for energy conversion processes

a. Catalytic Conversion of Bio-Glycerol into Value-added Chemicals

Biodiesel is an attractive bio-renewable alternative to petroleum-based transportation fuels. On the other hand, the by-product glycerol from the production of biodiesel may be utilized a building block that might serve as an important bio-refinery feedstock. Thus, there is an increasing attention for the conversion of the by-product to value added products. It can be converted many value added product such as acrolein/acrolic acid, propane diols, glyceric acid/glyceraldehyde through various kinds of reaction (Fig. 2). Conversion of glycerol into such useful products is a challenging catalytic reaction.

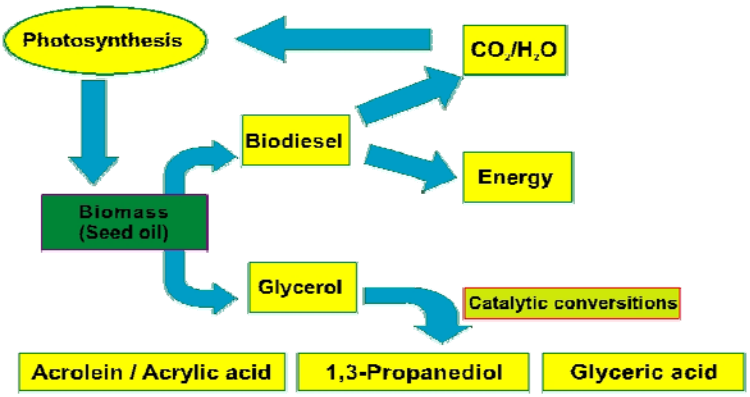

Fig. 2. Conversion of bio-glycerol into useful products.

Glycerol can be converted into acrolein and hydroxyacetone (acetol) through dehydration and further converted into propane diols through hydrogenation. For example, dehydration of glycerol in the presence of catalysts such as silicotungstic acid supported on ordered porous silicas shows complete glycerol conversion (100 %) with maximum acrolein selectivity (81 %). On the other hand, copper oxide supported on zinc oxide shows a maximum selectivity (90 %) of the intermediate hydroxyl acetone with a glycerol conversion of 45%. Hydrogenolysis of glycerol over reduced copper oxide-zinc oxide supported on a-alumina (HSAI-25) catalyst leas to 88 % 1,2-propane diol selectivity with a 55 % conversion of glycerol

In the case of the conversion to glyceric acid, the oxidation of glycerol was performed using nano-gold supported carbon. A maximum selectivity of > 90% glyceric acid was achieved with a glyceric acid was achieved with a glycerol conversion of > 70%. Even though a variety of value added products such as mono isopropyl ether of glycerol can be formed by a catalytic etherification reaction, the formation of any of the products is still challenging. It is also desirable in devising catalytic routes where the selectivity of the most value added product such as mono isopropyl ether of glycerol has to be optimized. The process, for the selective formation of mono isopropyl ether of glycerol, comprises the steps of reacting glycerol and isopropyl alcohol in a reactor with a zeolite catalyst heated in an inert atmosphere at 423-473 K for 6h. The resulting product, viz., mono isopropyl ether of glycerol (3 – isopropoxy 1,2 – propane diol), has a selectivity of 80-90% with a conversion of 15-40%, while that of other by products including diether being relatively low.

b. Catalytic Conversion of Carbohydrates to Key Platform Chemicals

Cellulose hydrolysis over alumina supported catalysts resulted in 24% yield of sorbitol. On the other hand, o-isopropylidene is a central intermediate product for numerous other glucose derivatives which is obtained by the condensation of monosaccharides with acetone. For this purpose, solid super acid catalysts such as sulphated metal oxides as well as sulphonic acid functionalized mesoporous silica were employed for the conversion of D-Glucose into mono- and di- isoporopylidene(70:30).

c. Catalytic Oxidation of Long- chain Linear Alkanes

Terminally oxidized hydrocarbons, i.e., at the a- or 1-positions, are important feed stocks for the chemical and pharmaceutical industry, but the selective oxidation of only the terminal methyl groups in alkanes remains a challenging task. It is well known that some enzymes are capable of performing selective terminal oxidations. Thus, cobalt and manganese containing aluminophosphate molecular sieves/phthalocyanine Catalysts were successfully employed for the terminal oxidation of long-chain linear alkanes such as dodecane and tetradecane using molecular oxygen.

D. APPLIED RESEARCH

Indian as well as multinational chemical industries have evinced keen interest in collaboration with NCCR on development / study of various catalytic processes & materials. A brief summary of industry sponsored projects is given in the table below.

S.No.	ndustry	Topic	Period	Output (expected)	Status
1	CPCL	Adsorptive de-sulphurization of diesel fraction End point reduction of diesel fuel.	2007-2009	Carbon based materials developed 5º reduction achieved	Completed
2	IOC	i.Development of alumina with defined textural properties ii.IOC fellowships	2009-2012	i. One patent to be filed ii.One Ph D scholar is working	Completed
3	SHELL	Metal grids as supports for catalysts	2008-2011	One patent to be filed	Part-A:Adherence of titania on SS surface completed Part-B: anchoring of metal in progress
4	NISSAN	Development of hydrocarbon trap materials	2010-2011	Based on Zeolite materials	Preparation & evaluation of suitable trap materials
5	HPCL	Chemical mitigation of carbon dioxide to fuels & chemicals	2010-2012	photo-catalytic process	Titania based photo catalysts prepared & evaluated for conversion of CO_2 and water to methane /methanol
6	P&G	Terminal oxidation of hydrocarbon molecules	2007-2008	Oxidation of long chain hydrocarbons	Terminated
7.	GM	De NOx chemistry	June 2010		In progress
8	TATA	PEC of water	2009-2011		In progress

A few more industry sponsored projects (from Nagarjuna Fertilizers, Granules India Ltd. and Shell) are in the pipeline.

E. Networking - National / International Collaborations

1. NMITLI project on "Value addition to glycerol from bio-diesel process"

Catalysts formulations for conversion of glycerol to value added products like propane diol, glyceric acid have been successfully developed. One patent application has been filed.

2. Hungarian Academy of Sciences

The project has seen exchange of two scholars from NCCR to Institute of Isotopes, Budapest and one technical staff from Hungary to NCCR. The work has been presented in an international Conference and is being published in Catalysis Letters.

3. The University of Queensland, Australia

Catalytic Conversion of Carbohydrates to Key Platform Chemicals: This work has been accepted for presentation in ACS meeting in March, 2011

4. *Technical University of Munich, Germany*

The Catalysis Research Centre (CRC) has entered an MOU with NCCR and various proposals of exchange are under consideration.

5. *University of Nevada, USA*

One MS scholar from the University of Nevada visited NCCR for a period of 4 months and three publications have come out of this collaborative endeavour.

6. Anna University, Chennai

The cooperation with Anna University is extensive. Four of their scholars are working full time in the Centre and a few more from the Centre are registered for Ph D with the faculty of Anna University.

7. Bharathidasan University, Tiruchirapalli

NCCR has an MOU with BU and one candidate has been registered for Ph D and is working full time in the NCCR. Discussions are going on for further sustained cooperation with BU.

8. Tezpur University, Assam,

Two Departments, Department of Chemical Sciences and also the Department of Energy have MOU with NCCR and cooperation goes beyond handling courses. A book jointly authored by a faculty of Tezpur University has been published.

9. Thiagrajar college, Madurai

In accordance with the NCCR's vision to collaborate with other academic institutions, a MOU with Thiagarajar College Madurai has been executed. This cooperation facilitates registering 5 candidates for Ph D degree. Already five publications have come out of this cooperation. Three of their M Sc students did their project work in the Centre.

10. Kalasalingam University, Sriperumpudhur

One M Tech student has carried out her Project work in the Centre and submitted the dissertation.

F. PUBLICATIONS / PATENTS / PRESENTATIONS

A brief summary of the contributions of NCCR in various activities is presented below. A detailed list is attached as Annexure 2.

Year	Publications	Patents	Presentations	Books
2006	22	Nil	25	1
2007	26	5	38	4
2008	15	1	35	4
2009	23	2	30	4
2010	18	1	25	1
2011	12	2(preparation)	-	-

G. CATALYSIS DATA CENTRE

The Centre has been maintaining a data base since 2006. There are more than ***1650 documents*** that have been already uploaded in this data base. The types of documents available include articles, book sections, Monographs, conference or work shop items, Books, Thesis, Patent, data sets, experiment, reaching resource and others which include power point presentation on various topics. This data base is unique in many respects since it serves not only the research community, but also a variety of people starting from students, teachers, common man and also experts. This data base has been regularly visited by a number of people both from India and abroad. In addition the centre maintains many other discussion sites for education and knowledge dissemination.

H. CATALYSIS SOCIETY OF INDIA

The Centre is the Head Quarters of the Catalysis Society of India. On behalf of the Society the following activities have been sustained all the five years.

i. Running the society, enrollment of members and also maintaining the day to day activity of the Society.

ii. B. Viswanathan in the last five years acted for one term as the President and all the five years was the Executive Committee member of the Society.

iii. The Centre has brought out the Bulletin of the Catalysis Society of India both in hard copy format and soft copy format for all these five years.

iv. The Centre has helped in the conduct of the National symposia, and workshops all these five years and in 2010, the centre conducted the 20th National Symposium on catalysis in Chennai during December 19-22, 2010.

v. The Centre has been responsible for the conduct of the preschools of the society in Bhubaneswar, Pune, Gauhati and Chennai prior to the national symposia or workshop.

vi. The faculty members of the Centre were members of the National Organizing Committee of all the symposia held by the catalysis society of India and a host of other symposia and conferences organized by various other institutes.

vii. Maintaining and updating the Catalysis Data base which is the store house of all necessary documents of relevance to catalysis. (Nearly 1650 documents are already freely available including e-books and other documents of relevance)

viii. The Centre also takes care of all the administrative work of the Society as well as the awards, announcements, nominations, and getting them evaluated by a panel of Judges.

3. Plan for Next 5 Years

During the past five years NCCR has laid a strong foundation for its seamless growth so that in future it can spread its wings over several emerging and new frontiers in the science of catalysis. NCCR has carved out its own place within IIT Madras as a vibrant entity with significant contributions in contemporary topics in Catalysis. In the next five years NCCR would focus on:

1. Intensifying Academic research leading to publications in high impact journals.
2. Aggressively pursuing Industry supported or industry oriented projects that would lead to patent disclosures that cover cutting-edge product development/process technologies.
3. Strengthening Academic activities related to:
   a. Research for imparting knowledge and training to young researchers.
   b. Resource generation in terms books, e-books and databases.
   c. Expanding and strengthening international collaboration with other Catalysis Research Centres across the globe and provide a platform for Indian scientists a uniform play ground to compete internationally.
4. Continuing its role as a Service Provider by:
   a. Enhancing the research activities of the other institutions associated with the Centre.
   b. Facilitating young researchers of this country for carrying out specific experimentation and also in interpretation.

c. Helping in effective knowledge transfer.

A. RESEARCH AND DEVELOPMENT AREAS

Focusing on ***Specific research areas*** for future that centre around:

1. Generation and rationalization of new materials as catalysts:

The approach is to consolidate and build further on the Centre's contributions in new meso porous materials like IIT-56 & NCCR-1. Research efforts towards developing alternate and new synthetic routes for a variety of materials with desired and well-defined textural characteristics that can be exploited as catalysts will be continued.

2. Catalytic bio- mass conversion processes:

Based on the earlier contributions by NCCR in valorization of glycerol, sorbitol & glucose, it is planned to expand research in the areas of lignin valorization and useful conversions with other platforms chemicals from biomass. Successful collaborative venture in this area in the past with University of Queensland, Australia would strengthen these efforts.

3. Development of catalysts and understanding of dream reactions / challenging processes:

Some of the frontline areas in this category are:

- Splitting of water for hydrogen generation
- Reduction of carbon dioxide with water to yield fuels & chemicals
- Fixing of nitrogen in the form of ammonia.

All these processes can give rise many spin off technologies like decontamination of water or air another active area. The Centre has contributions in these areas by developing hybrid catalysts by applying other molecular activation processes like, electro-catalysis, photo-catalysis and photo-electrochemical processes. Several postulates and principles that govern the selection of materials for such complex processes have been established have helped to enrich the knowledge domain. These efforts will be continued with direct focus on developing some governing principles which will enable the catalyst selection a rational process.

4. Difficult and challenging areas that the Centre plans to tread on include:

(i) Hydrogen generation technologies – devising alternate routes
(ii) Development of viable hydrogen storage materials
(iii) Design and fabrication of alternate electrodes for fuel cell applications

(iv) Theoretical studies of catalyst development especially employing DFT and other modern theories for condensed matter applications.

5. Pursuing with Applied research

While continuing with the current industry sponsored project, efforts would be made to aggressively work towards expanding the activity encompassing many other challenging areas/process/products. Research areas under consideration for collaboration with the industries include:

- Developing means of ***effective utilization of urea*** as the fertilizer and
- Processes for second generation bio-fuels like ***bio-butanol***

The Centre will continue the ***Academic activities*** for imparting knowledge and training to young researchers.

The Centre has been conducting continuously for the past 11 years, ***Orientation program for research scholars (350 students so far)*** of this country. Based on the feedback it is gathered that this happens to be one of the educational programs in their research career which has facilitated them to transform themselves into performing research scientists. The Centre is uniquely placed in the conducting this program since the DST has continuously supported all these 11 programs some of which had also been conducted in other Centres. These programs have also yielded development appropriate text books in this area and already 4 of them have been published and one of them has also been adopted for printing by the foreign publishers. ***The Centre intends to continue this special program in the coming years*** with appropriate modification with respect to syllabi and also the modules.

A special training program is being designed for Master's students during their winter or summer recess which will enable them to appreciate and cultivate scientific temper in them. Such courses have been conducted by the faculty of the Centre prior to its formation in 2006 and there was considerable response for the same. It is hoped that this exercise can be repeated with more emphasis on teaching resource generation.

The Centre is also contemplating ***Training programs in various analytical techniques*** like TP methods, spectroscopic and microscopic techniques since many of the researchers are not directly involved in making use of these techniques and they often get them recorded and hence, find difficulty in interpreting them. These courses will be offered by the Centre on need basis. Enhancing ***Academic activities towards resource generation*** in terms books, e-books and database

The Centre has been engaged in a variety of socially relevant activities. One of the activities, which have been continuously pursued by NCCR faculty, is to impart education at

the school level. A science program in the Children's Club in Chennai and summer program for two weeks have been conducted by the Faculty of the Centre and in that process over 7 e-books based on these courses have been produced. The Centre will continue these activities with other clubs and schools in the city of Chennai and also develop suitable science orientated programs and modules catering to the needs of school education.

6. Expanding International Collaborations

NCCR has already successfully established contacts and MOUs with ***Catalysis Research Center (CRC) at Munich, University of Queensland and Institute of Isotopes Budapest***. MOU has been initiated with ***NIMS*** for exchange of personnel between the two institutions. Efforts will be made in the coming years to establish contacts with the Catalysis group of South Africa, Brazil and other South American countries and also some Institutions in Europe and North America. This type of collaboration will not only be beneficial to both the collaborating countries but will also lead to pushing the knowledge barrier.

7. Strengthening the Activities as a Service Provider

In this role the following are envisaged:

(i) ***Servicing the industry*** in their trouble shooting and offering solutions
(ii) ***Extending service facilities*** for research work of other academic institutions
(iii) Providing ***a platform for young researchers*** to have their research results analyzed and interpreted – for this various modes will be evolved including on line discussion forum
(iv) Establishing **on-line lectures by eminent scientists from abroad** and exploring possibility of ***extending this facility*** from the Centre ***to other academic institutions*** in India.

a. Infrastructure Improvements

In order to carry out the research as well as educational programs as envisaged above, it is necessary to augment the infrastructural facilities and equipments. Since the major emphasis is on synthesis and characterization of materials it is proposed to add the following equipments:

- Laser Raman Spectrometer
- Table top GC-MS for analysis of complex samples
- TEM with EDAX/SAED attachments (to be installed process started)
- Gas chromatographs - 4 nos for various hydrocarbons/gas analysis
- Gas chromatograph for analysis of N & S containing samples and PIONA analysis
- Gas (N_2,H_2,Air,He) gas supply and distribution network all laboratories

- Ammonia TPD unit
- High pressure micro reactors (multiple)
- Parr reactors
- Berty reactor
- Reaction chamber for XPS
- Various laboratory equipment/apparatus
- Feed pumps
- Mass flow controllers
- Software packages for molecular modeling studies
- Setting up library / reading room, special instrument tables, computers etc

b. Man Power Development

- It is proposed to introduce M.Tech & Ph.D Fellowships to build research staff strength.
- M.Tech Fellowships is a part of the Centre's efforts to build human resource capital in Catalysis
- PDF fellowships could be offered to applicants from India and abroad. This will give the Centre an international character and also contribute to its growth. At the moment we receive many applications from abroad and we have to evolve a procedure to process these applications.
- Since a range of Analytical Instrumentation facilities are existing and more to be added it is necessary to recruit Technical Officers, who would have the responsibility to operate, generate data and maintain these units.
- Considering the current as well as proposed basic and applied research activities and various educational programs, it is essential that the three Senior Scientists (Prof.B.Viswanathan, Prof. S.Sivasanker and Prof. K.R.Krishnamurthy, who are currently on roll, may continue so that they can continue to contribute to the growth of the Centre.

To ensure that the Centre continues to expand its activities and actively participate in to man power development, scientific growth and benefits Indian industries to a greater extent, it is requested that the DST support it by extending its financial and other support for the next five years (2011 – 2016). The budget requested is given below.

c. Budget Estimates

Budget proposals for the five years covering requirements for faculty, research staff, students, Technical assistants, equipments and infrastructure are detailed below:

i. Man power:

S.No.	Description	Amount	Total per year (Rs. in lakhs)	Total for 5 yrs (Rs. in lakhs)
1	Senior Scientists (3)	Rs.50,000 per month	18.00	90.00
2	Technical officers (3)	Rs 40,000 per month	14.40	72.00
3	PhD Fellowships (5)	Rs 25,000 per month	15.00	75.00
4.	M Tech Fellowships (6)	To be provided by IITM	nil	nil
	Total			237

ii. Consumables, Contingencies, Travel and Educational Programmes:

S.No.	Description	Per year (Rs. in lakhs)	Total for 5 yrs (Rs. in lakhs)
5	Consumables	8.00	40.00
6	Contingency	5.00	25.00
7	Travel	2.00	10.00
8	Orientation programme and other academic programmes, short term courses for both research scholars and M.Sc students & college teachers	8.0	40.00
	Total		115.00

iii. Infrastructure and equipments:

S.No.	Description	Amount	Total per year Rs.in lakhs	Total for 5 yrs (Rs.in lakhs)
9	Infrastructure and equipment	-	-	900.00*
10	Institutional overhead	-	-	As per norms

Total of i, ii, iii = Rs. 1252 lakhs (+ institutional overheads as per norms)

*****Estimates on Equipments & Infrastructure are Given Below.

Estimates on Equipments & Infrastructure are Given Below.

S.No.	Instrument	Value (Rs. in lakhs)	
		Indian	Foreign
1.	Laser Raman Spectrometer		60
2.	Table top GC-MS		60
3.	SEM with EDAX attachments		150
4.	High temperature XRD		130
5.	Gas chromatographs (4 nos.)		50
6.	Special GCs (S & N) & PIONA (2 Nos.) with autosamplers		40
7.	TPD unit / chemisorption analyzer		60
8.	XPS attachments (reaction chamber etc.)		50
9.	TEM (EELS) attachment		60
10.	Batch reactors (4) with computer controls		50
11.	Berty reactor		50
12.	High pressure multiple reactors		60
13.	Feed pumps, MFCs,		20
14.	General laboratory equipment (ovens, furnaces, cryostats, stirrers, power supplies etc.)	20	
15.	Software for modeling		20
16.	Gas distribution system	10	
17.	PCs, power supply units etc.	10	
	Total	900	

4. Annexures

A. LIST OF FACILITIES AND EQUIPMENTS AVIALABLE

1) **Structural and textural characterization:**
   - X-ray diffractometer (Rigaku)
   - Surface area and pore volume distribution (Micromeritics ASAP 2030)
   - Temperature-programmed technique TPR, TPD, etc., (Micromeritics)
   - Thermal analytical instrument (TG/DTA) (Perkin Elmer)

2) **Spectral Characterization**:
   - Spectrofluorometer (Perkin Elmer)
   - FT-IR spectrometer (Bruker)
   - UV-Vis spectrometer (Thermo Electron)

   All with attachments for in-situ studies at different temperatures and atmospheres.

3) **Catalyst screening and testing**:
   - High pressure Batch reactors (Parr Autoclaves: 100 and 300 ml)
   - High pressure down flow reactor (Xytel: 100 ml reactor volume)
   - Atmospheric/low pressure down flow reactors (Hi-Tech)
   - High pressure micro reactor (Hi-Tech)

4) Analytical facilities:
   - Gas chromatographs, including on-line analysis of reactor effluents & attached to catalyst evaluation units
   - Simulated distillation GC

5) **Surface Analytical techniques**:
   - X-ray photoelectron spectrometer (Omicron)
     With UVPS and Auger spectroscopy

6) Photo-catalytic reactions
   - Light sources
   - Reactors for studying various photo-catalytic conversions

7) **Supporting equipments / Facilities:**
   - Two oil free compressors (reciprocating and scroll type) along with refrigerated drying units
   - One lab-scale extruder (manual) for preparing catalyst extrudates.

B. LIST OF PUBLICATIONS, PATENTS, BOOKS AND PRESENTATIONS

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74. T.M. Sankaranarayanan, M. Banu, R. Sumathi, J. Masih, G.Valavarasu, A. Meenakshisundaram, B. Sairam and S. Sivasanker, "End point reduction of a straight run diesel fraction using zeolite catalysts", *19th National Symposium on Catalysis, Pune, Jan. 18- 21, 2009 (oral paper).*
75. S.Sivasanker, "Nano-sturctures in heterogeneous catalysis" Workshop on Nanotechnology, SSN College, Chennai 20 th March, 2009 (Chief guest lecture).

76. K. Joseph Antony Raj, A.V. Ramaswamy and B. Viswanathan**,** Synthesis and characterization of organic-free, phosphate-modified anatase titania with high surface area, CATSYMP-19, Pune, January 18-21, 2009.
77. B.Viswanathan, Metal oxygen cluster compounds and their use in electrochemical devices, Presented in the International school on Nano Materials, Anna University, Feb 2009.
78. S.Chandravathanam, 'Enhanced utilization of Pt/C catalyst for methanol electrooxidation' in a National Seminar on 'Recent Trends in Chemistry, RTC- 3' conducted at Jayaraj Annapackiam College for Women, Periakulam, 26-27 Feb., 2009.
79. Vamshi Krishna, B.Viswanathan and P Selvam, Synthesis and Characterization of Novel Mesoporous (IITM-56) Silicates in Modern Trends in Inorganic Chemistry, MTIC-XIII" conference conducted in IISC, Bangalore, December 7 to 10, 2009
80. Anuradha, B.Viswanathan and P Selvam, "Synthesis of O-isopropylidene derivatives from D-glucose using sulphated metal oxides" to be presented in the 241 ACS meeting in Anaheim during March 27-29, 2011.
81. G.Magesh and B.Viswanathan, Photo-catalytic/electrochemical studies on cadmium stannates for water decomposition and pollution abatement, to be presented in the 241 ACS meeting in Anaheim during March 27-29, 2011.
82. A. Alagarasi, B.Viswanathan and P Selvam, Photo-catalytic activity of mesoporous Titania, to be presented in the 241 ACS meeting in Anaheim during March 27-29, 2011.

C. SERVICES RENDERED BY THE CENTRE IN THE LAST FIVE YEARS

1. The centre conducted five orientation programs for research scholars of this country and the success of these programs are already known to DST.
2. The centre has entered into academic and teaching cooperation with Anna University (originally envisaged in the sanction) Tezpur University and Thiagarajar College Madurai. The faculty of the centre has conducted regular semester courses in both Anna University and also in Tezpur University. They have been helping the science departments of Thagarajar College for the changes in the curriculum and also generating teaching resources in these new areas.
3. The faculty of the center have been rendering various teaching services to many other academic institutions in this country , the list is too long but typical ones are Pune University (Chemistry Department), other departments in IIT like Mechanical Engineering and so on.
4. The analytical services of the centre has been extended free of charge to various organizations in India typical ones are all the colleges in the city of Chennai, IIT Kharagpur, BHU, Varanasi, Gandhi Gram University, ICT, Mumbai and various other organizations.
5. The centre has been rendering services to various industries including CPCL, IOCL, NFCL, and many other industries in this country.
6. The centre has hosted many research scholars from other institutions for short periods and helped them in acquiring the data and also helped them interpret the data.
7. The centre has been the pivot of the catalysis society of India and has been contributing to the various activities of the society including in bringing out its bulletin, to maintain a

major data base on behalf of the society and also had been assisting the society in the conduct of the symposia and workshop of the society

8. The centre has been fully and totally responsible for the three preschools conducted by the Catalysis Society of India and has been responsible to make this tradition and maintain them.
9. The centre has been responsible to conduct the Indo Hungarian workshop in catalysis during Feb 2010, and the national symposium on catalysis during December 2010. In addition the centre has been regularly holding discussion and research seminars at the bi or multilateral level with Anna University, University of Madras regularly once in every six months.
10. The centre has entered into MOU with a variety of organizations these include (i) Anna University (ii) Departments of Energy and Chemical Sciences Tezpur University (iii) Thiagarajar College, Madurai (iv) Kalasalingam University Chemistry Department (vi) Chemistry Department of Bharathidasan University.
11. The centre has been responsible for bringing out more than 10 books and 6 ebooks each one of them has received international recognition. Two of the books namely Fuel cells and Heterogeneous catalysis the later authored by D K Chakrabarty and B.Viswanathan have been printed in foreign editions.
12. The centre has established international collaborations with a number of institutions abroad, typical ones are (i) Institute of isotopes Hungarian academy of sciences (two exchange of students and two faculty exchange have already taken place); University of Queens land (a joint project for biomass conversion is on-going, in addition to a joint program with Indo Taiwan, Indo Korean, Indo Japan programs where either student or faculty exchange have taken place and work is in progress in various bilateral projects.
13. The services rendered to industrial organizations is too numerous to list. Typical ones are development projects for CPCL, IOCL, P and G, Shell, HPCL and many other organizations in India and abroad. These collaborations have given rise to significant developments and also some patent disclosures jointly by the centre and also the sponsoring organizations.

D. FACULTY OF NCCR

1. Prof. Anju Chadha Department of Biotechnology
2. Prof. Debashis Chakraborty, Department of Chemistry
3. Prof. Raghuram Chetty, Department of Chemical Engineering
4. Prof. G Ranga Rao, Department of Chemistry
5. Prof. P Selvam, Department of Chemistry
6. Prof. Ramnarayanan, Department of Chemical Engineering
7. Prof. A Preeti, Department of Chemical Engineering
8. Prof. K R Krishnamurthy, NCCR
9. Prof. S Sivasanker, NCCR
10. Porf. B. Viswanathan, NCCR
11. Porf. V Murugesan, Department of Chemistry, Anna University
12. Prof. Velan, Department of Chemical Engineering, Anna University
13. Prof. K.Shanthi, Department of Chemistry, Anna University

E. RESEARCH FELLOWS, SCHOLARS, ASSOCIATES

List of candidates trained by the Centre in the last five years either for a degree or otherwise

Post Doctoral fellows worked in the Centre and left

1. Dr K Joseph Antony Raj
2. Dr Vidya Kridhna
3. Dr Joyce D'Souza
4. Dr Mahalaskshmi
5. Dr T Radhika
6. Dr B Murugan
7. Dr Jhanshi Lakshmi Kishore
8. Dr Sabiah
9. Dr P Sangeetha
10. Dr George

Post doctoral fellows on rolls

1. Dr Thirunavukarasu
2. Dr Anuradha

Candidates who have completed their Ph D (the number is around 20 in the past five years) and left the centre

1. Dr P Indraneel
2. Dr M Helen
3. Dr Ch Venkateswara Rao
4. Dr Himakumar
5. Dr M Sankaran
6. Dr T Maiyalagan
7. Dr Suresh P
8. Dr Srimurugan
9. Dr Sathiesh
10. Dr Janet
11. Dr Navaladian
12. Dr Magesh
13. Dr Jothiramalingam
14. Dr S. Chandravathanam
15. Dr J Rajeswari
16. Dr Kishore

Project Associates using NCCR facility from Prof. Ramnarayanan's group

1. Karthikayini M P
2. Meenakshi R
3. Rajendran M
4. Sundar M
5. Sowmya S (She works with VSSC in Kerala).
6. Shubhamangala B

List of candidates working for Ph D in the Centre

1. Mr.B.Kuppan
2. Mr.Vamshi Krishna
3. Mr.Ramanamurthy
4. Mr Anil kumar
5. Mr Suthagar
6. Mr.Mahendran
7. Ms. Alagarasi
8. Mr.Shanmugam
9. Mr.Muthukrishnan
10. Mr.T.M.Sankraranaryanan
11. Ms.M.Banu
12. Ms Jeyalakshmi
13. Ms. Vijaya Shanthi
14. Mr Ariharan
15. Mr.Keerthiga

16. Mr Ramana Mohan
17. Mr Prakash

Names of the people who have undergone training in the Centre in the last five years:

1. Ms. R.Sumathi (LEFT)
2. Ms. Nithya (IOC Project, left)
3. Mr.Poli Raju Kalluru (IOC Project,left)
4. Mr. Rajasekaran M (LEFT)
5. Mr. R.Jude (left,NCCR fellow)
6. Mr. Manikandan (CPCL fellow,left)
7. Mr. Kumaravel R (left,GM fellow)
8. Ms. A.Kiruba (fellow, left)
9. Mr. P.R.Venkatesan (fellow, left)
10. Mr. C.Bennet (IOC Visiting scientist, left for IOCL)
11. Ms. Gomathi K (GM fellow,left)
12. Ms.Smitha V S (GM Fellow left)
13. Mr. York Reed Smith (Visiting fellow from the University of Nevada, left)
14. Mr. Pachamuthu (Visiting fellow Anna University Tindivanam)
15. Ms.Premlatha (Visiting Fellow from Madras Christian College, Tambaram)
16. Mr.Vinothkumar, Research associate, SRF, left
17. Ms.Dhivya (Visiting M Tech student Kalasalingam University)
18. Ms.Sandya Research associate, SRF, Left
19. Ms Deepa (Anna University currently working for Ph D)
20. A. Santra M Sc Student
21. Mohan Raja, M Sc Student
22. K. Gopalakrishnan, M Sc Student
23. N. Kuthala M Sc Student
24. J.K. Ajay (Summer Project Under INSPIRE)
25. Anand Rengarajan, B Tech 2009, left
26. Sarvesh Rajagopal,B Tech 2009, left.
27. Janani Kannan, M Tech 2008, left
28. Mysore Raghavendra, M Tech 2008, left
29. Balaji Gupta, M Tech 2009,left
30. Anand Natarajan, M Tech 2009, left
31. Kripal Singh, M Tech 2011
32. Mr. Abhishek ShivKumar MIT, Manipal, Karnataka
33. Mr.Raghul Raghavan, NIT, Trichirapalli
34. Mr.K.T.Vikesh, Thiagarajar college, Madurai
35. Mr.R.Shanmugam, Thiagarajar College, Madurai
36. Ms. S.Esskkiammal, Thiagarajar College, Madurai

In addition a number of students of various other institutions in India have made use of the facilities of the Centre.

F. SEMINAR/ SYMPOSIA ORGANIZED

1. The centre conducts a special seminar on the foundation day of the centre in the first week of August every year and so far four such seminars have been conducted.
2. The centre conducts research scholars meet with Anna and Madras Universities once in every six months. So far three such seminars have been conducted.
3. Indo Hungarian seminar on frontiers in catalysis was held during February, 2010.
4. 20th National Symposium on Catalysis was conducted during December 19-22, 2010 on behalf of the Catalysis Society of India.
5. The Centre also conducts regular seminars (weekly) for the research scholars of the centre
6. Visiting persons have been requested to give special seminars. The director of CRC Technical University, Munich, Dr Seshan, Twente University, The Netherlands, Dr Ajayan Vinu from NIMS, Japan and various other visitors presented special seminars in the Centre

G. VISITING SCIENTISTS

1. Professor Notker Roesch Director, CRC Technical University Munich visited the centre in Feb 2009 and signed MOU and gave a seminar Presentation on the theoretical aspects of hydrogen activation by Transition metal Species in Zeolites and also signed an MOU between NCCR and CRC of University of Munchen.

2. Dr K Satan of the University of Twente, The Netherlands visited the centre and made a presentation on Production of Sustainable hydrogen.

3. Dr. Parthasarathi Bera of the Instituto de Catálisis y Petroleoquímica, CSIC, Madrid, Spain gave a presentaiton of Fuel cell catalysis on ceria based materials.
4. Professor Raghuram Chetty of the Chemical Engineering Department gave a presentation of Flexible Fuel Cells.
5. Professor Venkatesan V. Krishnan of IIT Delhi visited the centre and gave a presentation on Performance of SOFCs with Ni-impregnated anodes - long term stability and redox tolerance.
6. Prof Ogura visited the centre on Feb 17 and delivered a lecture on the synthesis of new functionalized zeolites from mesoporous silica.

H. HONOURS AND RECOGNITION RECEIVED BY THE FACULTY OF NCCR

Prof. B.Viswanathan

Editorial Board Member, Indian Journal of Chemistry Section A
Editorial Board Member, Eurasian Journal of Chemical Technology
Editor, Bulletin of the Catalysis Society of India

Prof. S. Sivasanker

Editorial Board Member, Catalysis surveys of Asia
News editor, Bulletin of the Catalysis Society of India

Prof. P. Selvam

Editorial Board Member: Bulletin of the Catalysis Society of India
Hon. Chairman**:** RSC – South India Section, 2010 onwards
Co-coordinator: Indo-Russia Delegation, Novosibrisk, 2009.
Member: American Chemical Society; The Royal Society of Chemistry, Catalysis Forum, International Zeolite Association, International Mesoporous Materials Association, Materials Research Society of Singapore, Catalysis Society of India; Materials Research Society of India, Indian Association of Solid State Chemists and Allied Scientists. Chemical Research Society of India

Chairing international/national conferences

- Technical session, Indo-French Symp. on Catal., Pune, July 12-14, 2010.
- Technical session, 19th National Symp. on Catal., Pune, Jan. 18-21, 2009.
- Technical session, Taiwan-India Conference on Nanomaterials, Taoyuan, Dec. 11-12, 2006.

International Advisory/Organizing Committee Member

- Int. National Advisory Board Member, Int. Sym. On Zeolites and Micro-porous Crystals (ZMPC 2009), Tokyo, 2009.
- Int. National Advisory Committee Member, 6th International Meso-structured Materials Symposium (IMMS 2008), September 8-11, Namur, 2008.
- Int. National Advisory Committee Member, Nano-porous Materials V, Vancouver, May 25-28, 2008.
- Co-Chair, International Conference on Advanced Materials (IUMRS-ICAM): Symposium R: Materials for Catalysis, BANGALORE, OCTOBER 8-11, 2007.

National Advisory/Organizing Committee Member:

- National Organizing Committee Member, 19th National Symposium on Catalysis, NCL, Pune, January 18-21, 2009.
- National Advisory Committee Member, National Seminar on "Recent Advances in Nano Science", Aurangabad, February 23-24, 2008.
- National Organizing Committee Member, 18th National Symposium on Catalysis, IIP-Dehradun, April 3-5, 2007.

Plenary Lecture Delivered in International / National Conferences/ Seminars/ Symposiums/Workshops

- 20th National Symposium on Catalysis held at IIT-Madras during 19-22 Dec. 2010.
  - Green Chemistry and Catalysis for Sustainability

Key-Note Address Delivered in International / National Conferences/ Seminars/Symposiums/Workshops

- XXI National Meeting of the Portuguese Chemical Society, Porto, June 11-13, 2008.
  - Nanoporous Carbon Supported Platinum (Pt/NCCR-1): Electrocatalyst for Methanol Oxidation
- National Seminar on Green Chemistry, Mumbai, March 20-21, 2008.
  - Green Chemistry and Catalysis

The certificate from NFCL for conducting the capsule course

Registered Office :
Nagarjuna Hills,
Hyderabad - 500 082. INDIA
Phones : 23357200, 23357204
23357589, 23356859.
Grams : "NAAGFERTS"
Fax : (91-40)23354788

NAGARJUNA
GROUP
Nagarjuna Fertilizers
and Chemicals Limited

Certificate

This is to certify that the training program on catalysis conducted during the month of September 2009 by NATIONAL CENTRE FOR CATALYSIS RESEARCH (NCCR), INDIAN INSTITUTE OF TECHNOLOGY, MADRAS (IITM) has been very useful in knowledge and skill set development of scientists of Nagarjuna Fertilizers and Chemical Ltd (NFCL). The theoretical and practical aspects of the training session are well received and truly appreciated by the NFCL scientists and management.

On behalf of NFCL, I sincerely thank Prof. B. Viswanathan and NCCR team for the commendable work performed as part of the training program. I also thank IITM management for the cooperation, support and warm hospitality extended to my team mates during this program. We hope to continue this fruitful interaction with IITM and NCCR in future, as well.

Sincerely,

R Swarup 29.09.09.

CIO & Head - Nagarjuna Innovation Center

I. NCCR ACADEMIC TRUST

Since NCCR has been engaged in both academic and applied research activities, proper monitoring and also evaluation (even if were to be self evaluation) are necessary components and with this view in mind an Academic Trust has been formed with our mentor **Dr Paul Ratnasamy** and our former colleague Dr A V Ramaswamy as external members and the four senior members of the Centre (Prof P Selvam, Prof K R Krishnamurthy, Prof S Sivasanker and Prof B.Viswanathan). This academic trust makes in internal audit for both academic activities and also gives guidelines for pursuing research activity in specific and appropriate areas. This trust will also help in various other ways like finding appropriate man power, guiding for international collaboration, and also the trust it is hoped will evolve guiding principles for improving the activities of the centre.

It is hoped that this academic trust will be an internal watch dog for the centre and will guide the activities appropriately. It will also evolve in future some incentive schemes for outstanding research in the Centre.