Orientation Program in Catalysis

The genesis of orientation program in catalysis

After conducting various programs for Masters and Bachelors students in Tamil Nadu in the department of chemistry, IIT Madras or elsewhere in various local institutions, it was felt that there is a need to orient the students who wish to pursue research as their career. Secondly, catalysis is not part of our curriculum in most of the Indian Universities, and this subject being interdisciplinary, there is a need to reorient the fresh scholars to this field. The situation of fresh scholars in the field of catalysis was evaluated, and it was found that many of them found themselves fish out of water due to various reasons especially the inter-disciplinary nature of the subject in these days. It requires domain knowledge in the fields of physics, chemistry, chemical engineering, and solid-state science. Even then, the research scholars found it difficult since the techniques they have to use and interpret the results obtained from the variety of surface analytical techniques.   Keeping all these factors into account, NCCR at IITM devised a program called orientation program in catalysis for research scholars of this country in the year 1999 and conducted this program in IIT Bombay, IIT Kharagpur, Tezpur University and Cochin University before bringing it back to NCCR, at IITM. From 2006 onwards, this program was continuously held year after year, and till the 19th Program in 2018 at NCCR, IITM.

Brief on the Program

About 750 research scholars of this country attended the orientation program in the 19 years, and many of them now occupy many research positions all over the world. Few of the names for reference include Professor Ajayan Vinu (University of New Castle), Professor N R Shiju Raveendran (Van't Hoff Institute of Molecular Science, The Netherlands), Dr Nagarajan. S (Assistant Professor, Chemistry, NIT Imphal), Professor John Kennedy (Associate professor, Physics, VIT, Chennai), Dr P Sangeetha (Associate Professor, Chemistry department, VIT, Chennai) and many others (the list is endless) all over the world performing to research and development to the science and application of the field of catalysis. DST, Government of India, has many of the responses of the 750 and odd participants of this program. It is in their domain and may or might have even utilized to evaluate the program and also used the feedback for supporting this program for so many years. For this, NCCR is grateful to the Department of Science and Technology, Government of India for this gracious financial assistance.

Special Features of the Program

The main attraction is the discussion section discussion which was utilized for clarifying the doubts and questions in the minds of the participants. The participants were made to be clear what do they mean and understand by the term Research. The program instils confidence in the minds of the research scholars, and many of them could complete their PhD program successfully. Also, the participant will get an idea about the entire field of catalysis research, and they moulded in such a way that in future they can start independent research work in any field of catalysis.

Syllabus

Homogeneous catalytic systems – Special bonding schemes – both geometry and electronic – molecular activation – applications for specific catalytic reactions like hydrogenation – hydroformylation – oxidation and a few other reactions. Energetics, homogeneous active sites, activation and deactivation, selectivity, stereochemistry, orbital symmetry and reactivity of transition metal complexes.

Heterogeneous catalysis – physical and chemical adsorption – adsorption isotherms texture evaluation chemisorption bond chemisorption on metals and oxides – Catalysis- concepts - evolution model catalytic reactions for elucidation H_2-D_2 exchange, Ethylene hydrogenation – CO oxidation and hydrocarbon reactions. Review of Catalysis Setting the Scene - Some of the Advanced Concepts to be discussed: Multiplet Theory, Ensembles, Geometric Factor; Local Field Effects; Coupled Interactions; Structure Sensitivity - Structure Insensitivity; Site Structure; Molecularity; Remote Control & Auto-remote; Bi- and Multi-functionality; Amorphisity; Forward and Back Spillover; Bifurcation Theory; Bi and Multi Layers; Bond Order Conservation; Electrochemical Promotion; Kinetic Coupling; Linear Free Energy relationships; Metal Support interactions; Entropic Trapping; Pore Efficiency and Effectiveness; Sanderson Electronegativity; Self Organization; Sorbate-sorbate interactions; Structure breaking & Directing; Structure Reactivity Relationships; Templating ; Surface Saturation Model; III. Fundamentals of Adsorption; Characterizing Catalysts; Pore and Surface Structure; Solid State and Surface Chemistry; Poisoning, Promotion and Deactivation – Selectivity; Catalytic Process Engineering Examples and Case Histories Environmental and Green Chemical Concepts (some of these topics will be covered under suitable headings as well.)

Industrial catalysis. Industrially important catalytic reactions their methods of study catalyst deactivation environmental catalysis and other recent developments.

Electrocatalysis. Fundamentals concept of exchange current density electron transfer rates and electrode-electrolyte interface and some examples of electrocatalytic reactions fuel cells.

Photocatalysis. Physical basis of reactions induced by light, semiconductors and catalytic reactions like the splitting of water, oxidation of organic substrates and other related developments.

Methods of reaction studies evaluation of parameters and also the elucidation of the mechanism of reactions.

Surface analysis. Basis, development of techniques detailed study of XPS, X-ray, UPS, Auger and any other techniques – these lectures will be with actual spectra and interpretation and also deal with experimental aspects. This portion will be expanded depending on the interest of the participants and also their desire for more information on this topic.

Modern topics. Catalysis in energy conversion, (natural gas, petroleum, and other non-conventional energy sources)

Solid State Chemistry.

Special topics like catalyst manufacture, supported catalysts, zeolites mesoporous solids, acid-base catalysis.

[Note: on an average, there will be 5-6 presentations in each of the ten topics, and some will have more than six presentations]

Tentative lecture schedule for the course

1, Adsorption and catalysis – Fundamentals	15 L
2, Catalytic reactions and various solid catalysts	15 L
3. Photocatalysis	6-7 L
4. Electrocatalysis	4-5 L
5. Bio-catalysis	4-5 L

6. Preparation of catalysts	4-5 L
7. Homogeneous catalysis	5-6 L
8. Solid state chemistry	10 L
9.Spectroscopic techniques and other characterization techniques	15 L
10. Total lecture	≈80 L

Time table for the orientation program

Day	8am to 8.30am	8.30am to 10am	10.00am to 10.30am	10.30am to12pm	12.00pm to 1.30pm	1.30pm to 3pm	3pm to 3.30pm	3.30pm to 5pm	7.45pm to 10pm
Day1	Free	L1	Break	L2	Lunch	L3	Break	L4	D1
Day2	SD1	L5		L6		L7		L8	D2
Day3	SD	L9		L10		L11		L12	D3
Day4	SD	L13		L14		L15		L16	D4
Day5	SD	L17		L18		L19		L20	D5
Day6	SD	L21		L22		L23		L24	D6
Day7	SD	L25		L26		L27		L28	D7
Day8	SD	L29		L30		L31		L32	D8
Day9	SD	L33		L34		L35		L36	D9
Day 10	SD	L37		L38		L39		L40	D10
Day11	SD	L41		L42		L43		L44	D11
Day12	SD	L45		L46		L47		L48	D12
Day13	SD	L49		L50		L51		L52	D13
Day14	SD	L53		L54		L55		L56	D14
Day15	SD	L57		L58		L59		L60	D15
Day16	SD	L61		L62		L63		L64	D16
Day17	SD	L65		L66		L67		L68	D17
Day18	SD17	L69		L70		L71		L72	D18
Day19	SD	L73		L74		L75		L76	D19
Day20	SD	L77		L78		L79		L80	D20
Day21	SD20	L81		L82		V"dictory	Free	Free	Free

SD= Short Discussion, D= Discussion, L= Lecture

About 6 lectures on adsorption, 10 lectures on zeolites, petrochemicals and petroleum, 10 lectures on homogeneous catalysis, 10 lectures on solids, 8 lectures on surfaces, Special topics on meso-porous solids, photo-catalysis, electro-catalysis and bio-catalysis. Other topics as desired.

Admission letter to the orientation program 2018.

National Centre for Catalysis Research (NCCR) proposes to conduct its annual orientation program in catalysis in **November-December 2018 for about 21 days**. This year program will be 19th in this series. Research Scholars (mostly in the first two years of their research career) can submit their application before **Tuesday, the July 31st, 2018**. There will be a selection of participants depending on the number of applications received as the maximum number of participants will be restricted to around **30**.

A format of the application form is given below, and this may kindly be used for applying to this program.

Every applicant must also make sure that their mentor sends a separate email confirming his permission and even in what way the attendance of the applicant will be useful to his research career.

Format of the application:

1. Name and affiliation of the candidate (include an email address)

2. A brief write-up in about 500 words on how the candidate considers attending this program will be beneficial to his/her research career.

3. Any other information the applicant wants to provide.

Conditions:

1. Please note this is a serious learning and knowledge transfer program, and hence the candidate must be willing to put in long working hours.

2. The selected candidates should attend all the sessions of the program (One can approach any-one who has participated in this program already to get an idea of the program).

3. All correspondence will be only through email (bviswanathan@gmail.com)

4. There will be a preschool preparation program through online or offline by email. Candidates must be willing to take up these preparation sessions for about 90 days.

Please bring this circular to the attention of candidates in your organization. **Late applications will not be considered.**

Expenditures

1. Accommodation and food @ Rs. 500 X 21days X 30 participants = 3 lakhs

2. Coffee and other expenses 20,000

3. Materials for participants 20,000

4. Travelling allowance if given

5. Honorarium for lectures and travel expenses for the speakers.