

**NATIONAL CENTRE FOR CATALYSIS RESEARCH  
INDIAN INSTITUTE OF TECHNOLOGY, MADRAS**



**A National Centre sponsored and supported by**

**DEPARTMENT OF SCIENCE AND TECHNOLOGY,  
GOVERNMENT OF INDIA, NEW DELHI**

**PROGRESS REPORT  
SUBMITTED TO THE MAC MEETING  
07, JULY 2008**

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## INTRODUCTION

The formation of the National Centre for Catalysis Research (NCCR) sponsored by DST, New Delhi was approved by the Board of Governors of IIT Madras, Chennai in July 2006. Since its formation, the members of the Centre have been striving hard to give it an organizational structure within IITM and make it a centre of excellence in the area of catalysis. The purpose of this document is to briefly outline the activities and achievements of the Centre during the period, Feb 2007 to June 2008 and to present the same to the Management Advisory Committee (MAC) for its consideration.

It may be recalled that the first MAC meeting was held on 26 February, 2007 under the chairmanship of Prof. M.M. Sharma. The minutes of this meeting and the recommendations of the MAC are enclosed. The action taken on each of the recommendations is presented along with this document. This forms **Part A** of this report.

The Centre has a mandate for contributing to education and development of human resource in the area of catalysis, as its primary function. **Part B** of this document gives a list of the man power at all levels at the Centre. A brief outline of the efforts taken by the Centre and the activities in education and human resource development are given in this part.

A number of experimental facilities have been installed during this period. The facilities created can be grouped as characterization facility, analytical tools and reactors for catalyst screening. A brief outline of the facilities created and the scope of their utility for research are outlined in **Part C** of this document.

The Centre has been active in carrying out sponsored projects for governmental organizations like CSIR, public sector undertakings (PSU) and also for multi-national industrial organizations. The necessary details of these projects are given in **Part D**.

The Centre has also established some international collaborations through government (DST) channels as well as through institutional contacts. The details of these collaborations are given in **Part E**.

The research output of NCCR in terms papers published, patents applied, books written and other tangible achievements are given in **Part F**.

The Centre is maintaining a catalysis data base (an open access system) and also conducting the affairs of the Catalysis Society of India, a national body. A brief report on these activities is given in **Part G**.

The Centre has participated in some other useful activities like the annual day (in July 2007), lecture on Nobel Prize winning work and many other special lectures. A few selected ones are given in **Part H**

## PART A

### **Minutes of the first meeting of the Management Advisory Committee of National Centre for Catalysis Research (NCCR)**

Date/time: 26<sup>th</sup> February, 2007 / 11.30 a.m.

Venue: The conference room, Administrative Building at the Indian Institute of Technology, Madras

The following members attended the meeting.

1. Prof. M.M.Sharma Chairman
2. Dr.T. Ramasami, Secretary, DST
3. Prof. M.S. Ananth, Director, IIT M
4. Dr. T.S.R.Prasada Rao
5. Prof. D.Viswanatham. VC, Anna University
6. Dr. R.P.Verma
7. Dr. Aiyagari Rao, Advisor, DST
8. Dr. Rajiv Kumar representing Director, NCL
9. Dr. M.Lakshimikantham representing Director, IICT
10. Dr.R. Brakaspathy, Scientist G, DST

The following investigators and others associated with the Centre were present at the meeting.

1. Prof. B. Viswanathan, Head, NCCR
2. Dr. A.V.Ramaswamy, Chair professor NCCR
3. Dr. S.Sivasanker, Chair professor NCCR
4. Prof. V.Murugesan, Dean, Sciences, Anna University
5. Prof. S.Sankararaman HOD Chemistry
6. Prof. T.K.Varadarajan, Department of Chemistry
7. Prof. P Selvam, Department of Chemistry
8. Prof. Anju Chadha Department of Biotechnology
9. Prof. G.Ranga Rao, Department of Chemistry
10. Dr.D.Chakrabarty Department of Chemistry

Before the meeting was started, two minute silence was observed to condole the sad demise of Prof. G. Sundararajan, Head of the Chem. Dept. IIT, Chennai.

The meeting started with the Director, IIT welcoming the participants.

The discussions that took place during the meeting are recorded below.

1. The Chairman, Prof. M. M. Sharma appreciated DST's support and the creation of the centre. He lauded the charter proposed in the proposal document and as well as those mentioned in the DST sanction letter. He also outlined the importance of the research in the area of catalysis with

- several examples and the need to commercialize some processes, especially, clean vapour phase processes.
2. He also pointed out the need to motivate students to work in the area of catalysis.
  3. He mentioned that GTL, bio-transformations, pharmaceuticals as some of the areas that need emphasis. He also remarked that the proposed alumina preparation project should have an industrial partner from the beginning and he suggested some possibilities.
  4. He pointed out that while Indian researchers were able to produce very good publications in catalysis, their contribution in making commercial processes are not praiseworthy.. He pointed out that the fundamental research ( to be undertaken at the Centre - NCCR) should ultimately lead to new commercial processes. He emphasized that excellence in both fundamental research and technology development can co-exist.
  5. Prof. D. Viswanatham, Vice-Chancellor, Anna University, thanked DST for setting up the Centre (NCCR) and complemented the Centre for the progress made to-date. He added that his university will extend all necessary help for the growth of the centre. He suggested that the Centre should conduct courses for teachers of engineering colleges to improve their knowledge of the subject. He mentioned that a MOU will soon be signed between Anna University and NCCR.
  6. Dr T Ramasami, Secretary, DST mentioned that compliance with the Centre's charter is important. He emphasized the need for capacity building which is one of the core issues in the original proposal document and restated the importance of education and creation of trained man-power *vis-a-vis* research. He outlined how the short, mid and long term research has to be prioritised with suitable identification of the area, which should also be need based. He said new initiatives that are unique to this centre should be taken. He pointed out the need for the Centre to get large endowments / grants from the industries that may typically be used in construction of buildings etc. He also pointed out the comments sent by Dr. Ratnasamy and the need for additional space.
  7. The Secretary, DST also pointed out that a research advisory committee under the chairmanship of the Director, IIT should be formed and they should meet periodically and examine the activities of NCCR and suggest the type of research NCCR should undertake.
  8. The Director IIT Madras said such a committee will be formed soon.
  9. Dr T.S.R.Prasada Rao said that the Centre should be a special one to enhance catalysis activities in India. It should not be an extension to the Chemistry Department at IIT and it should manifest itself as a global centre of excellence. He noted that both fundamental research and commercialization of catalytic processes are important for the centre.
  10. Dr.R.P.Verma also pointed out the need for the Centre to be independent of the Chemistry Dept. and the importance of academic freedom and preserving the uniqueness of the aspirations of the faculty (Centre). He said that the Centre should give emphasis to industrial R and D in addition to human resource generation. He also said that the areas pursued should be critical areas that have potential for commercialization, such as petroleum refining.

11. B. Viswanathan then presented the progress made in the creation of the centre. There were many discussions and comments on the presentation.
12. Dr. T. Ramasami asked the steps taken in "capacity building". He also pointed out that new educational programmes should be started and the faculty induction should be expedited.
13. Prof. Viswanathan mentioned that some of the activities proposed are foundation courses, special courses and capsule courses for working people. Summer internship programme and other internship programmes will be also introduced in the centre so that many other institutions can be effectively participate in the activities of the centre.
14. The chairman during the discussion on facilities being created mentioned the need for a spinning band column and advised the Centre to procure one.
15. The need for multi-tubular reactor and autoclaves was pointed out by Dr. Verma. The action taken in the procurement of reactors and autoclaves at the Centre was discussed.
16. The need for technical posts of technical officers was taken up and Prof. Viswanathan said that the Centre will look for experienced persons for these posts.
17. Prof. V. Murugesan stated that some of the ongoing programmes in Anna University in the area of catalysis will be shared between Anna University and NCCR. The chairman appreciated this proposal and asked NCCR to evolve a suitable frame work or MOU for this purpose and for other collaborations with Anna University.
18. Finally, the need to narrow down areas was restated by the Secretary, DST. He wanted education and training of manpower (creating professionals) to be given priority. He emphasized that the Centre should be an autonomous entity with the ability to sustain itself. Its academic and executive loads should be separated for smoother functioning. During the discussions, he wanted to know the possibility of introducing M.Sc. / M.Tech. courses in catalysis. The Director, IIT Chennai replied that introducing these course are taking time because of many procedures, and assured to look into this aspect. The secretary, DST suggested that a new building be planned for the Centre
19. The meeting ended with the Director, IIT proposing a special vote of thanks to the Chairman, Prof. M M Sharma, Dr. T. Ramasami, Secretary DST and members of the committee.
20. Some members of the committee later visited the Centre.

### **Recommendations:**

1. An Overview Committee with Director IIT as the Chairman should be formed and it should meet, in the initial phases, at least every quarter. The committee, apart from other members, may include Registrar and or Finance officer. The committee should evaluate the progress and advise on the research and other activities of the centre.
2. The centre should follow the charter laid down in the project proposal and in the sanction order of DST.

3. Education and capacity building must be the prime activity of the centre and the centre should do what other centres of catalysis in India could not do.
4. The centre should be an autonomous body and should not be an arm of the chemistry department of IIT.
5. Concerted efforts should be put in to focus research in some chosen areas instead of spreading too thin in many areas. The areas may be identified based on the expertise of the people at the centre. Experts from other institutions may also be invited as adjunct/visiting faculty wherever required. IIT Chennai should also try to recruit more faculty in the area, and some faculty members from Chemical Engineering may also be inducted into this centre.
6. There must be an appropriate mix of research and teaching and various types of teaching modules and training should be evolved keeping the needs of industry and academic institutions. Special courses, post graduate (MSc and MTech) programmes be introduced to train manpower.
7. Concerted attempts will be made to link the academic oriented work to industrial utilization.
8. The centre should look for endowments from industrial sector and also appropriate plan for a new building. The funds for the same may be generated from various sources.

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#### **Action taken on the recommendations of the first MAC meeting**

1. An overview committee with the Director of IIT as the chairman should be formed and it should meet in the initial phases at least every quarter. The committee, apart from other members may include Registrar and or Finance officer. The committee should evaluate the progress and advise on the research and other activities of the Centre  
**Action Taken:** The overview committee has been constituted by the Director, IITM with himself as the Chairman. The first meeting of the committee took place on 16 July 2007. The minutes of the meeting are given in **annexure 1**.
2. The centre should follow the charter laid down in the project proposal and in the sanction order of DST.  
**Action Taken:** It has been ensured that the centre follows the charter laid down in the proposal and also the sanction order of DST.
3. Education and capacity building must be the prime activity of the centre and the centre should do what other centers of catalysis in India could not do.  
**Action Taken:** Education and capacity building have been the focus of the activities of the centre in the last one year and will continue to remain

in the top of our activities in future. For details of the action taken in this regard, please see Part B of this document.

4. The centre should be an autonomous body and should not be an arm of the Chemistry Department of IIT.

**Action taken:** In this connection, under the instructions of the Director, a document has been prepared detailing the organizational structure of NCCR as an autonomous body, similar to the functioning of SAIF at IIT Madras. According to this proposal, both NCCR and SAIF will be independent centres at IITM. These documents are under the consideration with the Dean, Administration of IIT Madras for implementation and further action.

5. Concerted efforts should be put in to focus research in some chosen areas instead of spreading too thin in many areas. The areas may be identified based on the expertise of the people of the centre. Expert from other institutions may also be invited as adjunct /visiting faculty whenever required. IIT Chennai should also try to recruit more faculties in the area and some faculty members from Chemical engineering may also be inducted into this centre.

**Action Taken:** The centre has identified four areas for basic research based on the available expertise. These are: a) novel materials, b) energy conversion processes, c) surface and interfacial science and d) theoretical studies. The centre will concentrate on these areas. The summary of activities of the NCCR are shown in the PPT clip (**Annexure 2**)

In the meantime, Dr R. Ramnarayanan of the Department of Chemical Engineering has been inducted into the centre as an adjunct faculty. Already some of the professors of the Department of Chemistry of Anna University are participating in the activities of the centre.

6. There must be an appropriate mix of research and teaching and various types of teaching modules and training should be evolved keeping the needs of industry and academic institutions. Special courses, post graduate (M.Sc and M Tech) programmes be introduced to train man power.

**Action Taken:** This recommendation is being implemented. One Technology appreciation programme for industries was conducted and more specific capsules are being planned.

On the other front, we have attempted two times to conduct courses for college teachers, one refresher course for the faculty of Chemical Engineering Departments of universities in south India and one for M Sc Chemistry students of the various colleges in Chennai. Due to various reasons, the response was not adequate for both the courses and hence these could not be conducted. However, efforts will be made to conduct appropriate courses at times convenient for the teachers and the students.



7. Concerted attempts will be made to link the academic oriented work to industrial Utilization.

**Action Taken:** The projects carried out for CPCL and IOC are directly linking academic research to industry.

Similarly, the work being done for P&G and Shell International are challenging and provide this link.

The work on Fuel cell is directly linked to the Columbian Chemicals Company at Atlanta.

8. The centre should look for endowments from industrial sector and also appropriate plan for a new building. The funds for the same may be generated from various sources.

**Action Taken:** The centre has sounded a number of industries on the possibility getting endowments for various purposes. Nothing concrete has emerged as yet. However, efforts will be on for appropriate plans for a new building for NCCR.

## **PART B**

### **EDUCATION AND CAPACITY BUILDING AT NCCR**

The family of NCCR consists of the following personnel:

#### **Faculty of NCCR**

1. Prof. B. Viswanathan, Emeritus Professor and Head
2. Dr. A.V. Ramaswamy, Chair Professor
3. Dr. S. Sivasanker, Chair Professor
4. Prof. P. Selvam (Department of Chemistry, IITM)
5. Prof. R.P. Viswanath, CSIR Emeritus Scientist

#### **Associate Faculty**

1. Prof. A. Chaddha (Biotechnology, IITM)
2. Dr. D. Chakrabarty (Chemistry, IITM)
3. Prof. R. Dhamodaran (Chemistry, IITM)
4. Prof. V. Murugesan (Chemistry, Anna University)
5. Dr. G. Ranga Rao (Chemistry, IITM)
6. Dr. R. Ramnarayanan (Chemical Engineering, IITM)
7. Prof. T.K. Varadarajan (Chemistry, IITM)
8. Prof. Velan (Chemical Engineering, Anna University)

#### **Post Doctoral Fellows of NCCR**

1. Dr. Vidya Krishna, DST Young Scientist
2. Dr. R. Mahalakshmi, DST Young Scientist
3. Dr. Joyce Queeny D'Souza, DST Young Scientist
4. Dr. B. Murugan, Shell Fellow
5. Dr. S. Sabaiah, NCCR Fellow
6. Dr. Jhansi Lakshmi Kishore, P&G Fellow
7. Dr. P. Sangeetha, NMITLI Fellow

#### **Ph.D Students at NCCR**

1. Mr. S. Navaladian (Thesis submitted)
2. Ms. C.M. Janet (Thesis submitted)
3. Mr. Ch. Venkateswara Rao (Thesis submitted)
4. Mr. L. Himakumar (Thesis submitted)
5. Ms. J. Rajeswari (Thesis submitted)
6. Mr. P.S. Kishore (IITM Scholar)
7. Mr. P. Indraneel (Columbian Chemicals Scholar)
8. Ms. M. Helen (CSIR-SRF)
9. Ms. S. Chandravadanam (CSIR-SRF)
10. Mr. G. Magesh (IITM Scholar)
11. Mr. B. Kuppan (IITM Scholar)
12. Mr. N. Vamsi Krishna (IITM Scholar)

13. Mr. G. Ganesh (IITM Scholar)

**Project Assistants at NCCR**

1. Mr. T.M. Sankaranarayanan (CPCL Project)
2. Ms. M. Banu (CPCL Project)
3. Ms. R. Sumathi (CPCL Project)
4. Ms. T. Nithya (IOC Project)
5. Mr. K. Suthakar (NMITLI Project)
6. Mr. K. Polli Raju (IOC Project)
7. Mr. P. Ramana Murthy (IOC Project)
8. Mr. Jude Vimal Michael R (NCCR)
9. Mr. M. Manikandan (CPCL Project)
10. Mr. S. Seetha Raman (P&G Project)

Dr. T. Radhika, who joined NCCR as a post-doctoral fellow has since left the Centre to take up a new appointment. Mr. Rajendran who was a project associate also left for other assignment.

The following are some of the highlights of our efforts in Education and capacity building in the area of catalysis:

**1. The Orientation Program in Catalysis**

This program is the one of the unique educational endeavors of the Centre, conducted every year for the young research scholars of the country. The last such program was conducted in the month of December 2007 for three weeks (3 to 21 December 2007). There were 40 participants from various institutions like IICT, IIP, UICT, CUSAT, Anna University and IITM. This program is well structured and conforms to a syllabus, which is evolved and undergoes changes every year, depending on the trends and future scope of research in the area of catalysis. The fundamentals are stressed. The responses of the participants on the conduct of the course are available with Dr. R. Brakaspathy of DST.

**2. Participation in Anna University Teaching Program**

The faculty of NCCR has handled two courses in the curriculum of the Department of Chemistry, Anna University during the first semester of 2007 (July to November 2007).

The courses are:

- (i) AC 086 INDUSTRIAL CATALYSIS for M.Sc. (Applied Chemistry) students
- (ii) CY 073 CONCEPTS AND TECHNIQUES IN CATALYSIS for M Phil students.

These two courses were conducted by NCCR staff as per the syllabus and the time table provided by the Department of Chemistry, Anna University. Internal tests and final examinations were also conducted by faculty of NCCR. It may be mentioned that the course for the M.Phil students of Anna University was conducted at NCCR.

### **3. National Level Tutorial on Temperature programmed technique**

NCCR took the initiative of conducting a two-day (15-16 February 2008) Tutorial on temperature-programmed technique (TPR, TPD, TPO, etc) for the research scholars from different organizations at Institute of Minerals and Materials Technology, Bhubaneswar, prior to the National Workshop on Catalysis (18-20 February 2008). Considering the importance of the TP technique in catalysis research, the origin, theory and practice of this technique were illustrated with examples, problems and solutions.

### **4. Annual Children's Club program**

NCCR also conducted this years Children's Club summer programme on synthetic strategies in Chemistry for two weeks. This course material is now available as 'e' book in the NCCR website.

### **5. Special Training Program**

In addition, the faculty of the centre have participated in various educational and refresher programmes conducted by other institutions like PSG Institute, Coimbatore, IGCAR, Kalpakkam, Madras University etc.

Special training in catalysis was offered to number students of sister organizations like VIT. NCCR also hosted and entertained two summer teacher fellows sponsored by the Indian Academy of Sciences, students from Chemical Engineering Department of IIT Madras, and Dr Sushanta Badamali from North Orissa University.

Two summer teacher fellows sponsored by I ASC spent two months learning catalysis and carrying out experiments.

### **6. Ph.D. thesis work**

The centre has turned out 6 Ph. D students in this year and has enlisted few new students for the Ph D programme. The centre has also initiated joint Ph.D students with Bharathidasan University, Tiruchirappalli in the new scheme.

One student of Anna university carried out M Phil research work at NCCR.

## PART C

### FACILITIES CREATED AT NCCR

The following facilities have been created at NCCR during the last one year. All the instruments have been installed, tested and are being used.

#### **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)

#### **Spectral Characterization of solids:**

- Spectrofluorometer (Perkin Elmer)
  - FT-IR spectrometer (Bruker)
  - UV-Vis spectrometer (Thermo Electron)
- All with attachments for in-situ studies at different temperatures and atmospheres.

#### **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)

#### **Analytical facilities:**

- 3 Gas chromatographs, including on-line analysis of reactor effluents
- Simulated distillation GC

#### **Surface Analytical technique:**

- X-ray photoelectron spectrometer (Omicron)  
With UVPS and Auger spectroscopy

#### **Supporting equipment:**

- Two oil free compressors (reciprocating and scroll type) along with refrigerated drying units
- One lab-scale extruder (manual) has been installed for preparing catalyst extrudates.

These facilities are now being routinely used by students for their research and maintained by the existing staff and students. These are also extended to other organizations (Anna University, CPCL, CLRI and other institutions).

For the up-keep and maintenance of these instruments/facilities, the center will require the services of technical staff (technical assistant, technical officer) in future. Necessary steps will be taken to recruit such personnel for the centre.

## **PART D**

### **1. Some highlights of basic research at NCCR**

The basic research component of NCCR has various facets. The can be listed as follows:

1. Preparation of various kinds of meso-porous materials including carbon materials both synthetic and natural sources.
2. Exploitation of the synthetic strategies for generation of new generation nano state materials for possible catalyst applications.
3. Examining the cluster compounds especially poly oxometallates for a variety of organic transformations.
4. Evolving suitable catalyst systems for specific reactions like conversion of glycerol to value added products like 1,2 or 1,3 propandiol or acrolin.
5. Evolving strategies to increase the surface area of carbon with specific application in mind.
6. Fuel cell electro catalysts and membranes are another area of research in which the group is contributing considerably.

### **2. Industrial sponsored projects at NCCR**

Eight sponsored projects are being carried out in NCCR at present. Out of these, seven have been sponsored by industries. These are briefly described below.

#### **1. Chennai Petroleum Corporation Limited**

There are two on-going projects sponsored by Ms.CPCL, Chennai. Details of these projects have been given in our previous report. In short, these projects are:

- (a) Adsorptive Desulphurization: The aim of the project is to remove sulfur in the SR diesel fraction of Narimanam crude by an adsorptive desulfurization process for which suitable adsorbents have been developed, screened and selected. The process at the laboratory level has been demonstrated and the scale up studies are being pursued at CPCL R and D centre with the participation of NCCR. It is also proposed to convert the removed sulphur compounds into useful products.
- (b) End Point Reduction: The objective of this project is to bring down the T95 distillation point of straight run heavy diesel (T95 ~ 380°C) to less than 360°C without substantial yield loss. A number of catalysts have been screened and the most suitable catalyst is to be evaluated in detail.

#### **2. Indian Oil Corporation :**

IOC, R and D centre at Faridabad has sponsored two projects

- (a) Development of alumina of certain specifications for the use of IOC in their catalyst formulations; and

(b) Basic understanding of the hydrotreating catalyst systems

3. **Procter and Gamble**

This project involves development of specific catalysts for the conversion of long chain hydrocarbons into alcohols.

4. **Shell International Pvt. Ltd.,**

Development of high throughput catalyst systems on stainless steel grids

5. **CSIR NMITLI Project**

Conversion of glycerol into 1,2 or 1,3 propanediol and acrolein (jointly with NCL, UICT and IICT)

6. **General Motors India Limited**

The project envisages the understanding of the kinetics of deNOX reaction under SCR conditions.



## **PART E**

### **INTERNATIONAL COLLABORATION**

#### **1. Indo- Hungarian Program**

This program deals with the application of nanoscience and nanotechnology in bi-metallic catalysts systems and is funded by DST, New Delhi. This two year program commenced in October 2007. Under this bilateral cooperation, Prof. Laszlo Guzzi and Dr. Zoltan Schay of the Department of Surface Chemistry and Catalysis, Institute of Isotopes, Budapest visited NCCR during 12-22 February 2008 to discuss the project details. They gave lectures at NCCR and also participated in the National Workshop on Catalysis held at IMMT, Bhubaneswar, where they delivered lectures on surface science.

Subsequently, with our XPS facility in place, Dr. Zoltan Paszti, who has expertise in surface analytical technique visited NCCR and spent two weeks in April 2008 working and training students on this technique.

One of our research fellows, Mr. G. Magesh is spending three months carrying out research at the Department of Surface Science and Catalysis, Budapest under the supervision of Prof. L. Guzzi.

#### **2. Indo-Australian Program**

This program has just been approved by DST, New Delhi  
The collaborative research involves strategies for conversion of bio-sources into valued chemicals.

#### **3. Indo-French Program:**

Development of strategies for the fabrication of 1-D nanostructures and microstructures of metal oxides and mixed metal oxides and simultaneous evaluation of their catalytic, electrocatalytic and sensor applicability with Dr. Benoît Louis, Laboratoire des Matériaux Surfaces et Procédés pour la Catalyse, Research Fellow CR2, UMR 7515 du CNRS, 25 rue Becquerel, F-67087 Strasbourg Cedex 2, France has been submitted to CEFIPRA and is under consideration.

#### **4. A MOU has been signed between NCCR and the New Chemistry Research Division, Korea Research Institute of Chemical Technology, for joint collaboration and exchange of research students.**

Efforts are being made to have similar MOU with Sung Hwa Jung, Department of Chemistry, Kyungpook National University, Daegu 702-701, Korea.

7. Proposals are being either prepared or submitted for Into-European programme, Indo-Taiwan Programme and also some initiatives are being made with other international schools like the Department of Chemical Engineering, University of Nevada, Reno, USA

## PART F

### RESEARCH OUT PUT OF THE CENTRE FOR 2007-2008

The output of the centre for the period 2007-till day in terms of publications, books and patents are given in this part.

1. V.Chidambaram and B.Viswanathan "Single Step Catalytic Production of Diisopropyl ether (DIPE) from Acetone Feedstock over Nickel Based Catalysts" *Applied Catalysis B: Environmental*, 71(1): (2007), 32–43.
2. S. Navaladian, B. Viswanathan, R.P. Viswanath and T.K. Varadarajan, "Thermal decomposition as route for silver nanoparticles" *Nanoscale Research Letters*, 2: (2007) 44-48.
3. M.Helen, B.Viswanathan and S.Srinivasa Murthy,"Synthesis and characterization of composite membranes based on a-zirconium phosphate and silicotungstic acid" *Journal of Membrane Science*, 292 (2007) 98-105 2007.
4. P. Suresh, Babu Varghese, T.K. Varadarajan and B. Viswanathan, "2,4,6-Tris{[(S)-1-hydroxy-3-methylbutan-2-ylamino] methylene}cyclohexane-1,3,5-trione" *Acta Crystallographica Section E,Acta Cryst.* (2007). E63, (2007),0984-0986..
5. S. Srimurugan, P. Suresh, B. Viswanathan and T.K. Varadarajan, "Facile synthesis and unusual methanesulfonylation reaction of (2R,3R)-1,4-dimethoxy- 1,1,4,4- tetrasubstituted- 2,3-butanediols" *Synthetic Communication* 37 (2007),2483-2490.
6. V.Chidambaram and B.Viswanathan "Single Step Liquid Phase Synthesis Of Methyl Isobutyl Ketone (MIBK) From Acetone" *Eurasian chemico-technological journal (Under Revision)*.
7. B.Viswanathan and M.Helen " Is Nafion the only choice? " *Bulletin of the catalysis society of India*, 6 (2007),50-66.
8. M.Sathish, B.Viswanathan and R.P.Viswanath "The Characterization and photocatalytic activity of N-doped TiO<sub>2</sub> prepared by thermal decomposition of Ti-Melaminecomplex" *Applied Catalysis B Environmental* 74 (2007),308-313
9. S.Shanmugam, B.Viswanathan and T.K.Varadarajan " Photochemically reduced polyoxometalate assisted generation of silver and gold nano particels in composite films: a single step route" *Nano scale Res.Lett* 2, (2007) 175-183.
10. M.Sankaran and B.Viswanathan " Hydrogen aborption by boron substituted carbon nanotubes " *Carbon* 45, (2007), 1628-1635..
11. C. M. Janet, B. Viswanathan, R. P. Viswanath, T. K. Varadarajan "Characterization and Photoluminescence Properties of MgO Microtubes Synthesized from Hydromagnesite Flowers " *Journal of Physical Chemistry C* 28(2007), 10267-10272.

12. J.Rajeswari, B. Viswanathan and T. K. Varadarajan "Tungsten trioxide as supports for platinum in methanol oxidation " *Materials Chemistry and Physics* 106, (2007), 168-174.
13. S.Shanmugam B. Viswanathan and T. K. Varadarajan " The preparation of metal oxygen molecular cluster embedded organic-inorganic nanocomposite and its rectification behaviour, *Materials Chemistry and Physics (in press).* "
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7. R.Ulaganathan, R.Mahalakshmy, and B.Viswanathan, *Identification of Active Phase of Sn-Sb-Mixed Oxide Partial Oxidation System, Submitted to the Bulletin of the Catalysis Society of India*
8. S, Arunachalam and B, Viswanathan (2008) *A historiographic analysis of fuel cell research in Asia – China racing ahead. Curent Science . (In Press)*
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23. P.Selvam, **NANOMATERIALS IN CONFINED ENVIRONMENT, WORKSHOP ON CATALYST FOR ENVIRONMENTAL APPLICATIONS, DECEMBER 2-3, 2007, NIT, TRICHIRAPPALLI.**

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26. P.Selvam, *Green Chemistry and catalysis for sustainable production of organics*, Green Chemistry Workshop, NATIONAL INSTITUTE OF PHARMACEUTICAL EDUCATION AND RESEARCH (NIPER), Sep. 3-4, 2007, Mohali.
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28. P.Selvam, Awareness Campaign in Nanotechnology, Science City, Department of Higher Education, CHENNAI (December 10, 2007). *Nanomaterials in Confined Environment*
29. P.Selvam, Winter School on 'Orientation Programme in Catalysis Research' for Research Scholars, IIT-Madras, CHENNAI (Dec. 3–21, 2007; Organized by National Centre for Catalysis Research, Department of Chemistry) – *Introduction to Solids, Basic crystallography, Structure of elements and compounds, X-ray diffraction and Introduction to surfaces, Surface analytical techniques* .
30. P.Selvam, DEPARTMENT OF PHYSICS, ANNA UNIVERSITY, CHENNAI.(JANUARY 22-23, 2007). § *NANOMATERIALS IN NANOPOROUS MOLECULAR SIEVES AND STRUCTURE OF SOLID STATE MATERIALS*, DEPARTMENT OF CHEMISTRY, UNIVERSITY OF MALAYA, KUALA LUMPUR, MALAYSIA (JULY 9, 2007). *NANOMATERIALS IN CONFINED ENVIRONMENT*.
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## Presentations for 2008

1. B. Kuppan, B.Viswanathan and P. Selvam, "Synthesis and Characterisation of Ordered Mesoporous Carbon, *National workshop on catalysis, IMMT, Bhubaneswar, Feb 18-20 (2008)*.
2. K.Vidya, P.Selvam and B.Viswanathan, "Synthesis, Characterization and Catalytic Properties of VSBA-15, *National workshop on catalysis, IMMT, Bhubaneswar, Feb 18-20 (2008)*.
3. M.Bhaskar, A.Meenakshisundaram, B.Sairam, M.Banu and S.Sivasanker, Development of catalysts for end point reduction of straight run diesel fractions, *National workshop on catalysis, IMMT, Bhubaneswar, Feb 18-20 (2008)*.
4. B.Murugan and A.V.Ramaswamy, *National workshop on catalysis, IMMT, Bhubaneswar, Feb 18-20 (2008)*.
5. B.Viswanathan, "Appropriateness of Arrhenius equation for kinetic analysis of solid state reactions, *National workshop on Thermal analysis at IGCAR, Kalpakkam, Feb 2008*.
6. B.Viswanathan " Hydrogen production and storage for catalysis and future fuels, *Hydrocarbon conclave, II January 11, (2008) Goa.*
7. B.Viswanathan, Conceptual reflections on hydrogen generation through PEC and its storage, *235 th ACS meeting in New Orleans, USA, April 7, 2008*,
8. B.Viswanathan and M.Sankaran, Hetero-atoms as activation centres for hydrogen absorption in carbon nanotubes, *Taiwan International conference on carbon materials, MDNC 2008, May, 26, (2008)*.
9. P.S.Kishore, B.Viswanathan and T K Varadarajan, Silicotungstic Acid (STA) based carbon supported noble metal electrodes for energy conversion and storage applications, *14th International congress on Catalysis.(to be presented in July 2008)*
10. V.Venkatasubramanian and B.Viswanathan, The role of tungsten carbide as support for Pt in electrochemical reactions, *14th International congress on Catalysis.(to be presented in July 2008)*
11. P, Selvam and B, Viswanathan and B, Kuppan (2008) *NANOPOROUS CARBON SUPPORTED PLATINUM (Pt/NCCR-1) ELECTROCATALYST FOR*

- METHANOL OXIDATION*. Portuguese National Conference of Chemistry to be held at Porto during June, 11-13 (2008).
12. B. Murugan and A.V. Ramaswamy, Poster presentation: "The Nature of Manganese Species in Mn/CeO<sub>2</sub>-TiO<sub>2</sub> Solid Solutions Synthesized by Solution Combustion Route", National Workshop on Catalysis, Institute of Minerals and Materials Technology, Bhubaneswar, 18-20 February, 2008. (Best Poster Award)
  13. A. V. Ramaswamy, Plenary Lecture: "Designing Functional Ceria Materials by Nano-architecture" International Catalysis Conference 2008, Shahid Beheshti University, Tehran, 28-30 April 2008.
  14. S.Khaire and S.Sivasanker, Heteropoly acids supported on ordered mesoporous materials as catalysts for fine chemicals synthesis, National Workshop on Catalysis, Institute of Minerals and Materials Technology, Bhubaneswar, 18-20 February, 2008.
  15. S.Khaire and S.Sivasanker, Phosphotungstic acid supported on SBA-15 as catalysts for the synthesis of fine chemicals, 14<sup>th</sup> International congress on Catalysis July 13-18, 2008 Seoul (to be presented)

#### BOOKS 2007

1. B.Viswanathan S.Sundaram, R.Venkataraman, K.Rajendran, P.S.Raghavan, Electrochemistry, S.Viswanathan Publishers, Chennai (2007).
2. D.K.Chakrabarty and B.Viswanathan, Heterogeneous catalysis, New Age International (September) (2007).
3. B.Viswanathan, Nano materials, The Narosa publishing House in press (2007).
4. B.Viswanathan, and Aulice Scibioh, Fuel cells Principles and applications, CRC Press August 2007
5. B.Viswanathan, Frontiers in Chemistry, National Centre for Catalysis Research, IITM (ebook at the NCCR web site) (2007).
6. B.Viswanathan, (Editor) Catalysis some selected topics (Submitted to Narosa Publishing house and in consideration) (2008).
7. B.Viswanathan, (Editor) Surface Characterization techniques (Submitted to Narosa Publishing house and in consideration) (2008).
8. B.Viswanathan, (Editor) Nano materials (book with Narosa Publishing House and in Preparation.) (2008).

#### PATENTS-2007

1. B.Viswanathan, J.Rajewari and T.K. Varadarajan, supercapacitors based on tungsten trioxide nanorods, (being filed, 2007)
2. B.Viswanathan, S.Kishore and T.K.Varadarajan, Supercapacitors based on Ru-Polyoxometalate systems (being filed, 2007)

## PATENTS-2008

1. R P Viswanath and B.Viswanathan, Process and an apparatus for the removal of dissolved solids from water( Filed)

## PART G

### The Catalysis Society Activities

The centre's contribution to the national body namely the Catalysis Society of India is outlined in this section.

- 1..The Catalysis society of India brings out a quarterly bulletin. For the year 2007 this bulletin had four issues with a total of 166 pages and the bulletin was also available in the electronic form.
2. In addition, the catalysis Society conducted its National symposium in IIP Dehradun and the selected papers of this symposium is being published in Catalysis Today. B. Viswanathan is one of the editors for this special issue.
3. In February, 2008, the catalysis society conducted a workshop in IMMT, Bhubaneswar and the faculty of the NCCR conducted a special tutorial on TPX methods and the details are as follows:

#### NATIONAL CENTRE FOR CATALYSIS RESEARCH

#### PROGRAMME FOR THE TUTORIAL ON TEMPERATURE PROGRAMMED METHODS

15 & 16 Feb 2008 IMMT at Bhubaneswar

15 th Feb 2008

9.30 -10.00 am Introduction 9.30-9.40 am Course introduction

9.40-10.00 am Address by Prof AVR and Dr K M Parida Convener of the Tutorial

10.00 to 10.4am Introduction to thermal methods –BV

10.45-11.15 am Tea Break

11.15-12.00 noon Thermal methods some quantitative aspects TGA/DTA - BV

12.00-12.45pm TP methods for catalyst characterization

12.45-2.15pm LUNCH BREAK  
2.15-3.00 p m TPD-TPR-TPO for characterization of solid acids and oxides (CVS)  
3.00-3.20 p m. Tea Break  
3.30-4.15pm Analysis of TP traces BV  
4.15-5.00pm. Quantitative aspects of TP BV  
16th Feb 2008  
9.30-10.15AM Shape index and consequences BV  
10.15-11.00AM Isothermal kinetics BV  
11.00-11.30AM Tea Break  
11.30-12.15PM Some theoretical aspects of thermal methods BV  
12.15-1.00PM TP techniques- Some case studies (CVS)  
1.00-2.15PM LUNCH  
2.15-3.15PM Exercises and tutorials BV  
3.15-3.45PM Tea Break  
3.45-4.30PM Prospects AVR  
4.30-4.45PM Conclusion and recommendations – AVR,CVV, KMP and BV

4. On behalf of the Catalysis society of India on open access Catalysis Data base has been maintained by NCCR. In this one and half years, the data base has over **1100 full length** articles uploaded. More than 50 Ph D theses have also been uploaded. This may become one of the best sources of information for the field of catalysis in India.

PART H

**General Activities**

NATIONAL CENTRE FOR CATALYSIS RESEARCH

AND

DEPARTMENT OF CHEMISTRY, IITM, CHENNAI

( POSTED ON 22ND OCTOBER 2007)

**Meeting on Nobel Prize in Chemistry to Prof. Gerhard Ertl and  
Release of book on Catalysis**

*Date: Monday, 29 October 2007 Time: 4.00 p.m.*

*Venue: CB 306*

*Programme*

- 4.00 -4.05 Welcome address by Prof. T.K. Varadarajan
- 4.05-4.10 Presidential remarks by the Dean, Academic Research
- 4.10-4.40 Prof. Gerhard Ertl and his Work  
Presentation by Prof. B. Viswanathan
- 4.40-4.45 Introducing the book on Heterogeneous Catalysis  
Prof. A.V. Ramaswamy
- 4.45-4.55 Release of the book by the Dean ( Academic Research) and remarks  
The book will be received by the HOD, Chemistry
- 4.55-5.00 Vote of Thanks by Dr. G. Ranga Rao
- 5.00 Refreshments

Similarly the annual day of the centre was conducted on July , 2007 with three presentations from the research members of the centre and a special lecture by Dr K. S. Dhathatreyan of the Centre for Fuel Cell Technology, ARCI, Chennai Unit.

There were many lectures by eminent scientists including Prof L Guzzi, DR. Zolten Paszti of the Hungarian academy of sciences and other visitors to the centre

**NATIONAL CENTRE FOR CATALYSIS RESEARCH  
INDIAN INSTITUTE OF TECHNOLOGY MADRAS  
CHENNAI 600 036**

To mark the first anniversary of the Centre, a function is being organized on Saturday, 28 July 2007 at MVC Sastri Hall of the Centre from 9.30 am to 12.00 noon.

Dr. K.S. Dhathathreyan, Head, Centre for Fuel Cell Technology, Chennai will deliver the Annual Day Lecture.

The program is as follows:

- |              |  |
|--------------|--|
| <b>09.30</b> | <b>Welcome address:</b>  |
| <b>09.40</b> | <b>One year of NCCR: Dr. A.V. Ramaswamy</b>                                |
| <b>09.55</b> | <b>Release of the book “Fuel Cells: Principles and Applications”</b>       |
| <b>10.00</b> | <b>Presentation by Research Scholars:</b>                                  |
|              | 1) “The Marvel of Carbon morphologies”<br>Mr. P. Indra Neel                |
|              | 2) “Ammonia Synthesis: A Bio-inspired dream or reality?”<br>Ms. C.M. Janet |
|              | 3) “Reactivity of Metal Clusters”<br>Dr. M. Sankaran                       |
| <b>11.00</b> | <b>Coffee Break</b>  |
| <b>11.15</b> | <b>Annual Day Lecture:</b>   |



**“Catalyst development needs for PEM Fuel Cells”  
Dr. K.S. Dhathathreyan**

**12.00           Vote of Thanks: Prof. P. Selvam**

**Annexure 1**

The first advisory committee meeting of the centre was held on 16.07.07 at 2 p.m. under the chairmanship of the director. The minutes of the meeting is reproduced Minutes of the first meeting of the Advisory Committee of NCCR

Date/time: 16th July 2007 at 2.00 p.m.

Venue: Board room of the administrative building

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**Present:** Members 1. Director Chairman

2. Dean Administration

3. Dean Academic Research

4. Prof S.Pushpavanam, Member of the committee

5. Prof Prathap Haridoss, Member of the committee

6. Prof. B.Viswanathan Convener Others:

7. Prof A V Ramaswamy NCCR

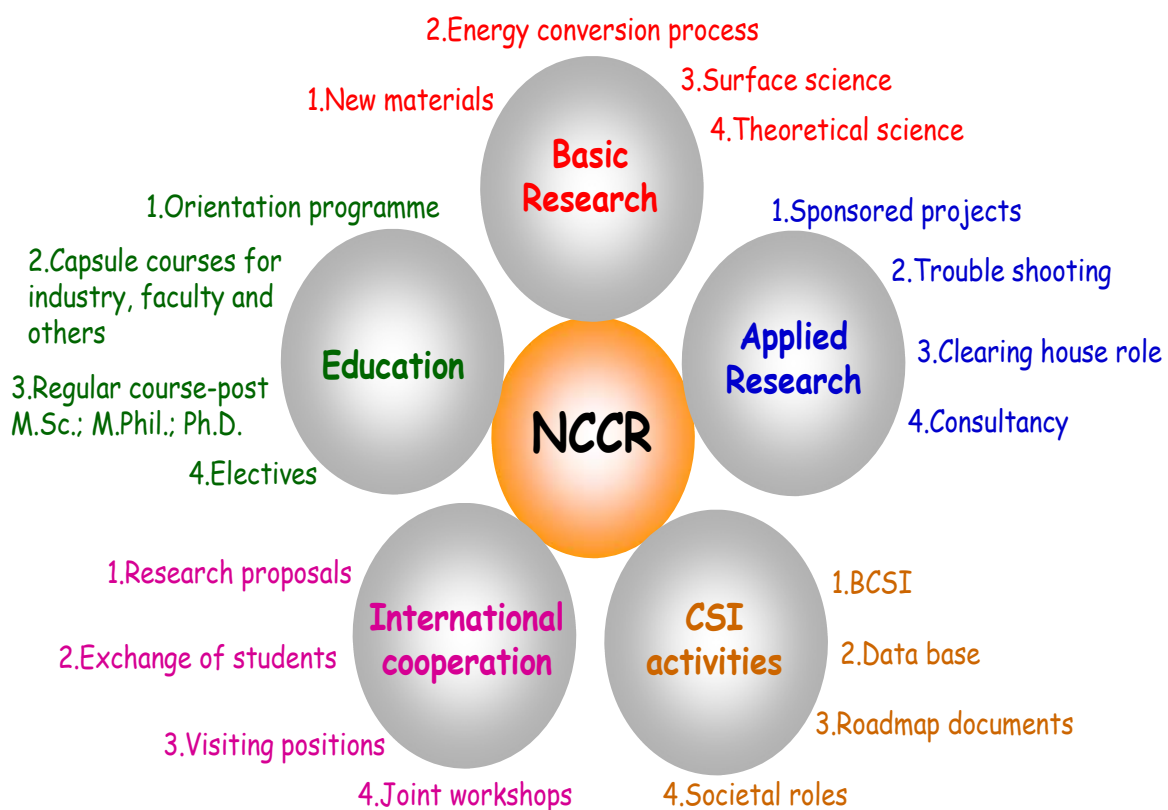
8. Prof S Sivasanker NCCR

9. Prof P Selvam NCCR

10. Prof Ramnarayanan NCCR

1. Prof. B.Viswanathan made a brief presentation of the activities of NCCR. A copy of the Power point presentation is attached to this report as annexure.
2. The Chairman wanted the recommendations of the PMC to be highlighted and the same was done.
3. The Dean administration said that the impact of the work should give rise to tangible output and work should be carried out in this direction.
4. The chairman also analyzed the five different activities of the centre and asked to look for specific areas where the societal role of the centre can be strengthened.
5. The question of the space for accommodating the various facilities was considered and the chairman asked BV to come up with a plan for utilization of the space in the present building and also identify space for reactors. He suggested that an unutilized shed in the Chem. Eng. could be used to house the reactors.
6. On the issue of the supporting staff and other sanctioned positions, the Chairman pointed out this can be done within the project mode and the filling of positions of the technical assistants has to wait till certain issues are sorted out.
7. The Dean academic research raised points on the research front and commented that soot oxidation is a good area to work in. Other members also agreed with this comment.

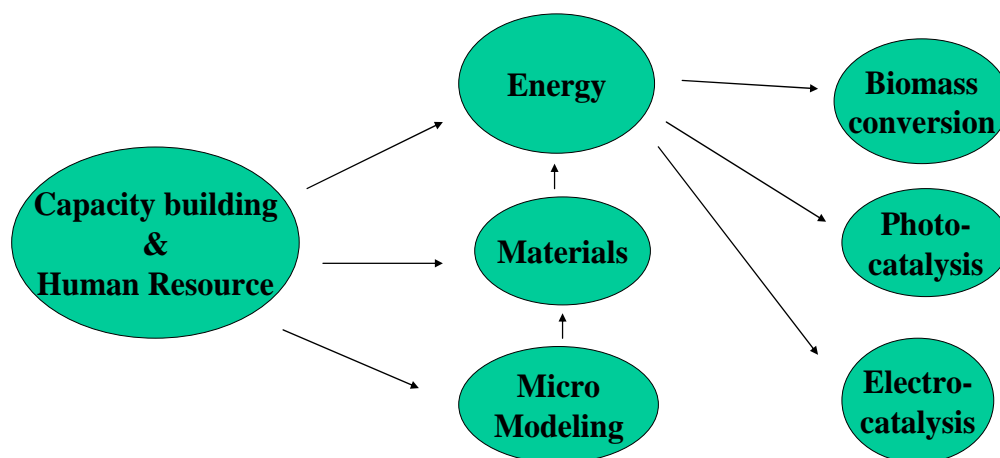
## ANNEXURE 2



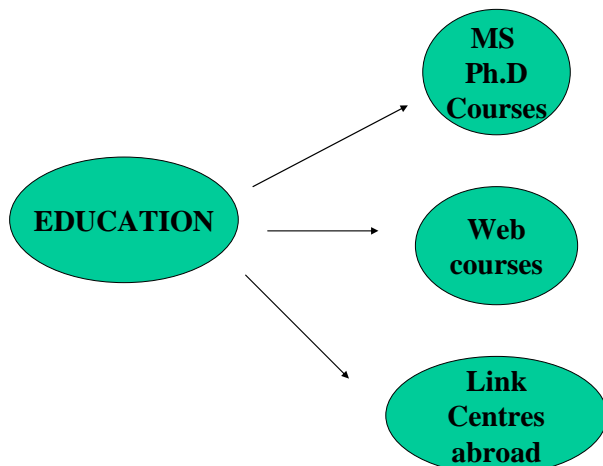
## WHAT HAVE WE ACHIEVED IN ONE YEAR?

- **Formation of the core faculty**
- **Strategy, introduce a culture for the functioning of the Centre**
- **Steps to create facilities, devoted to catalysis research**
- **Education/Human Resource Development**
  - Orientation program, other initiatives
- **Basic research**
  - Identify core areas
- **Applied research**
  - Sponsored projects (CPCL, P&G, NMITLI.....)
- **International cooperation**
  - New initiatives

## How do we look at the Future?



## How do we look at the Future?



## Future Challenges for the Centre

- **Faculty: Professors and Associates in each selected core areas of research**
- **Develop into an Institute of Excellence devoted to Fundamental Research and Education in Catalysis**
- **State of Art facilities open to any student of catalysis**
- **Foster effective links with industry: Innovate and improve chemical processes and catalysts**
- **A resource centre for the nation**
- **How will the Centre make an impact at the national and international level?**