

Department of History  
Remedial Class Program Register, 2018-2019

Sl. No.	Date	Topics Covered.	Sim
1.	6.7.18.	Rise of the Cholas	
2.	13.7.18	Urban developments & town life.	
3.	27.7.18	Advent of Muslims in India.	
4.	3.8.18	Mohaud's Invasion of India	
5.	10.8.18	Sources of Sultanate period	
6.	17.8.18	Causes for growth of Capitalism.	
7.	24.8.18	Agricultural Expansion.	
8.	31.8.18	Problems for transition from feudalism to capitalism.	
9.	07.09.18	Black and white policy of Balban	
10.	14.9.18	Tribes as Peasants	
11.	21.9.18	Estimation of Alauddin Khilji	
12.	05-10.18	Merits & Demerits of Colonialism.	
13.	12-10.18	Inter-Regional Trade	
14.	19-10.18	Formation of Nation States in India	
15.	26.10.18	Ambitious projects of Muhammad bin Tughluq.	
16.	2.11.18	Merchant Guilds of South India.	
17.	9.11.18	Sufism in India	
18.	23.11.18	The growth of territories in Europe in 16th C.	
19.	7.12.18	Tombism	
20.	14.12.18	Bhakti movement in India	
21.	21.12.18	Kelilingam Art.	

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Department of English  
Remedial class Progress Register (Session:)

Sr No	Date	Topic Covered
01	06.07.2018	S.T. Coleridge's Kubla Khan is analysed
02	13.07.2018	Ode on Intimations of Greatness discussed
03	27/07/2018	Thirteen Ways Looking at a Blackbird discussed
04	03/08/2018	Preface to Lyrical Ballads
05	10.08.2018	Tintern Abbey is narrated in great detail
06	17.08.2018	Desecration of a Grave is analysed
07	24/08/2018	Disillusionment of Ten O'clock analysed
08	31.08.2018	Ode on Grecian Urn
09	07.09.2018	Features of Romantic Poetry discussed
10	14.09.2018	London is analysed
11	21/09/2018	Culture and Anarchy discussed
12	5.10.18	John Keats as a poet is analysed
13	12.10.2018	John Keats's Ode on Melancholy is discussed
14	19.10.18	Victorian Poetry discussed in details.
15	26.10.2018	Decease Under the Elms
16	09.11.2018	Pride & Prejudice is discussed
17	09.11.2018	Shelley's To a Sky-lark is discussed
18	22.11.18	The Age of Revolution is analysed
19	07/12/2018	Billy Budd discussed
20	14.12.18	Classicism and Romanticism discussed
21	21.12.2018	Preface to Lyrical Ballads is analysed in detail

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Dept. of Zoology  
Remedial class Program Register - 2018-19.

Date	Topic	Sign.
06.7.18	Composition of Blood.	SW
13.7.18	Sphenodon & abbinity	SW
27.7.18	Mechanism of muscle contraction.	SW
03.8.18	Mechanism of blood coagulation	SW
10.8.18	Parental care in fishes.	SW
17.8.18	Blood groups	SW
24.8.18	Archaeopteryx.	SW
31.8.18	Thyroid gland	SW
07.9.18	Endocrine pancreas	SW
14.9.18	Structural peculiarities of proto- theria	SW
21.9.18	Flight adaptation in birds	SW
05.10.18	Poisonous glands & mechanism of biting	SW
12.10.18	Comparative anatomy of Aortic Arches, Reproductive organs	SW
19.10.18	Immunoglobulin	SW
26.10.18	Structure & properties of Lecithin	SW
02.11.18	Structure & properties of Amylase	SW
09.11.18	Structure & properties of Amylase	SW
23.11.18	Darwinism	SW
07.12.18	Natural Selection	SW
04.12.18	Lamarckism	SW
21.12.18		

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Department OF EDUCATION  
Remedial class progress Register  
Session 2018-19.

Sl.No	Date	Topic Covered
01	6.07.18	Qualitative and quantitative approach by res
02	13.07.18	Measures of Central Tendency
03	27.7.18	Describe the nature of educational research
04	3.08.18	Measures of Central Tendency
05	10.08.18	Describe the process of research in edu
06	17.08.18	Measures of dispersion
07	24.8.18	State the types of educational assessment
08	31.8.18	Measures of dispersion
09	7.9.18	Describe the characteristic of a good test
10	14.9.18	Standard Deviation
11	21.9.18	Relationship of evaluation procedure with objects
12	5.10.18	Normal Probability curve
13	12.10.18	Describe the development of education in India during post-independence period
14	19.10.18	Normal Probability Curve
15	26.10.18	Features of education during medieval period
16	2.11.18	Z-score
17	9.11.18	Indian Education Commission (1884)
18	23.11.18	T-score
19	7.12.18	Major recommendations of Education Commission (1964-66)
20	14.12.18	Inferential statistics
21	21.12.18	National Policy on Education (1986)

  
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Department of Botany  
Remedial Class Progress Register  
Session 2018-19

Sl.No	Date	TOPIC COVERED	Sign
1	06.07.18	Application of Anatomy in forensics	Jm
2.	13.7.18	Vascular Cambium.	Jm
3	27.07.18	Organization of shoot apex	Jm
4.	3.8.18	Periderm.	Jm
5	10.08.18	organization of root apex	Jm
6.	17.8.18	Adaptive and Protective System.	Jm
7	28.08.18	Cytodifferentiation of tracheary elements.	Jm
8.	31.8.18	Secretory system.	Jm
9	07.09.18	structure of monocot & dicot root	Jm
10.	14.9.18	Mendelian Genetics.	Jm
11	21.09.18	crop domestication & loss of genetic diversity	Jm
12.	5.10.18	Exception to Mendelism.	Jm
13	12.10.18	Processing of sugarcane	Jm
14.	19.10.18	Extrachromosomal inheritance	Jm
15	26.10.18	Essential oils - General account & extraction method	Jm
16.	2.11.18	Linkage, Crossing over	Jm
17	09.11.18	Tobacco - morphology, processing, use	Jm
18.	23.11.18	Mutation, Polyploidy	Jm
19	07.12.18	oil yielding plants	Jm
20.	14.12.18	Fine structure of gene -	Jm
21	21.12.18	Para-rubber, tapping, processing & uses	Jm

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Department of Economy  
Remedial class Progress Register session 2018-19

L.No	Date	TOPIC covered	signature
01	06/07/18	Absolute income Hypothesis.	P. Pradha
02	13/07/18	measure of Central tendency	S. mithan
03	27/07/18	Permanent income Hypothesis.	P. Pradha
04	03/08/18	measure of dispersion	S. mithan
05	10/08/18	Residential investment and MRE	P. Pradha
06	17-08-18	Skewness and Kurtosis	S. mithan
07	24-08-18	Indifference Curve and its Properties.	P. Pradha
08	07-09/18	Karl Pearson's Correlation	S. mithan
09	07-09/18	Direct and indirect utility function.	P. Pradha
10	21-09-18	Regression and estimation	S. mithan
11	05-10-18	Income Consumption Curve and Engel Curve	P. Pradha
12	12-10-18	Properties of regression	S. mithan
13	19-10-18	The money demand function and other goods	P. Pradha
14	02/11/18	Methods of measuring time series trend	S. mithan
15	09/11/18	Money multiplier and measuring money supply	P. Pradha
16	23/11/18	index number: Ideal index number	S. mithan
17	07/12/18	IS and LM function.	P. Pradha
18	14/12/18	Addition and multiplication rule of probability	S. mithan
19	21/12/18	Hawtrey's monetary theory.	P. Pradha

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Department of Philosophy  
Remedial class progress Register Session-2

Sl-No	Date	Topic covered	MA
1	6/07/18	what is Prama & Aprama.	MA
2	13/07/18	Nature and scope of Ethics	E-J
3	27/07/18	what is concept of god	M
4	3/08/18	Aristotle's Eudaimonia	E-J
5	10/08/18	what is Nyaya Pramana	M
6	17/08/18	Philosophy of Science	E-J
7	24/08/18	what is ethics, what is scope of ethics.	*
8	31/08/18	90-Eudaimonistic routes of Eudaimonia	E-J
9	7/9/18	what is Moral-nonmoral action.	
10	14/9/18	Difference of Moral & Nonmoral	E-J
11	21/9/18	what is Hedonism, what is Utilitarianism.	
12	5/10/18	Utilitarianism	E-J
13	12/10/18	what is retributive theory	
14	19/10/18	Retribution	E-J
15	2/11/18	what is retributive theory	
16	23/11/18	Hedonism	E-J
17	7/12/18	what is prescriptive theory.	
18	14/12/18	Perfectionism	E-J
19	21/12/18	what is Utilitarianism.	*

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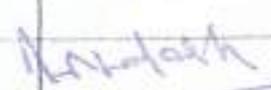
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# Department of Mathematics

## Remedial Class Progress Register Session 2018-19

Sno	Date	Portion Taught	Signature
01	06/9/18	Basic theory of linear systems	[Signature]
02	13/9/18	Sequential criterion for limits	[Signature]
03	27/9/18	Simultaneous linear $kx$ and eqns in three variables	[Signature]
04	03/10/18	continuous function, sequential criterion for continuity	[Signature]
05	10/10/18	Methods of solution of Pfaffian differential eqns	[Signature]
06	17/10/18	Types of discontinuity and uniform continuity	[Signature]
07	24/10/18	Linear and Non linear partial differential equations of $kx$ order	[Signature]
08	31/10/18	Mean value theorem and its applications	[Signature]
09	7/11/18	Special types of $kx$ and eqns	[Signature]
10	14/11/18	Applications of Rolle's, Cauchy, Lagrange MVT	[Signature]
11	21/11/18	Linear partial differential equations with constant coefficients	[Signature]
12	05/12/18	Taylor's theorem, Maclaurin's theorem	[Signature]
13	12/12/18	Partial differential eqns with variable coefficients	[Signature]
14	19/12/18	Introduction of group and properties	[Signature]
15	26/12/18	Plane equation	[Signature]
16	02/1/19	Subgroup, Centralizer, Normalizer	[Signature]
17	09/1/19	Cyclic group and its properties	[Signature]
18	23/1/19	One dimensional wave equation	[Signature]
19	07/2/19	Permutation group and Alternating group	[Signature]
20	14/2/19	Differential equation	[Signature]
21	21/2/19	External direct product, group homomorphism	[Signature]

  
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# Department of Commerce

## Remedial class Progress Register

2017-18

Sl No	Date	TOPICS Covered	Signature
1	11.8.17	Management Concept and Nature	SrDady
2	18.8.17	Time Series & Cross Sectional data	Shruti
3	25.8.17	Various Electronic Commerce business Models	Shruti
4	8.9.17	Income Under the head Salary - Theory/Practical	Mam
5	15.9.17	Evolution of Management Thought	SrDady
6	22.9.17	Positional Average Graphical determination	Shruti
7	29.9.17	Types of Electronic Payment systems	Shruti
8	05.10.17	Income from House property	Mam
9	13.10.17	Planning Function and Strategic Planning	SrDady
10	20.10.17	Pearson's Coefficient of Correlation	Shruti
11	27.10.17	Application of Ecommerce in wholesale business	Shruti
12	10.11.17	Income from capital gain	Mam
13	17.11.17	Trends and Challenges of Management	SrDady
14	01.12.17	Regression Equations	Shruti
15	08.12.17	Security issues over the Internet	Shruti
16	15.12.17	Income from other sources	Shruti
17	22.12.17	Control concept and Process with Technique	Mam SrDady

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= Department of Chemistry =  
Remedial class Progress Register

SINO.	Date =	Topics covered	
1.	11.08.17	Therm. Content. Degree of Freedom.	6
2	18.08.17	Amino acids: Classification, Prop <sup>n</sup> .	6
3	08.09.17	Chemical & Physical Properties	
4	15.09.17	Phase Rule and Dehydration	
5	22.09.17	Proteins: Prop <sup>n</sup> , Properties, Synthesis	6
6	29.09.17	2 Phase, One Component System	6
7	05.10.17	Enzymes: Types, Co. enzymes.	6
8	12.10.17	Water System.	6
9	20.10.17	Lipids: Classification, Types, Solubility	6
10	27.10.17	Sulphur System.	6
11	10.11.17	Pharmaceuticals: Types, Prop <sup>n</sup> uses	6
12	17.11.17	Critical Sol Temp. LCST, UCST.	6
13	01.12.17	Antibiotics, Analgesics, Antimicrobials	6
14	08.12.17	Dyes: Types: Prop <sup>n</sup> & Dispersing Agents	6
15	15.12.17	Triphenyl methane dyes, azo dyes.	6
16	22.12.17	Congruent melting point Graph	6

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10/11/2017  
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# Department of Physics - 2017-18

## Remedial class Progress Registered

Sl. no	Date	Topic Covered	Signature
01	11.08.17	Fourier series	Bot
02	18.08.17	Carnot's Theorem, 2nd Law of thermodynamics	Per
03	25.08.17	Legendre's diff. eqn	Bot
04	15.09.17	Legendre's polynomial	Bot
05	22.09.17	Maxwell's Equations	Per
06	29.09.17	orthogonality of Legendre's polynomial	Bot
07	05.10.17	Stochastic process probability.	Per
08	13.10.17	Hermite's diff. eqn	Bot
09	20.10.17	Maxwell's Distribution of velocities	Per
10	27.10.17	Hermite's polynomial	Bot
11	10.11.17	Ordinary Motion	Per
12	17.11.17	orthogonality of Hermite's polynomial	Bot
13	08.12.17	Transport phenomena	Per
14	15.12.17	Gamma function	Bot
15	22.12.17	Phenomenon Brown's, Play Expt.	Per
16	08.09.17	Concept of Entropy	Per
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Department of Sociology. 2017-  
Remedial class Progress Register.

Sl. No.	Date	Topics Covered.	S
1.	11.8.17	Law of Three Stages - Comte	1
2.	18.8.17	Difference between Progress and Development	1
3.	25.8.17	Theory of suicide Durkheim	1
4.	8.9.17	Feature of Social Evolution -	1
5.	15.9.17	Technological factor of Soc. Change	1
6.	22.9.17	Classifying Political Apathy	1
7.	24.9.17	Westernization.	1
8.	5.10.17	Distinguish between Authority & Legitimacy	1
9.	13.10.17	Modernization.	1
10.	20.10.17	Rural-urban Continuum	1
11.	27.10.17	Tribal system.	1
12.	10.11.17	what is political socialization	1
13.	17.11.17	Community Dev. Programme	1
14.	1.12.17	what is Anomie -	1
15.	8.12.17	C. D. P.	1
16.	15.12.17	what is Alienation -	1
17.	22.12.17	Types of (Kishki)	1

*Anil Dash*

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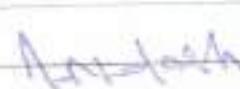


# Department of History

Session 2017-2018

## Remedial Class Progress Register

Sl.	Date	Topics Covered	Sign
1	11.8.17	work on development & to be led during the period	[Signature]
2	18.8.2017	Historical Geography	[Signature]
3	25.8.2017	Blood and iron policy of Balban	[Signature]
4	8.9.17	Rise of Rajputs	[Signature]
5	15.9.17	Arab Invasion of Sindh	[Signature]
6	22.9.17	The life of the Afrikan Sultan	[Signature]
7	29.9.17	Market regulation of Alauddin Khilji	[Signature]
8	5.10.17	Landlords and Peasants	[Signature]
9	13.10.17	Development of Art & Architecture during Renaissance	[Signature]
10	20.10.17	Emergence of Bahaman Kingdom	[Signature]
11	27.10.17	Process of Urbanisation	[Signature]
12	10.11.17	Art and Architecture of Vijaynagar	[Signature]
13	17.11.17	Sufism in India	[Signature]
14	1.12.17	Dravidian Civilization	[Signature]
15	8.12.17	The Growth of Religious Reformation movement	[Signature]
16	15.12.17	Bhakti movement	[Signature]
17	22.12.17	CAW & Economic growth during the late period	[Signature]

  
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# Department of English

## Remedial class progress register (Session-2017-18)

Sl. No	Date	Topics Covered	Sign
01	11.08.2017	British literature of 19thc. discussed	Scd
02	18.08.2017	English literature in 19th-century narrated	Scd
03	25.08.2017	Victorian age narrated	Scd
04	08.09.2017	Preface to Lyrical Ballads, explained	Scd
05	15.09.2017	Poetry of Victorian Age 2's analysed	Scd
06	22.09.2017	Development of Novel in 19th-century discussed	Scd
07	29.09.2017	Modern age discussed	Scd
08	05.10.2017	Psychoanalytical theory in relation to <i>Poems</i> Unelated class	Scd
09	13.10.2017	How industrialisation influenced literature is discussed	Scd
10	20.10.2017	9th Memoriam as a grotesque discussed	Scd
11	27.10.2017	American Literature discussed	Scd
12	10.11.2017	Foreshadowings of British Fiction discussed	Scd
13	17.11.2017	Mathew Arnold's <i>Culture &amp; Anarchy</i> discussed	Scd
14	01.12.2017	<i>Ulysses</i> as 9th Memoriam analysed	Scd
15	08.12.2017	<i>Hard Times</i> discussed	Scd
16	15.12.2017	<i>Ode on Greece</i> line explained	Scd
17	22.12.2017	Tennyson as the representative poet analysed	Scd

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Dept. of Zoology  
Remedial class progress Register (2017-18)

Sl. No.	Date	Topics covered	Remarks
1	11.8.17	Muscular Tissue	PS
2	18.8.17	Mechanism of muscle contraction	SW
3	25.8.17	Nervous tissue	PS
4	08.9.17	Action potential	SW
5	15.9.17	Nervous conduction	PS
6	22.9.17	Synaptic transmission	PS
7	29.9.17	Mechanism of Hormone Action	SW
8	05.10.17	Pituitary gland & hormones	PS
9	13.10.17	Adrenal gland (st & function)	SW
10	20.10.17	Migration in Birds	SW
11	27.10.17	Mechanism of hormone action	PS
12	10.11.17	Parental care in Amphibia	SW
13	17.11.17	Migration in fishes	PS
14	01.12.17	parental care in Fishes	SW
15	08.12.17	Respiratory organs in fishes	PS
16	15.12.17	Structural peculiarities of Agnatha	SW
17	22.12.17	Dipnoi	PS

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Department of Odia  
Remedial class progress Register see  
2017-18

Sl. No	Date	Topics covered	Signature
1	11.8.17	ଉତ୍ପାଦନ ଓ ସାଧନ ସାହିତ୍ୟର ଉତ୍ପତ୍ତି	...
2	18.8.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
3	25.8.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
4	8.9.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	L.P
5	15.9.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
6	22.9.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
7	29.9.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
8	5.10.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	L.1
9	13.10.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
10	20.10.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
11	27.10.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
12	10.11.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	L.1
13	17.11.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
14	1.12.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
15	8.12.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
16	15.12.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	...
17	22.12.17	ଉତ୍ପାଦନ ଉପରେ ଉପଲବ୍ଧ ସାହିତ୍ୟର ସମୀକ୍ଷା	L.

Principal  
Tattamundai College

Inspector



Department of Botany  
Remedial class progress Register  
Session-2017-18

TOPICS COVERED

Sl. NO	Date	TOPICS COVERED	sig
1	11-08-17	organization of shoot apex	
2.	18-8-17	Vascular Cambium	
3	25-08-17	organization of Root apex	
4.	8-9-17	Periderm	
5	15-09-17	Application of Anatomy in Forensics	
6.	22-9-17	Adaptive, Protective and Secretory	
7	29-09-17	Cytodifferentiation of tracheary elements	
8.	5-10-17	Mendelian Genetics.	
9	13-10-17	structure of monocot & dicot leaf	
10	20-10-17	Extrachromosomal inheritance	
11	27-10-17	Crop domestication & loss of genetic diversity	
12.	10-11-17	Linkage, Crossing over.	
13	17-11-17	Processing of sugarcane	
14.	1-12-17	Variation in chromosome number	
15	8-12-17	Essential oils - general accounts extraction method	
16.	15-12-17	Fine structure of gene	
17	22-12-17	para-rubber, tapping, processing & uses	

*Arundhathi*

Principal  
Pattamundai College

*[Signature]*

16/6/21  
IQAC Co-ordinator  
Pattamundai College



A NATIONAL WEBINAR



**ON  
A MAPPING THE INNOVATION ECO-  
SYSTEM FOR ATMANIRBHAR  
BHARAT**

**17<sup>TH</sup> SEPTEMBER 2020**



**INTERNAL QUALITY ASSURANCE CELL  
PATTAMUNDAI COLLEGE  
PATTAMUNDAI**

## REPORT

A National Level Webinar was organised by Internal Quality Assurance Cell, Pattamundai College, Pattamundai on the topic "**MAPPING THE INNOVATION ECOSYSTEM FOR ATMANIRBHAR BHARAT**" at 10.30 am on 17.09.2020 through online platform : ZOOM CLOUD APP and YOU TUBE LIVE. The resource person of this webinar was Prof. Dr. Subhas Prasad Rathor, Professor and Head, Department of Environment and Legal Order, University School of Law, Gujarat University, Ahmedabad.

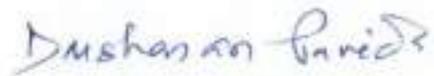
Prof Adhikari Laxmi Narayan Dash, Principal of the college delivered the inaugural speech and welcomed the esteem resource person, all the staff and IQAC members of this institution and all the participants associated to this webinar. Dr Dushasan Parida, Convenor, IQAC coordinator, Pattamundai College introduced the resource person, Principal and Prof Duryodhan Parida, senior IQAC member present before the participants in the webinar. Prof. (Dr) Subhas Prasad Rathor, delivered the talk on "**MAPPING THE INNOVATION ECOSYSTEM FOR ATMANIRBHAR BHARAT**". He elaborated about importances of different innovative processes for being self reliant towards Atmanirbhar Bharat with complete database information of India with the other developed and developing countries all around the world. He welcomed the government steps regarding this matter and encouraged all the learned delegates and students linked to the webinar to be streamlined their mind to become self reliant.

Mr Jitendra Malik, IQAC member of this college co-ordinated the question answer session of the talk.

More than 500 professors, associate professors, assistant professors, research scholars, students, from different universities and colleges of India and abroad were actively participated as well as interacted with the resource persons.

The webinar was successfully conducted by technical support Mr Subhasis Mishra, assistant professor in Economics and Mr Jitendra Kumar Malik assistant professor in commerce.

Lastly Dr Sunil Kumar Pradhan, co-convenor of the webinar extended vote of thanks to the resource persons, all participants, faculty members and staff of the college.



**Dr Dushasan Parida,**

Convenor & IQAC Co-ordinator



**Subhas Rathor** Jul 5, 2020, 9:29 PM (13 hours ago)

to me

Dear Sir,

With reference to your mail dated 3rd July, 2020, it gives me pleasure to accept your invitation to be a resource person for your webinar on **Atmanirbhar Bharat**. I have decided to speak on **"MAPPING THE INNOVATION ECOSYSTEM FOR A ATMANIRBHAR BHARAT"**.

Hope this title will be appropriate for the webinar.

As desired I am attaching herewith my photograph and a brief CV.

Thank you.

Prof. Dr. S.P. Rathor  
Professor and Head,  
Department of Environment and Legal Order,  
University School of Law,  
Gujarat University,  
Ahmedabad,  
(M): +91 94285 03211

2 Attachments

## Brief CV

Joined School of Law Gujarat University in the year 1996.

Become Professor in the year 2012.

Presently heading the PG Department of Environment and Legal Order.

Area of specialized interest: Intellectual Property Rights, Environmental Laws and International Law.

Published more than 25 research papers.

Guided successfully 11 Ph.D scholars and 8 more are working mostly in the area of IPR and Environmental Law.

Presented papers in more than 50 National and International Conferences as Resource Person.

Delivered Keynote address in National and International Conference.



# PATTAMUNDAI COLLEGE

PATTAMUNDAI, KENDRAPARA, ODISHA, INDIA



## INTERNAL QUALITY ASSURANCE CELL (IQAC)

Organises

A NATIONAL LEVEL WEBINAR

on

## MAPPING THE INNOVATION ECOSYSTEM FOR ATMANIRBHAR BHARAT

Date: 17 September 2020, Time: 10.30 AM

Platform: Zoom Meeting App and YouTube Live



### Resource Person

Dr. S.P. Rathor  
Professor and Head,  
Department of Environment and Legal Order,  
University School of Law,  
Gujarat University, Ahmedabad.



Prof. A.L.N Dash  
Principal  
Pattamundai College



Mr. Subhasis Mishra  
Moderator



Dr. Sunil K. Pradhan  
Co- Convenor



Dr. Dushasan Parida  
Convenor, IQAC Co-ordinator

Registration Link: <https://forms.gle/2rAhPnQyrTsYaTob8>

Telegram Group Link: <https://telegram.me/iqacpmcollege>

**No Registration Fee**

**E-Certificates to all participants**

Website: [www.pattamundaicollege.ac.in](http://www.pattamundaicollege.ac.in)

Mail ID: [pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com) / [iqacpmi@gmail.com](mailto:iqacpmi@gmail.com)

## MAPPING THE INNOVATION ECOSYSTEM FOR ATMANIRBHAR BHARAT

PROF. DR. S.P. RATHOR  
PROFESSOR & HEAD

DEPARTMENT OF ENVIRONMENT AND LEGAL ORDER

SCHOOL OF LAW

GUJARAT UNIVERSITY

AHMEDABAD

## 10 BEST-RANKED INNOVATIVE COUNTRIES

1	Switzerland (1)
2	Sweden (2)
3	United States of America (3)
4	United Kingdom (4)
5	Netherlands (5)
6	Denmark (6)
7	Finland (7)
8	Singapore (8)
9	Germany (9)
10	Republic of Korea (10)

Source : Global Innovation Index, 2020

• Innovation is the process by which ideas are generated and commercialized

• Today's globalize landscape, innovation is often associate with progress.

• To innovate is a survival instinct compulsory to stay relevant.

• Innovation = Invention + Exploitation

## GLOBAL INNOVATION INDEX INDIA RANKING

Year	Ranking
2020	48
2019	52
2018	57
2017	60
2016	66

Source : Global Innovation Index Report 2020

# INNOVATION CULTURE IN INDIA

## APPLICATIONS FILED BY INDIAN APPLICANTS (STATE-WISE)



Source : Annual Report 2017-18, Intellectual Property India

## TOP 5 INDIAN APPLICANTS FOR PATENTS IN THE FIELD OF INFORMATION TECHNOLOGY

Sl. No.	Name of Companies	Applications filed
1	WIPRO LIMITED	125
2	TATA CONSULTANCY SERVICES LIMITED	90
3	HIKE LIMITED	66
4	DR. KANAPATHY GOPALAKRISHNAN	36
5	HCL TECHNOLOGIES LIMITED	32
5	SJM UNIVERSITY	32

Source : Annual Report 2017-18, Intellectual Property India

## TRENDS IN PATENT APPLICATIONS

Year	2013-14	2014-15	2015-16	2016-17	2017-18
Filed	42,951	42,763	46,904	45,444	47,854
Examined	18,615	22,631	16,851	28,967	60,330
Granted	4,227	5,978	6,326	9,847	13,045

Source : Annual Report 2017-18, Intellectual Property India

### TOP 10 INDIAN APPLICANTS FOR PATENTS FROM SCIENTIFIC AND RESEARCH & DEVELOPMENT ORGANIZATIONS

Sl. No.	Name of Scientific and Research & Development Organizations.	Applications filed
1	COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH	176
2	DEFENCE RESEARCH & DEVELOPMENT ORGANISATION	126
3	G.H.R. LABS AND RESEARCH CENTRE	57
4	INDIAN COUNCIL OF AGRICULTURAL RESEARCH	37
5	LAT TECHNOLOGY SERVICES LIMITED	19
6	COGNIGANT TECHNOLOGY SOLUTIONS INDIA PVT. LTD.	16
7	INDIAN SPACE RESEARCH ORGANISATION	14
7	MERIL LIFE SCIENCES PVT LTD	14
8	ALLINOV RESEARCH & DEVELOPMENT PRIVATE LIMITED	13
8	S.N. BOSE NATIONAL CENTRE FOR BASIC SCIENCES	13
9	IDEAPORGE TECHNOLOGY PVT. LTD.	10
10	GSP CROP SCIENCE PVT. LTD.	9

Source : Annual Report 2017-18, Intellectual Property

### TOP 10 FOREIGN RESIDENT APPLICANTS

Sl. No.	Name of Organisation	Number of Applications
1	QUALCOMM INCORPORATED	960
2	KONINKLIJKE PHILIPS N.V.	520
3	PHILIPS LIGHTING HOLDING B.V.	217
4	GOOGLE LLC	184
5	MIYUBISHI ELECTRIC CORPORATION	176
6	GENERAL ELECTRIC COMPANY	142
7	DAIMLER AG	134
8	TELEFONAKTIEBOLAGET LM ERICSSON (PUBL)	128
8	ABB SCHWEIZ AG	128
9	HUAWEI TECHNOLOGIES CO., LTD.	120
10	HONDA MOTOR CO., LTD.	110

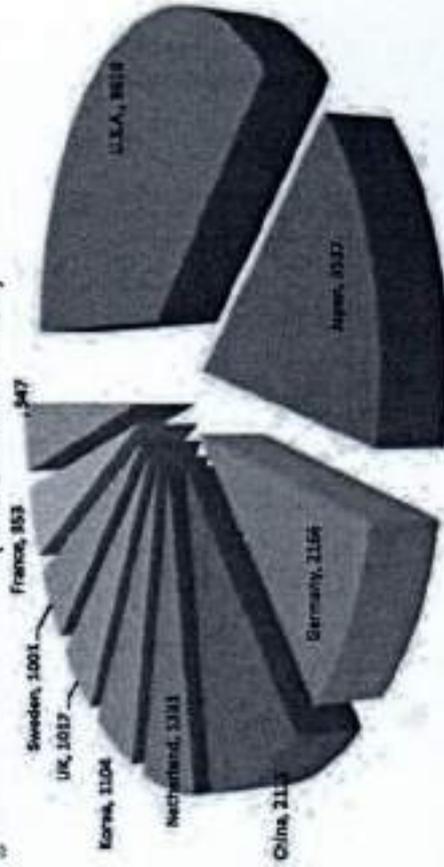
Source : Annual Report 2017-18, Intellectual Property India

### TOP 10 INDIAN APPLICANTS FOR PATENTS FROM INSTITUTES AND UNIVERSITIES

Sl. No.	Name of Institutes/Universities	Applications filed
1	INDIAN INSTITUTE OF TECHNOLOGY (COLLECTIVELY)	540
2	AMITY UNIVERSITY	119
3	SAVEREETHA DENTAL COLLEGE AND HOSPITALS, SAVEREETHA UNIVERSITY	118
4	SRM UNIVERSITY	81
5	BHARATH UNIVERSITY	66
6	SHOOLINI UNIVERSITY	62
7	CHANDIGARH GROUP OF COLLEGES	58
7	INDIAN INSTITUTE OF SCIENCE	58
8	G.H. RAISONI COLLEGE OF ENGINEERING	56
8	G.H.R. LABS AND RESEARCH CENTRE	56
9	SAMDIP INSTITUTE OF ENGINEERING AND MANAGEMENT	46
10	KCG COLLEGE OF TECHNOLOGY	40

Source : Annual Report 2017-18, Intellectual Property India

### TOP TEN APPLICANTS FOR PCT NATIONAL PHASE (COUNTRY-WISE)



Source : Annual Report 2017-18, Intellectual Property India

## PCT INTERNATIONAL APPLICATIONS FILED BY INDIAN APPLICANTS

Year	Individual	Legal Entity	Total
2013-2014	248	568	816
2014-2015	235	566	801
2015-2016	234	459	693
2016-2017	272	472	744
2017-2018	274	490	764

Source: Annual Report 2017-18, Intellectual Property India

ONLY 1/5TH OF OVER 25,000 APPLICATIONS FILED BY INDIAN INSTITUTES FROM 2009-19 GRANTED PATENTS

- TOTAL PATENTS FILED BY INDIAN UNIVERSITIES/INSTITUTES DURING 2009-2019: 25,200
- TOTAL PATENTS GRANTED WERE 5,089 OUT OF 25,200
  - CSIR GRANTED 1,917 OUT OF 2,413
  - IIT'S GRANTED 519 OUT OF 3,751
  - DRDO GRANTED 519 OUT OF 998
  - NIT'S GRANTED 11 OUT OF 2,016

## Patents in Force

2013-14	42632
2014-15	43256
2015-16	44524
2016-17	48765
2017-18	56764

Source: Annual Report 2017-18, Intellectual Property India

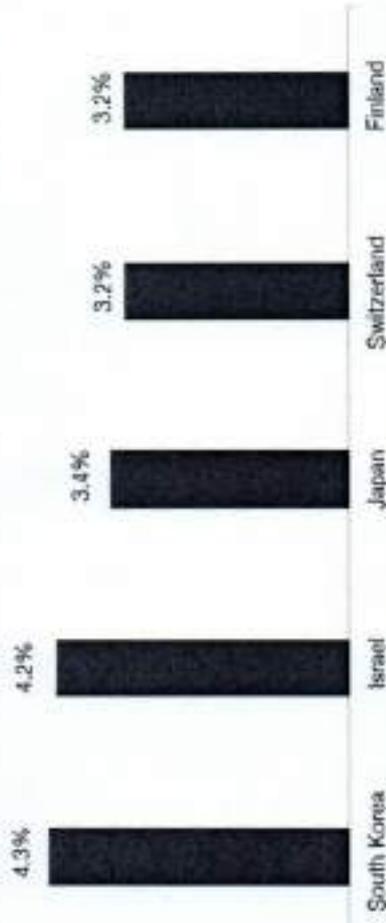
## R&D EXPENDITURE GLOBALLY

### TOP FIVE COUNTRIES IN GLOBAL R&D SPEND

Rank	Country	R&D Spending in Billion PPP \$
#1	United States	543.2
#2	China	496.0
#3	Japan	175.8
#4	Germany	127.1
#5	South Korea	89.8

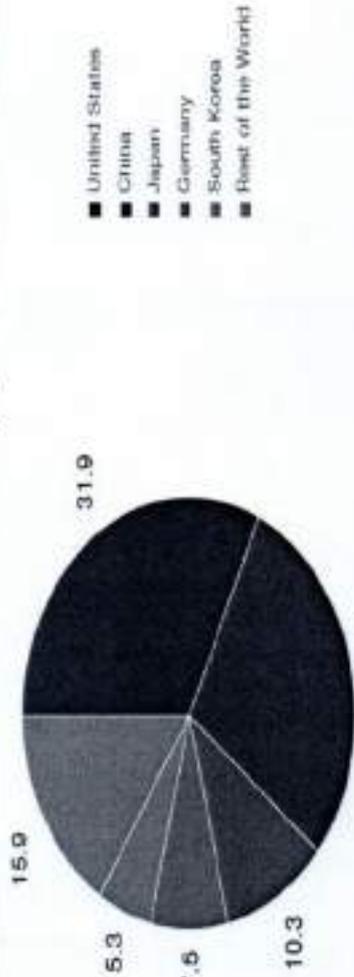
Source: R&D Expenditure Ecosystem 2019 by EAC-PM

### TOP 5 COUNTRIES R&D (AS A % OF GDP)



Source: R&D Expenditure Ecosystem 2019 by EAC-PM

### TOP 5 COUNTRIES GLOBAL SHARE OF R&D SPENDING (%)

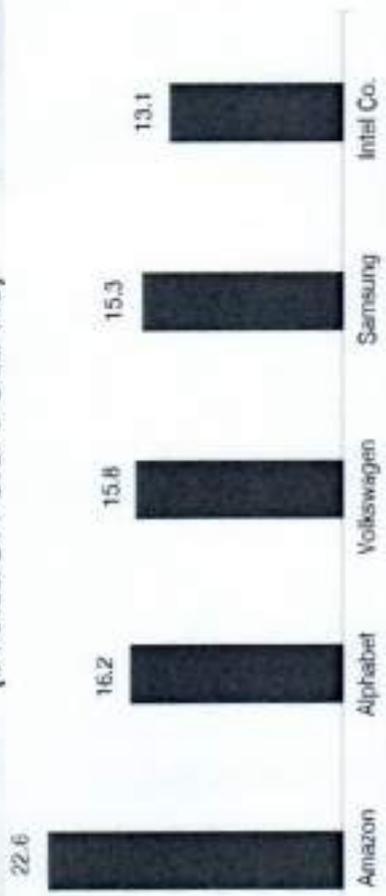


Source: R&D Expenditure Ecosystem 2019 by EAC-PM

### PUBLIC EXPENDITURE IN R&D

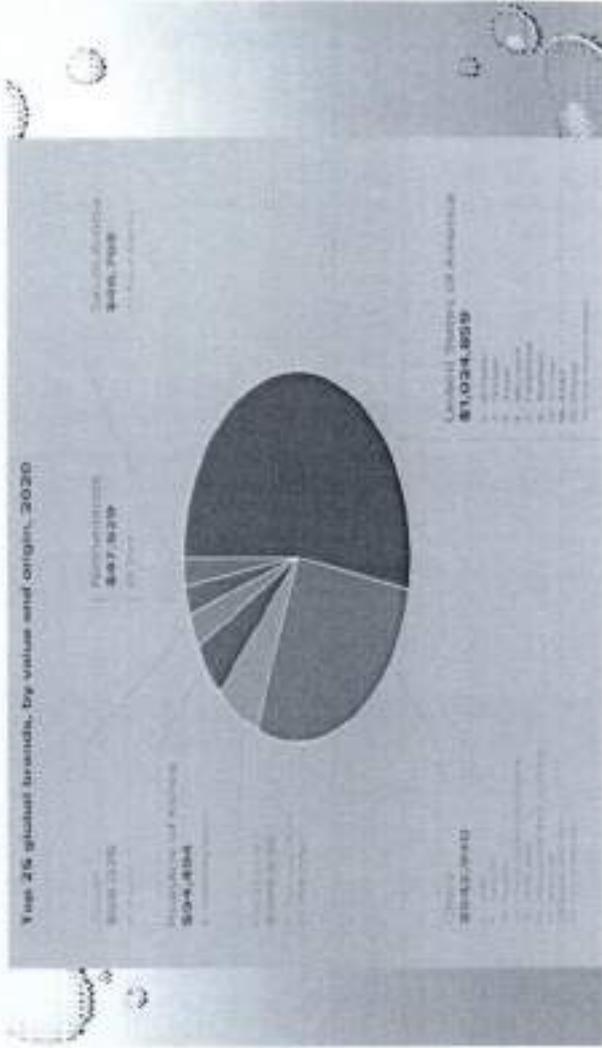
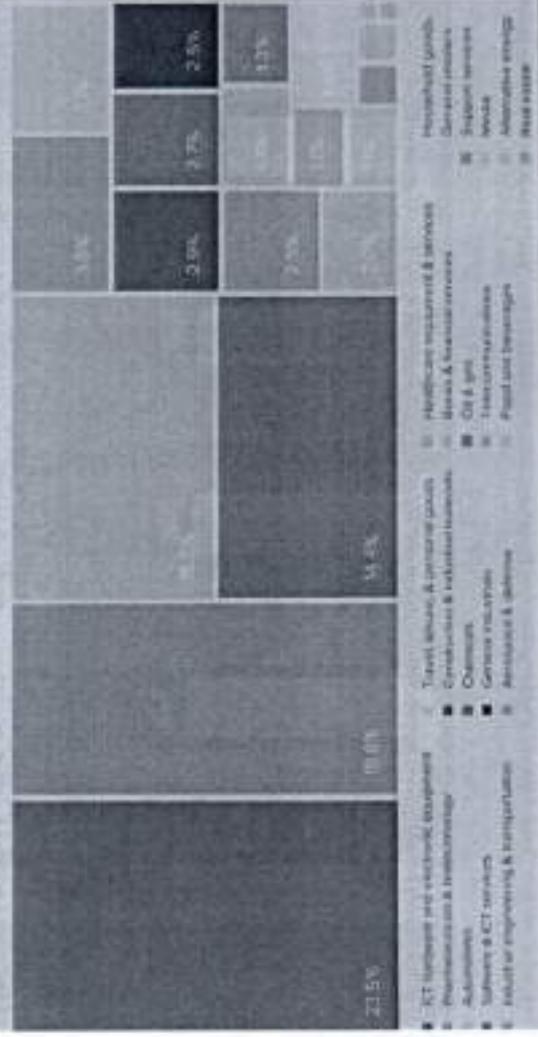
- INDIA'S INVESTMENT IN R&D HAS DECREASED OVER THE LAST DECADE FROM 0.85% OF GDP IN 2008-2009 TO REMAIN STAGNANT AT AROUND 0.7% FOR THE LAST SEVERAL YEARS.
- THIS IS SIGNIFICANTLY LOWER THAN THE TOP FIVE R&D SPENDERS GLOBALLY IN 2017
  - 4.3% FOR THE REPUBLIC OF KOREA,
  - 4.2% FOR ISRAEL,
  - 3.3% FOR JAPAN, AND
  - 3.2% FOR BOTH SWITZERLAND AND FINLAND—AND LOWER THAN THE R&D INVESTMENTS OF OTHER BRIC COUNTRIES, WHICH INCLUDE BRAZIL, RUSSIA, INDIA, AND CHINA

## TOP FIVE COMPANIES WITH MAXIMUM R&D SPEND (IN BILLION U.S. DOLLARS)



Source: R&D Expenditure Ecosystem 2019 by EAC-PA

## Top R&D-spending sectors as share of global top R&D spenders, 2018-2019



- TWELVE MAJOR SCIENTIFIC AGENCIES ACCOUNTED FOR 99.8% OF THE R&D EXPENDITURE INCURRED BY THE CENTRAL GOVERNMENT IN 2017-18.
- OF THIS, 61.4% WAS SPENT ON R&D IN DEFENSE, ATOMIC ENERGY, AND SPACE, WHILE THE REMAINDER WAS ALLOCATED AS FOLLOWS:
  - 11.1% TO THE INDIAN COUNCIL OF AGRICULTURAL RESEARCH (ICAR),
  - 9.5% TO THE COUNCIL OF SCIENCE & INDUSTRIAL RESEARCH (CSIR),
  - 7.3% TO THE DEPARTMENT OF SCIENCE & TECHNOLOGY (DST),
  - 3.7% TO THE DEPARTMENT OF BIOTECHNOLOGY (DBT),
  - 3.1% TO THE INDIAN COUNCIL OF MEDICAL RESEARCH (ICMR), AND
  - 3.7% TO THE MINISTRY OF EARTH SCIENCES, MINISTRY OF ELECTRONICS AND INFORMATION TECHNOLOGY, MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE, AND MINISTRY OF NEW & RENEWABLE ENERGY.



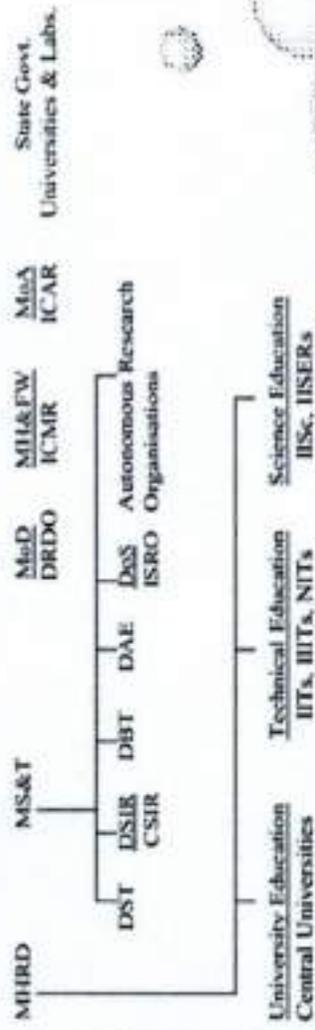
## INDIA'S SCIENCE, TECHNOLOGY AND INNOVATION SYSTEM

- THE OVERALL STRUCTURE OF THE RESEARCH SYSTEM OF THE COUNTRY IS CONSTITUTED BY FOUR MAIN ACTORS;
- PUBLIC RESEARCH SYSTEM UNDER GOVERNMENT AND PUBLIC ENTERPRISES;
- ACADEMIC RESEARCH SYSTEM AND UNIVERSITIES;
- PRIVATE RESEARCH LABORATORIES UNDER BUSINESS ENTERPRISES;
- NON-GOVERNMENTAL RESEARCH INSTITUTIONS AIDED BY BOTH PUBLIC AND PRIVATE SOURCES.

## SCIENCE AND TECHNOLOGY SYSTEM IN INDIA

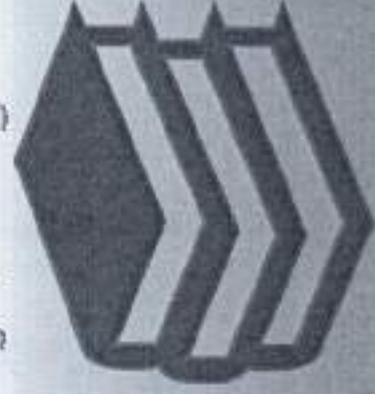
- CENTRAL GOVERNMENT S&T DEPARTMENT
- INDEPENDENT RESEARCH INSTITUTE
- IN-HOUSE R&D IN PRIVATE INDUSTRY
- S&T IN NON-GOVERNMENT ORGANIZATIONS (NGOS)
- STATE GOVERNMENT S&T DEPARTMENT
- CENTRAL SOCIO-ECONOMIC & OTHER MINISTRIES

### Science in Indian Academia



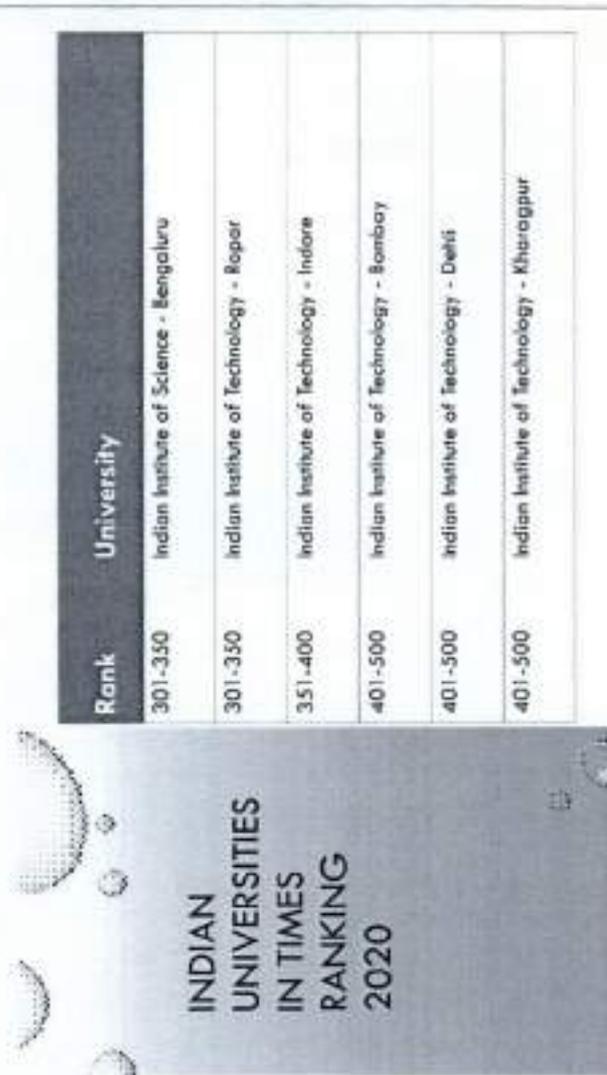
### NETWORK OF PUBLIC FUNDED SCIENCE RESEARCH IN INDIA

## TIMES HIGHER EDUCATION WORLD UNIVERSITY RANKINGS - 2020





Rank	Institution	Country
1	University of Oxford	United Kingdom
2	California Institute of Technology	United States
3	University of Cambridge	United Kingdom
4	Stanford University	United States
5	Massachusetts Institute of Technology	United States
6	Princeton University	United States
7	Harvard University	United States
8	Yale University	United States
9	University of Chicago	United States
10	Imperial College London	United Kingdom
11	University of Pennsylvania	United States
12	Johns Hopkins University	United States
13	University of California, Berkeley	United States
14	ETH Zurich	Switzerland
15	UCL	United Kingdom



Rank	University
301-350	Indian Institute of Science - Bengaluru
301-350	Indian Institute of Technology - Ropar
351-400	Indian Institute of Technology - Indore
401-500	Indian Institute of Technology - Bombay
401-500	Indian Institute of Technology - Delhi
401-500	Indian Institute of Technology - Kharagpur



Rank	University	Country
16	Columbia University	United States
17	University of California, Los Angeles	United States
18	University of Toronto	Canada
19	Cornell University	United States
20	Duke University	United States
21	University of Michigan - Ann Arbor	United States
22	Northwestern University	United States
23	Tsinghua University	China
24	Peking University	China
25	National University of Singapore	Singapore



**• PATENT RULES 2003 HAVE BEEN AMENDED WITH EFFECT FROM 16TH MAY, 2016 TO SIMPLIFY PATENT PROCEDURES AND COMPLETE IT ENABLEMENT IN FUNCTIONING.**

**THE FOLLOWING IMPROVEMENTS HAVE BEEN BROUGHT ABOUT IN THE FUNCTIONING OF PATENT OFFICE BY PATENTS (AMENDMENT) RULES, 2016:**

- STREAMLINING TIMELINES FOR DISPOSAL OF PATENT APPLICATIONS.
- CREATION OF STARTUP AS A NEW CATEGORY OF APPLICANT AND FACILITATING STARTUP APPLICATIONS WITH 80% FEE CONCESSION.
- EXPEDITED EXAMINATION OF PATENT APPLICATIONS FILED BY STARTUPS AND THE APPLICANTS SELECTING INDIAN PATENT OFFICE AS ISA/PEA FOR THEIR PCT APPLICATIONS.
- WITHDRAWAL OF APPLICATION BEFORE THE ISSUANCE OF THE FIRST EXAMINATION REPORT, IF APPLICANT IS NOT INTERESTED IN PURSUING EXAMINATION OF HIS APPLICATION FILED FOR PATENT AND REFUND OF FEES PAID FOR REQUEST FOR EXAMINATION ALLOWED.

Auto-allocation of Requests for examination of patent applications.



In continuation to the important initiative,



Unique Numbering System for Patent Applications and Requests for Examination", started from 1st January, 2016, the Office has introduced electronic module-based system of "Auto-allocation of Requests for examination" from 1st April, 2016.



**PROCEDURAL IMPROVEMENTS**

- HEARING THROUGH VIDEO-CONFERENCING OR AUDIO-VISUAL COMMUNICATION DEVICES IS ALLOWED ON REQUEST MADE BY APPLICANT AT ALL PATENT OFFICE LOCATIONS.
- ADJOURNMENTS OF HEARING IN OPPOSITION PROCEEDINGS HAS BEEN RESTRICTED TO MAXIMUM TWO BY EACH PARTY, WHICH WILL HELP TO DISPOSE OF THE MATTERS IN TIME. IT IS ALSO PROVIDED THAT EACH ADJOURNMENTS SHALL NOT BE MORE THAN 30 DAYS.
- MANDATORY ONLINE FILING BY PATENT AGENTS IN ORDER TO SPEED UP DIGITIZATION AND PROCESSING OF PATENT APPLICATIONS.
- PCT APPLICANT CAN NOW DELETE SOME CLAIMS WHILE ENTERING THE NATIONAL PHASE ENTRY IN INDIA.
- FEES FOR SEQUENCE LISTINGS HAS BEEN REDUCED WITH THE MAXIMUM FEE PUT AT INR 1,20,000.

**E-COMMUNICATION:**

- FIRST EXAMINATION REPORTS ARE SENT THROUGH E-MAIL FROM 1ST APRIL 2016.
- THUS, PAPER MODE OF COMMUNICATION FOR EXAMINATION REPORTS DISCONTINUED AND E-COMMUNICATION WITH THE STAKEHOLDERS IMPLEMENTED.
- HEARING NOTICES ARE ALSO SENT THROUGH E-MAIL. THIS HELPS IN SPEEDING UP THE PROCEDURES.

## AUTOMATION OF PATENT GRANT CERTIFICATES:

- THE PROCESS RELATING TO GENERATION AND ISSUANCE OF PATENT GRANT CERTIFICATES HAS BEEN FULLY AUTOMATED.
- CERTIFICATES ARE GENERATED AND TRANSMITTED TO THE APPLICANT ON THE REGISTERED EMAIL AND MADE AVAILABLE ON THE OFFICIAL WEBSITE.
- SAME CAN BE DOWNLOADED AND PRINTED AS DESIRED BY THE APPLICANT.

- ELECTRONIC PAYMENT GATEWAY FOR PCT APPLICATION FEES HAS BEEN INTRODUCED FROM 1<sup>ST</sup> APRIL 2016 TO AVOID DELAY IN TRANSMISSION OF FEES FOR PCT APPLICATIONS TO INTERNATIONAL BUREAU AND INTERNATIONAL SEARCHING AUTHORITY.

## PATENT SEARCH SYSTEM:

- A LOGIN-FREE ONLINE PUBLIC SEARCH FACILITIES FOR PATENTS, "INDIAN PATENT ADVANCED SEARCH SYSTEM (INPASS)", HAVING FULL TEXT SEARCH CAPABILITY, ALREADY IN PRACTICE HAVE BEEN UPDATED DURING THE YEAR TO FURTHER STREAMLINE THE SEARCH SYSTEM.

## DYNAMIC UTILITIES:

- MANY DYNAMIC UTILITIES ON PATENT ARE AVAILABLE IN THE IPO WEBSITE FOR THE BENEFIT OF PUBLIC LIKE DISPLAYING THE STATUS ON DISPOSAL OF PATENT APPLICATIONS BY THE RESPECTIVE EXAMINATION GROUPS DURING THE SPECIFIED PERIOD, VIEWING "FIRST EXAMINATION REPORT (FER)" ISSUED (JURISDICTION AND GROUP-WISE) AT ALL LOCATIONS OF PATENT OFFICE ETC.



THANK  
YOU



## NATIONAL LEVEL WEBINAR ON "MAPPING THE INNOVATION ECOSYSTEM FOR ATMANIRBHAR BHARAT"

Organised By: Internal Quality Assurance Cell (IQAC), Pattamundai College, Pattamundai, Kendrapara, Odisha

Date: 17.09.2020

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mousumiparida55@gmail.com	MOUSUMI PARIDA	Saipur autonomous college	Student	Jaipur	6371233131
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cps_pali@rediffmail.com	DR GAJENDRA TIWARI PRINCIPAL	CHHATTISGARH PUBLIC H	PRINCIPAL	PALI	9424150282
adhikarysankarprasadd6@gmail.com	DR. SANKAR PRASAD ADHIKARY	Aska Science College, Asks.	Associate Prof	Aska Science College, Aska	9437545982
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puvrendu.rantu@gmail.com	PURNENDU DEY	KOWGACHI F.P. SCHOOL	ASST TEACHE	NORTH 24 PGS	9038944189
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nksingh_1572@gmail.com	MR. VINEET ARORA	Ex. B. M. A. S. ENGINEERIN	Associate Profe	Ex. B. M. A. S. ENGINEERIN	8126362369

INTERNAL QUALITY ASSURANCE CELL (IQAC)

PATTAMUNDAI COLLEGE

PATTAMUNDAI, ODISHA

Affiliated to Utkal University, Bhubaneswar

*Certificate of Participation*

This is to certify that Mr./Ms./Mrs. <<full name>>, <<Designation>> of <<college name>> has actively participated in the National Level Webinar on "MAPPING THE INNOVATION ECOSYSTEM FOR ATMANIRBHAR BHARAT"  
Organized by Internal Quality Assurance Cell (IQAC), Pattamundai College, Pattamundai, Kendrapara, Odisha on 17th September 2020.

  
Dr. D. Parida  
Convenor

  
Prof. S.P. Rathor  
Resource Person

  
Prof. A.L.N Dash  
Principal

Command

Dr. D. P. Singh

Secretary, Council

Prof. S. K. Mishra

Principal

Prof. V. L. N. Dasg

**Committee of Organization**

Internal Quality Assurance Cell (IQAC)  
BATHINDA COLLEGE

INTERNAL QUALITY ASSURANCE CELL (IQAC)











A NATIONAL WEBINAR



**ON**  
**ADVANCES IN CHEMICAL SCIENCES**  
**AND THEIR APPLICATIONS**  
**16<sup>TH</sup> SEPTEMBER 2020**



**DEPARTMENT OF CHEMISTRY,**  
**PATTAMUNDAI COLLEGE,**  
**PATTAMUNDAI**

## REPORT

A National Level Webinar was organised by Department of Chemistry in association with Internal Quality Assurance Cell, Pattamundai College, Pattamundai on the topic ADVANCE CHEMICAL SCIENCES AND THEIR APPLICATIONS at 10.30 am on 16.09.2020 through online platform : ZOOM CLOUD APP and YOU TUBE LIVE. The resource persons of this webinar were Prof ( Dr) A. Sakthivel, FRSC, Prof and Head, School of Physical Sciences, Central University, Kerala and Prof(Dr) Prodeep Phukan, Prof, Department of Chemistry , Gauhati University, Assam. Prof Adhikari Laxmi Narayan Dash, Principal of the college delivered the inaugural speech and welcomed the esteem resource persons to the webinar. Dr Dushasan Parida, Conveor, HOD Chemistry & IQAC coordinator introduced both the resource persons of the webinar with their brief CV. In the first session Dr. A. Sakthivel delivered a talk on **Recent progress in heterogeneous catalysis & their significance on several chemical transformations**. In his talk he elaborated some of his research findings in the use of inorganic materials in petrochemical processes, microporous, mesoporous materials, molecular sieve materials, meso-micro-composite materials which are known as potential catalysts for various petrochemical processes and their properties. He pointed out that Introduction of functionality inside the channel of molecular sieve materials broaden their scope as support for heterogenization.

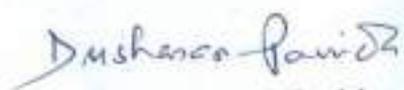
In the second session, Dr Prodeep Phukan delivered a talk on the topic **Surface Functionalized Magnetic Nanoparticles for Catalytic Applications**. He emphasized the use of polymer supported nano particles in different simple chemical reactions. He also elaborated the detail discussion on nano particles of iron chromate which was synthesized in his laboratory and their applications as catalyst in different chemical reactions during the presentation. Mr Ranjan

Kumar Gahan, faculty member, chemistry of this college co-ordinated the question answer session for both the talks.

More than 500 professors, associate professors, assistant professors, research scholars, students, from different universities and colleges of India and abroad were actively participated as well as interacted with the resource persons.

The webinar was successfully conducted by technical support Mr Subhasis Mishra, assistant professor in Economics and Mr Jitendra Kumar Malik assistant professor in commerce.

Lastly Dr Sunil Kumar Pradhan, co convenor of the webinar extended vote of thanks to the resource persons , all participants ,faculty members and staff of the college.

  
Dr Dushasan Parida,

Convenor, HOD Chemistry



OFFICE OF THE PRINCIPAL

Mobile : 9437376724

# PATTAMUNDAI COLLEGE

NAAC ACCREDITED B+ GRADE

PATTAMUNDAI, KENDRAPARA, ODISHA - 754215

Ref No. : 779

Date: 27.08.2020

To

**Dr A. SAKTHIVEL**  
Professor and head, department of chemistry  
Central University of Kerala,  
Karnataka.

**Sub- Invitation as Resource Person in National Level Webinar in Chemistry at Pattamundai College, Pattamundai.**

Sir,

It is my pleasure to invite you as a resource of person in national level webinar which is going to be organized by department of chemistry, Pattamundai College, Pattamundai, odisha tentatively in the 2<sup>nd</sup> week of September 2020.

Your kind consent in this regard is highly solicited.

*A. Sakthivel*  
Principal 27.08.20

**Pattamundai College**

Principal  
Pattamundai College



OFFICE OF THE PRINCIPAL

Mobile : 9437376724

# PATTAMUNDAI COLLEGE

NAAC ACCREDITED B+ GRADE

PATTAMUNDAI, KENDRAPARA, ODISHA - 754215

Ref No. : 780

Date: 27-05-2020

To

Dr Prodeep Phukan  
Professor in Chemistry,  
Gauhati University, Assam.

Sub- Invitation as Resource Person in National Level Webinar in  
Chemistry at Pattamundai College, Pattamundai.

Sir,

It is my pleasure to invite you as a resource of person in national level  
webinar which is going to be organized by department of chemistry,  
Pattamundai College, Pattamundai, odisha tentatively in the 2<sup>nd</sup> week of  
September 2020.

Your kind consent in this regard is highly solicited.

*Principal*  
Principal

Pattamundai College

Principal  
Pattamundai College

[www.pattamundaicollege.ac.in](http://www.pattamundaicollege.ac.in),

E-mail : [pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com), [pattamundaicollege@yahoo.com](mailto:pattamundaicollege@yahoo.com)

## RE-SCHEDULE OF NATIONAL LEVEL WEBINAR ON "ADVANCE CHEMICAL SCIENCES AND THEIR APPLICATIONS"

Inbox

Dear Sir/ Madam

Due to unavoidable circumstances, the National level Webinar on "Advance Chemical Sciences and their Applications" is rescheduled at 10.30 AM on dated 16.09.2020. The meeting link will be sent one day before the webinar. Kindly bear with us.

**With Regards**

Dr.D. Parida

**IQAC**

**Pattamundai College**

## **Fwd: Invitation as resource Person in National level webinar**

Inbox x



**Principal Pattamundai College** 10:14 AM (58 minutes ago)

to me

**Principal  
Pattamundai College**  
[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)

----- Forwarded message -----

**From: Dr. A. Sakthivel Chemistry Faculty** <[sakthivelcuk@cukerala.ac.in](mailto:sakthivelcuk@cukerala.ac.in)>  
**Date:** Thu, Aug 27, 2020 at 2:19 PM  
**Subject:** Re: Invitation as resource Person in National level webinar  
**To:** Principal Pattamundai College <[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)>

Dear Dr. Dushasan Parida,

Greetings! Thanks for your invitation. I am happy to accept your invitation and I can present the talk on

"Recent progress in heterogeneous catalysts & their significance on several chemical transformations"

Here I also attached my resume & photo for your reference.

With regards

**Prof. (Dr.) A. Sakthivel, FRSC**  
Professor & Head  
Department of Chemistry, School of Physical Sciences  
Room No. 116, Sabarmati Building  
Central University of Kerala  
email: [sakthivelcuk@cukerala.ac.in](mailto:sakthivelcuk@cukerala.ac.in) / [sakthiveldu@gmail.com](mailto:sakthiveldu@gmail.com)  
Phone : 7907682580  
URL: <http://cukerala.irins.org/profile/102436>

On Thu, Aug 27, 2020 at 1:03 PM Principal Pattamundai College  
<[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)> wrote:

Respected Sir, I send herewith the invitation letter for your kind perusal. kindly send a photograph, topic of webinar and CV in detail as soon as possible for the invitation as well as advertisement. We will discuss the date of webinar over the phone. with kind regards

**Principal**  
**Pattamundai College**  
[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)

**Dr. Dushasan Parida**  
**Assoc. Prof. of Chemistry**

2 Attachments

Noted.



Thank you for the mail.

Received the mail.

## Fwd: invitation letter as resource person for national webinar

Inbox x



Principal Pattamundai College 10:14 AM (1 hour ago)

to me

Principal  
Pattamundai College  
[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)

----- Forwarded message -----

From: **Prodeep Phukan** <[pphukan@gauhati.ac.in](mailto:pphukan@gauhati.ac.in)>

Date: Thu, Aug 27, 2020 at 3:18 PM

Subject: Re: invitation letter as resource person for national webinar

To: Principal Pattamundai College <[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)>

Dear Mr. Laxminarayan Dash and Dr. Parida  
Please find attached herewith a brief biodata and photo.  
The topic of my webinar is

### **Surface functionalized magnetic nanoparticles for catalytic applications**

best regards,  
PPhukan

---

Prodeep Phukan, Ph.D.  
Professor, Department of Chemistry  
Gauhati University, Guwahati-781014, Assam, India  
Tel +91-361-2570535(O)  
Email: [pphukan@gauhati.ac.in](mailto:pphukan@gauhati.ac.in); [pphukan@yahoo.com](mailto:pphukan@yahoo.com)

On Thu, 27 Aug 2020 at 13:09, Principal Pattamundai College  
<[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)> wrote:

Respected Sir, I send herewith the invitation letter for your kind perusal. kindly send a photograph, topic of webinar and CV in detail as soon as possible for the invitation as well as advertisement. We will discuss the date of webinar over the phone. with kind regards

Principal  
Pattamundai College

**Dr. Dushasan Parida**  
Assoc. Prof. of Chemistry

[pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com)

The sender of this mail is an authorised user of email services of Gauhati University.

2 Attachments

Received, thank you.

 Noted.

Noted with thanks.

## Curriculum vitae of Prof. (Dr.) A. SAKTHIVEL

**Name and Designation:** Prof. (Dr.) A. Sakthivel, *M.Sc. Ph.D., FRSC*  
**Professor & Head, Department of Chemistry**  
School of Physical Sciences  
Central University of Kerala  
Kasaragod District, 671316, Kerala  
**Mobile:** 8527103259 / 7907682580,  
**E-mail:** sakthiveldu@gmail.com / sakthivelcuk@cukerala.ac.in  
**URL:** [http://cukerala.ac.in/images/chm/Chemistry/Dr.Sakthivel\\_CV.pdf](http://cukerala.ac.in/images/chm/Chemistry/Dr.Sakthivel_CV.pdf)  
<http://cukerala.irins.org/profile/102436>



### **Educational Qualification: M.Sc. Ph.D., FRSC**

Degree	Year of Passing	Main Subjects	Institute/ University	% of marks obtained	Division/ Class/ Grade	Remarks
B.Sc.	1995	Chemistry	VHNSN College, Madurai Kamaraj, Tamil Nadu	79.11	I	—
M.Sc.	1997	Chemistry	VHNSN College, Madurai Kamaraj, Tamil Nadu	73.2	I	University 4 <sup>th</sup> rank
Ph.D.	2002	Chemistry (Heterogeneous catalysis)	Indian Institute of Technology-Bombay (IIT-Bombay), Powai, Mumbai	82.1	I	12 articles from Ph.D. work
PDF	2002-2008	Postdoctoral Fellowship	PDF, Taiwan, AvH-Germany, Max-Planck-Germany, JSPS Japan	Worked in various projects relevant to heterogeneous catalysis		

### **PROFESSIONAL EXPERIENCE**

**Total Experience : 18 years**

**Professor & Head, (Since 29<sup>th</sup> January 2020 - present) Department of Chemistry, SPS, CENTRAL UNIVERSITY OF KERALA, Periyar, P.O. 671320, Kasaragod Dist. Kerala, India.**

**Associate Professor, (29<sup>th</sup> Jan. 2016- 28<sup>th</sup> January 2020) Department of Chemistry, School of Physical Sciences, CENTRAL UNIVERSITY OF KERALA, Periyar, P.O. 671320, Kasaragod Dist. Kerala, India.**

**Head (Jan. 2016-Jan. 2019), Department of Chemistry, School of Physical Sciences, CENTRAL UNIVERSITY OF KERALA, Periyar, P.O., 671320, Kasaragod Dist. Kerala, India.**

**Assistant Professor: DELHI UNIVERSITY, Department of Chemistry, Delhi, From 22<sup>nd</sup> Nov. 2010 – 28<sup>th</sup> Jan. 2016.**

**Senior Manager (R &D) : RELIANCE INDUSTRIES LIMITED (Vadodara Manufacturing Division) 3<sup>rd</sup> Jun 2008 – 30<sup>th</sup> October 2010 (Developed an industrial catalysts process in pilot scale).**

### **SPECIALIZATION AND CORE AREA OF EXPERTISE**

- *Materials Chemistry (Preparation and characterization of Novel nano-porous and nano-materials)*
- *Development of eco-friendly heterogeneous catalysts for fine & petrochemical processes*

- **Nano particles synthesis and its catalytic application for hydrogenation / hydroformylation Heterogenization of homogeneous catalysts**

### **AWARDS AND DISTINCTIONS**

- **Fellow of Royal Society of Chemistry**, Royal Society of Chemistry, **Since-2019**.
- **Mayadevei Juneja Endowment Medal Award – 2017**, India Association of Solid State Chemists and Allied Scientists (ISCAS), India
- **Dr. Sistla Kameswari Young Scientist Award – 2015**, Catalysis Society of India, **India**
- **Young Researcher Award**, in 5<sup>th</sup> AOC Green & sustainable catalysis, RSC-North India Chapter-2015.
- **Japan Society for the Promotion of Science (JSPS) Fellow**, Gifu University, JAPAN (**Sep. 2006-June 2008**).
- **Max-Planck Gesellschaft Postdoctoral Research Fellow (MPG)**, Fritz-Haber-Institut der Max-Planck Gessellschaft Berlin , Germany (**January 2006-2nd July 2006**).
- **Alexander von Humboldt Fellow (AvH)**, Technische Universität München, Germany (**Feb. 2004 – Dec. 2005**).
- **Postdoctoral Research Fellow**, IAMS, Academia Sinica, Taipei, Taiwan (**Oct. 2002 – Jan. 2004**).
- **Authored of 4 patents, 3 internal reports (at Reliance Industries Limited) and 102 research papers in peer-reviewed international journals.**
- **Received DST-Travel Grant**-to deliver Invited Talk in "International Conference on Emerging Advanced Nanomaterials (ICEAN-2018), Newcastle, Australia
- **Awarded Junior / Senior Research Fellowships**, IIT-Bombay, Mumbai, India.
- **Qualified Graduate Aptitude Test in Engineering with 79.07 % (GATE; INDIA).**
- **Secured 4th RANK in M.Sc. Department of Chemistry**, Madurai Kamaraj University (1997).

### **TOP TEN PUBLICATIONS IN LAST TEN YEARS**

S. No.	Titles	Journal with ISSN / IBBN	IF
1	Hydrogenation of Lignin-derived Phenolic Compound Eugenol over NiRu-HT-Type Materials	<b>Industrial &amp; Engineering Chemistry Research</b> ; 59 (2020) 11979-11990	3.573
2	Rhodium porphyrin molecule-based catalysts for the hydrogenation of biomass derived levulinic acid to biofuel additive $\gamma$ -valerolactone	<i>New J. Chem.</i> 44 (2020) 11064-11075	3.288
3	Oxidation of a lignin-derived-model compound: Iso-eugenol to vanillin over cerium containing MCM-22	<i>Catal. Commun.</i> 145 (2020) 106099	3.612
4	Recent Advances in the Preparation and Applications of organo-functionalized Porous Materials	<i>Chemistry An Asian J.</i> (2020) <a href="https://doi.org/10.1002/asian.202000651">https://doi.org/10.1002/asian.202000651</a>	4.056
5	Rhodium-calix [4] pyrrole and rhodium-tetraphenyl porphyrin: preparation, surface grafting and their catalytic application in nitro-benzene reduction	<i>Dalton Transactions</i> 47 (2018) 12353-12361	4.01
6	Framework of ruthenium-containing nickel hydrotalcite-type material: preparation, characterisation, and its catalytic application	<i>RSC Advances</i> , 8 (2018) 25248-25257	3.119
7	Ruthenium based macromolecules a potential catalysts for the utilization of CO <sub>2</sub> into cyclic carbonate	<i>ACS Omega</i> 4 (2019) 13454-13464.	2.584
8	Preparation of cyclic carbonate via cycloaddition of CO <sub>2</sub> on epoxide using amine-functionalized SAPO-34 as catalyst	<i>J. CO<sub>2</sub> Utilization</i> 22 (2017) 392-399	5.993
9	In-situ preparation of functionalized molecular sieve material and a methodology to remove template	<i>Scientific Reports</i> , (2016). ISSN: 2045-2322	4.576
10	Uniform mesoporous silicoaluminophosphate by vapor phase treatment: Catalytic and Kinetic study in hydro-isomerization of 1-octene	<i>J. Phys. Chem. C</i> , 118 (2014) 27961. ISSN: 1932-7447	4.189

### **Summary of Research Output**

- Published research articles **106** in international peer-reviewed journals
- **H-index of 32; Total citation of 3056**
- Book chapters written **05** ; Guest Lecture **10**
- **Book 01**
- Invited Talk **40**
- No of external projects **5** (Completed DST, CSIR, UGC) + 2 (in progress) = **7**
- No of internal projects **4** (completed) = **4**
- Number of Ph.D. students **5** (completed) + **5** (in progress)
- Number of M. Tech. students **1** (at Reliance Industries)

#### **MAJOR SPONSORED R & D PROJECT COMPLETED / HANDLED**

<b>S. No.</b>	<b>Title of the Project</b>	<b>Funding Agency</b>	<b>Status</b>
1	Synthesis of novel micro-mesoporous aluminophosphate nanostructures and their application in hydrocarbon transformation	DST	Completed 2012-2015
2	Heterogenisation of Homogeneous M(CO) <sub>x</sub> L Complexes (where M = Co, Rh, Fe, W) Catalysts: A Green Environmental Processes for Various Catalytic Applications	CSIR	Completed 2012-2015
3	Silicoaluminophosphate Materials: As Eco-friendly Catalysts Isomerization of Long Chain Hydrocarbon	UGC	Completed 2012-2015
4	Functionalized Nano-structured Silico-aluminophosphates Materials: Synthesis, Characterization and its Catalytic Applications (DST 2015-2018; completed 39,00,000)	DST	Completed 2015-2018
5	Grafting of organo-functional and metal-functional macro-molecules into the framework nano-materials: A Potential environmental friendly catalysts for organic transformations	CSIR	In progress 2018-2021
6	Nano-layered Transition Metal Based Hydrotalcite Materials: Preparation, Characterization and its Catalytic Applications on Hydrogenation of Bio-mass model compounds & CO <sub>2</sub> Utilization	SERB	In progress 2020-2022
7	Development of solid acid catalysts for isomerization and trans-alkylation processes	Reliance Industries Limited	2 Internal reports made
7	Development of heterogeneous zeolite based absorbent for the olefin removal processes	Reliance Industries Limited	Pilot scale preparation of Zeolite

#### **TECHNOLOGY DEVELOPMENT/TRANSLATION/INITIATION:**

- Novel method on preparation of MCM-22 zeolite & its commercialization
- Transalkylation catalysts formulated for aromatic enhancement
- Functionalized silicoaluminophosphate (SAPO-37) materials prepared & novel method on stabilization of materials after removal of template

### Details of Ph.D. students Supervised

Name of student(s)	Area of research	Current position
Dr. Arvind Kumar Singh	Meso-micro composite materials	Assistant Prof. (SB College, Bihar)
Dr. T. Baskaran	Silicate intercalated hydrotalcite materials	PDF-University of Western Cape
Dr. Rekha Yadav	Framework alumino-phosphate materials	Assistant Prof. (Adcoh)
Dr. Maqsood Ahmed	Functional molecular sieve materials	Scientist, IICT
Dr. Dhanjay Sharma	Inorganic layered composite materials	Guest lecture

### Details of Ph.D. students in progress

Name of student(s)	Area of research	Present status*
Ms. Anjali, K	Encapsulation of functional molecules into the framework molecular sieve	In-progress
Ms. Sreenavya, A	Nobel metal containing HT materials	In-progress
Ms. Preeti Sahu	Transition & inner-transition containing framework materials	In-progress
Ms. Neethu PP	Early transition metal containing HT materials	In-progress
Mr. Aswin	Transition metal containing HT materials	In-progress

### ORGANIZING EXPERIENCE:

- Convenor: National Science Day Celebration, Central University of Kerala, 19<sup>th</sup> Jan-28<sup>th</sup> Feb. 2019
- Convenor: Salter's Chemistry Camp, Dept. of Chemistry, CU-Kerala, 7<sup>th</sup> - 9<sup>th</sup> Sep. 2019
- Convenor: National Training Course on "Prerequisites to Recent Advances in Catalysis" 16<sup>th</sup> - 20<sup>th</sup> December 2019, Department of Chemistry, Central University of Kerala.

### Notable research achievements

- (1) Developed silico-aluminophosphate based meso-/micro composite materials & utilized for hydroisomerization of olefin
- (2) Developed method on preparation of industrial important MCM-22 zeolite & in process for commercialization for the removal of aromatics in olefin feed.
- (3) Prepared series of functional molecular sieve materials and heterogenized the homogeneous catalysts like  $\text{Co}_2(\text{CO})_8$ ,  $\text{Mo}(\text{CO})_6$ , Rhodium tetraphenyl porphyrins & explored its applications on hydrogenation &  $\text{CO}_2$  utilization
- (4) Novel Group VIII based hydrotalcite materials (viz., Ni, Co, Rh, Ru based hydrotalcite) prepared and showed its importance on conversion of biomass into valuable chemicals.

(5) Group VIII metal containing tetraphenylporphyrin, tetracarboxyphenylporphyrin (TCPP) and calix[4]pyrrole prepared and utilized for conversion of biomass to valuable chemicals.

#### **Academic Societies Memberships**

- Fellow of the Royal Society of Chemistry (FRSC 549566)
- Member, American Chemical Society (ACS Membership No. 30763223)
- Life member, Catalysis Society of India
- Life Member of Association of Chemistry Teacher (ACT) LM-1966
- Life member, Indian Association of Solid State Physicists and Chemists
- Member, International Zeolite Association (IZA)
- Life Member of Indian Society of Analytical Scientists (Delhi Chapter) LMT-2013/52

#### **Major Administrative Contribution**

- **Head, Department of Chemistry, Central University of Kerala (Jan. 2016-April 2017)**
- Chairman, Board of Studies, Department of Chemistry, Central University of Kerala (Jan. 2016-April 2017)
- Chairman, Faculty Council, Department of Chemistry, Central University of Kerala (Jan. 2016-April 2017)
- Convenor, Department Research Committee, Department of Chemistry, Central University of Kerala (Jan. 2016-April 2017)
- **Convenor, National Science Day Celebration -2019**
- Member, NAAC committee-2016-18
- Member, Foundation Day & Convocation Committee
- IQAC, Central University of Kerala, Member, 2016-till now
- **Selection Committee member, MEXT Research Scholarship 2019, JAPAN**
- Editorial Advisory Board Membership-Recent Patents on Materials Science, Bentham science (May, 2018 till now)
- Academic Council member, Central University of Kerala (Jan. 2016-April 2017)
- Deputy-coordinator for Centralized evaluation of M.Sc. & M.Tech. (2011)
- Member, M.Tech. Syllabus Committee (2011)
- Member, University space committee (2011)
- Member, M.Sc. Chemistry Admission evaluation board (2013-2014)
- Member, Department of instrumentation committee (FT-IR-2011-12; TG-DTA-2013-14; HPLC-2014-2015)
- JURY of National Level Exhibition and Project Competitions (NLEPC) (2012-2014)
- Organizer, Training Course on Prerequisites to Recent Advances in Catalysis" December 2019.

## **Dr. PRODEEP PHUKAN, FRSC**

**PROFESSOR**

Department of Chemistry, GAUHATI UNIVERSITY



### **Education**

**Ph.D:** CSIR-National Chemical Laboratory, Pune (University of Pune), 1999

**Post Doctoral Studies:** University of Tuebingen, Tuebingen, GERMANY

2002 (Jan) -2003 (March), 2007 (June-Aug), 2009 ((June-Aug) & 2010 (June-July)

**M. Sc.** Chemistry, Gauhati University, 1992

**B. Sc.** Chemistry, Dibrugarh University (Science College, Jorhat), 1989

### **Honours /Awards:**

1. **Fellow of the Royal Society of Chemistry, (FRSC), London, 2017**
2. **Alexander von Humboldt Fellowship (AvH Foundation, Germany): 2002-2003 and revisits in 2007, 2009, 2010.**
3. **Ramanna Fellowship (Only fellow from North East India); DST, India: 2007.**
4. **Bronze medal from Chemical Research Society of India (CRSI): 2013**
5. **Best Chemistry Teacher award 2013** for promotion for chemistry as subject by Tata Chemicals, Association of Chemistry Teachers, India, Confederation of Indian Industries, Royal Society of Chemistry, UK
6. **J. N. Baruah Memorial Science Award, Assam Science Society (Jorhat Branch): 2008**
7. **B. M. Das Memorial Science Award (Dr. B. M. Das Memorial Trust, Guwahati, Assam), : 2009**
8. **Syamasri Gupta Memorial Young Scientist Award (Indian Society for Surface Science and Technology): 2011**
9. **Prof. H. C. Bhuyan award, Assam Science Society: 2013**
10. **Represented the Indian delegation (as a mentor) for 46<sup>th</sup> International Chemistry Olympiad held at Hanoi, Vietnam, during 20-29 July 2014.**
11. **Represented the Indian delegation (as a mentor) for 47<sup>th</sup> International Chemistry Olympiad held at Baku, Azerbaijan, during 20-29 July 2015.**
12. **Highly cited paper (Top 10%) award for the year 2018 from RSC for the publication *Chem. Commun.* 2016, 52, 1170-1173. (2019)**
13. **Most Cited Paper 2004-2007 award (Tetrahedron Letters) Elsevier, UK: 2007**
14. **Top Cited Paper Award 2011-2012 (Journal of Molecular Catalysis) Elsevier, UK**
15. **Reviewer of several International Journals (>40)**

**Ph. D. Guidance:** Ph. D. Awarded: 28; working for Ph. D.: 6

**Scientific Projects Undertaken:** As Principal Investigator: 9; As Co-PI: 6

**No. of International Paper Published:** 134; **Number of Patents:** 3

**Citation Statistics (Google Scholar):**

**Total number of Citations:** 2815;

**h-index:** 26;

**i10 index:** 73



# PATTAMUNDAI COLLEGE

PATTAMUNDAI, KENDRAPARA, ODISHA, INDIA



## DEPARTMENT OF CHEMISTRY

Organises

### A NATIONAL LEVEL WEBINAR

on

## Advance Chemical Sciences and their Applications

in Association With

INTERNAL QUALITY ASSURANCE CELL (IQAC)

**Date: 16 September 2020, Time: 10.30 AM**

Platform: Zoom Meeting App and YouTube Live

### Resource Persons



**Dr. A. Sakthivel, FRSC**  
Professor & Head  
Department of Chemistry  
Central University of Kerala



**Dr. Prodeep Phukan**  
Professor  
Department of Chemistry  
Gauhati University, Guwahati, Assam



**Dr. Sunil K. Pradhan**  
Co-Convenor



**Dr. Dushasan Parida**  
Convenor/IQAC Co-ordinator



**Prof. A.L.N Dash**  
Principal

Registration Link: <https://forms.gle/4HAaxPAAgm1biWR96>

Telegram Group Link: <https://telegram.me/iqacpmcollege>

**No Registration Fee**

**E-Certificates to all participants**

Website: [www.pattamundaicollege.ac.in](http://www.pattamundaicollege.ac.in)

Mail ID: [pattamundaicollege@gmail.com](mailto:pattamundaicollege@gmail.com) / [iqacpmi@gmail.com](mailto:iqacpmi@gmail.com)

# Recent progress in heterogeneous catalysts & their significance on several chemical transformations

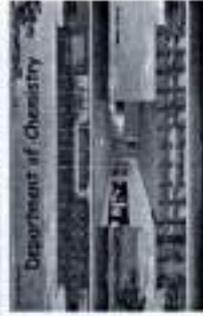
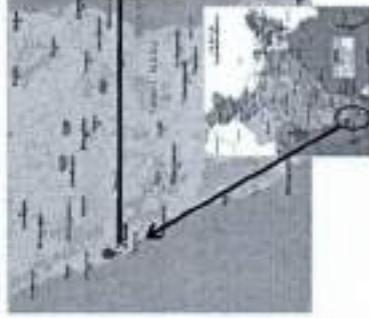


**Prof. (Dr.) A. Sakthivel** *FRSC*

Inorganic Material & Heterogeneous Catalysis Laboratory  
 Head, Department of Chemistry, School of Physical Sciences  
 Central University of Kerala, Kerala

Website on Advances Chemical Sciences & Their Applications @ FortranIndia, Delhi

CENTRAL UNIVERSITY OF KERALA



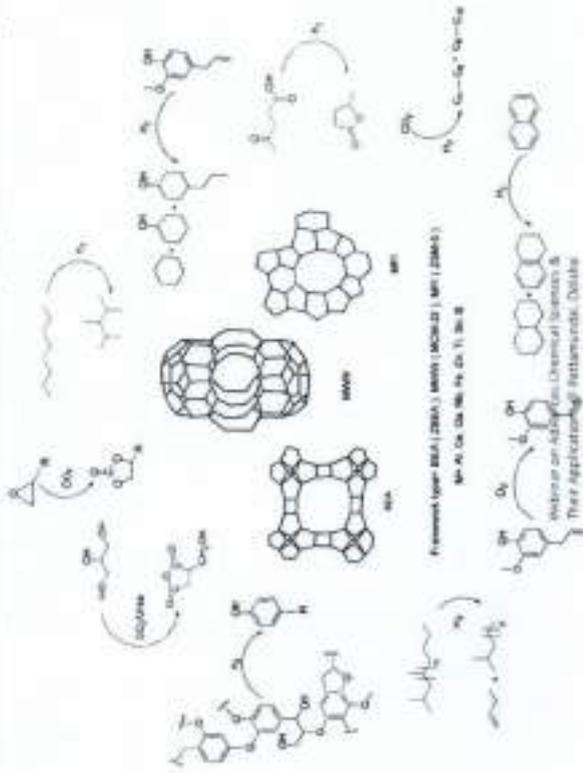
Nearest Airport, Mangalore

http://www.cukerala.ac.in/Website/Advances\_Chemical\_Sciences\_Their\_Applications\_@\_FortranIndia\_Delhi

Website on Advances Chemical Sciences & Their Applications @ FortranIndia, Delhi

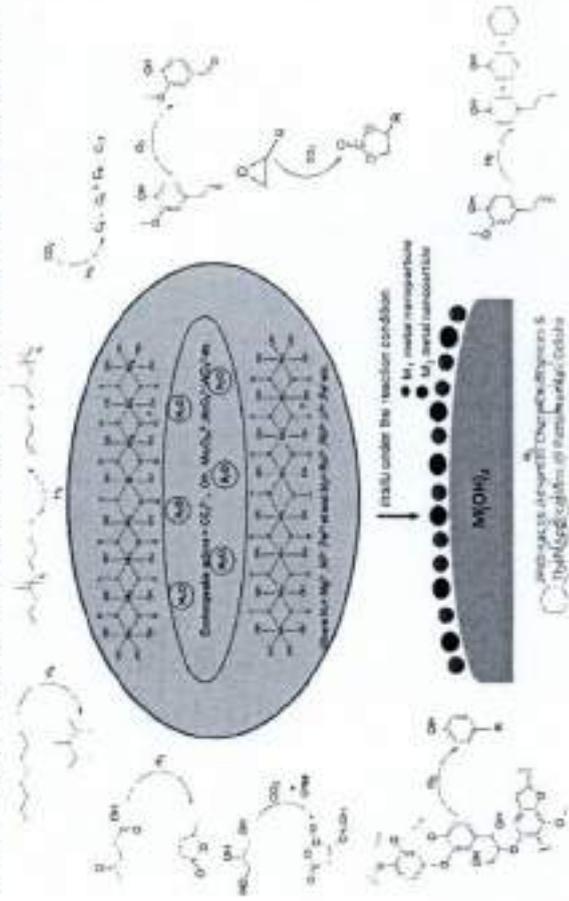
## Prof. (Dr.) Sakthivel's research group focuses

(I) Zeolite based composite for CO<sub>2</sub> utilization, Biomass hydrogenation & Plastic degradation



## Prof. (Dr.) Sakthivel's research group focuses

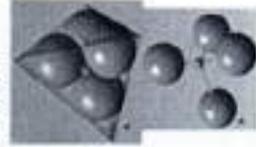
(II) Group VIII metal based HT for CO<sub>2</sub> utilization, Biomass hydrogenation & Plastic degradation



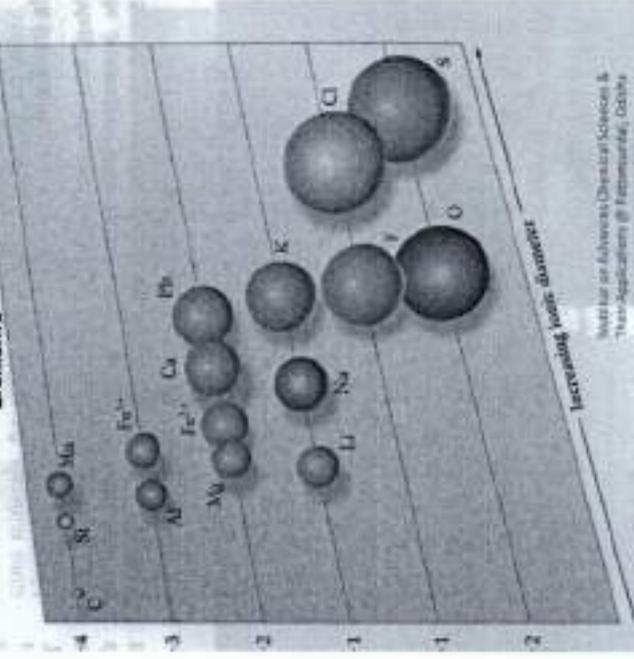
## Silicates

- Most linked polyhedra occurs in silicon chemistry, which involves the chemistry of silica
- **fundamental building unit:  $[\text{SiO}_4]^{4-}$  tetrahedron**
- Earth's crust composed of silicates and silica
- Natural silicates formed from complex of Molten Magma
- It is all Mineral rather than components
- The variety of silicate minerals is produced by the  $(\text{SiO}_4)^{4-}$  tetrahedra linking to self-similar units sharing one, two, three, or all four corner oxygens of the tetrahedron
- Isomorphous replacement is common in silicate minerals (cations of similar size is replace with silicon)
  - eg.  $\text{Al}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Mn}^{2+}$ ,  $\text{Ca}^{2+}$ , etc.

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## Sizes and Charges of the Most Common Elements



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Aluminium occupy special role in silicate chemistry

$\text{Al}^{3+}$  is similar size to  $\text{Si}^{4+}$

When  $[\text{AlO}_4]^{5-}$  replace  $[\text{SiO}_4]^{4-}$  tetrahedra extra negative charge is compensating by cation

Such as  $\text{Fe}^{3+}$ ,  $\text{Fe}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Na}^+$ ,  $\text{Mg}^{2+}$ , etc.

## Different type of silicate structures

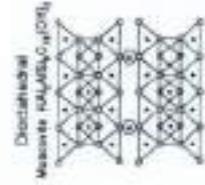
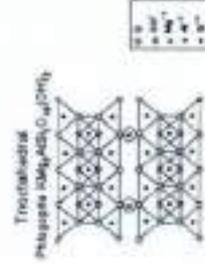
- Subdivision of silicates structures are according to number of shared vertices
- Nesosilicates or orthosilicates
  - $(\text{SiO}_4)^{4-}$ ; eg. Olivine  $(\text{Mg}, \text{Fe})_2\text{SiO}_4$ ; Garnets  $\text{R}_1\text{R}_2(\text{SiO}_4)_3$
- Sorosilicates / Pyrosilicate (one O atom shared with other  $\text{SiO}_4$ )
  - $(\text{Si}_2\text{O}_7)^{6-}$ ; Thortveitite  $(\text{Sc}, \text{Y})_2\text{Si}_2\text{O}_7$
- Cyclosilicates (Two O atom shared with other  $\text{SiO}_4$ )
  - $(\text{SiO}_3)_n^{2n-}$ ; Beryl:  $\text{Be}_3\text{Si}_6\text{O}_{18}$
- Inosilicates
  - Single chain inosilicates
    - $(\text{SiO}_3)_n^{2n-}$ ; Pyroxene;  $(\text{Mg}, \text{Fe})\text{SiO}_3$
  - Double chain inosilicates
    - $(\text{Si}_4\text{O}_{11})_n^{6n-}$ ; Tremolite;  $\text{Ca}_2(\text{Mg}, \text{Fe})_5\text{Si}_8\text{O}_{22}(\text{OH})_2$
- Phyllosilicates (Three O atom shared with other  $\text{SiO}_4$ )
  - $(\text{Si}_2\text{O}_5)_n^{2n-}$ ; Biotite;  $\text{K}(\text{Mg}, \text{Fe})_3\text{AlSi}_3\text{O}_{10}(\text{OH})_2$
- Tectosilicates (sharing of all vertices)

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## Important group of silicates

### Phyllosilicate

$(\text{SiO}_4)^{4-}$  tetrahedra (Td) connected to other  $(\text{SiO}_4)^{4-}$  units via 3 out of 4 oxygen and extend outward in infinite sheets.



Tectosilicates: eg. Zeolites  
 Infinite 3-dimensional network of  $(\text{SiO}_4)^{4-}$  or  $(\text{Si}_3\text{Al})\text{O}_8^{3-}$   $(\text{Si}_2\text{Al}_2)\text{O}_8^{2-}$  building blocks  
 All oxygen atoms are shared between two  $\text{SiO}_4^{4-}$  tetrahedron.

Examples: Quartz, Zeolites



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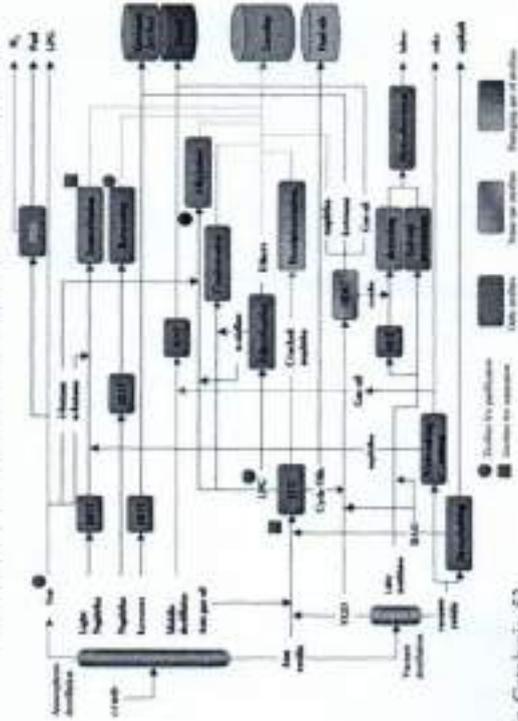
## Introduction to Molecular Sieves

- The term "Molecular Sieve" was originated by J. W. Mc. Bain to define "Porous solid materials which exhibit the property of acting as sieves on a molecular scale"
- In other words a class of materials to be a molecular sieves, it must separate mixture of components on the basis molecular size and shape.

Zeolite is a well known molecular sieves and play an important role as shape selectivity materials as catalysts and adsorbent

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## Importance of inorganic materials in petrochemical processes

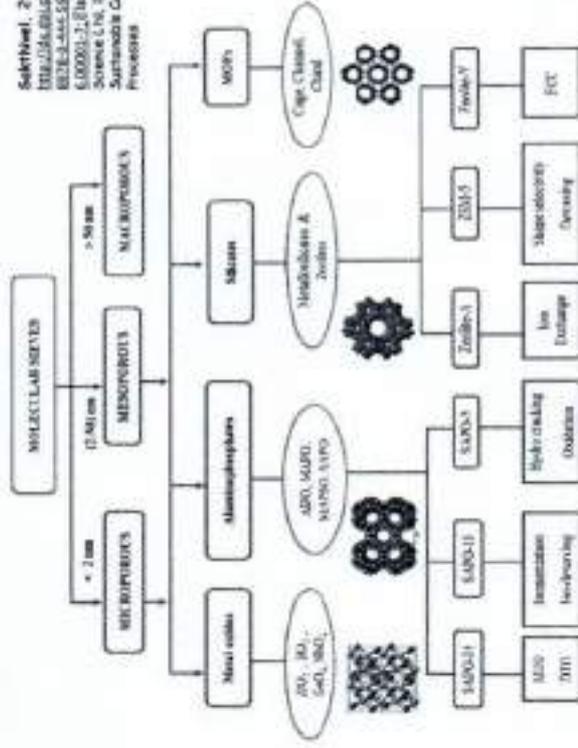


Topics in Catalysis, 52 (2009) 1131-1161

Website on Advances Chemical Sciences & Their Applications @ Pafnshankar Joshi's

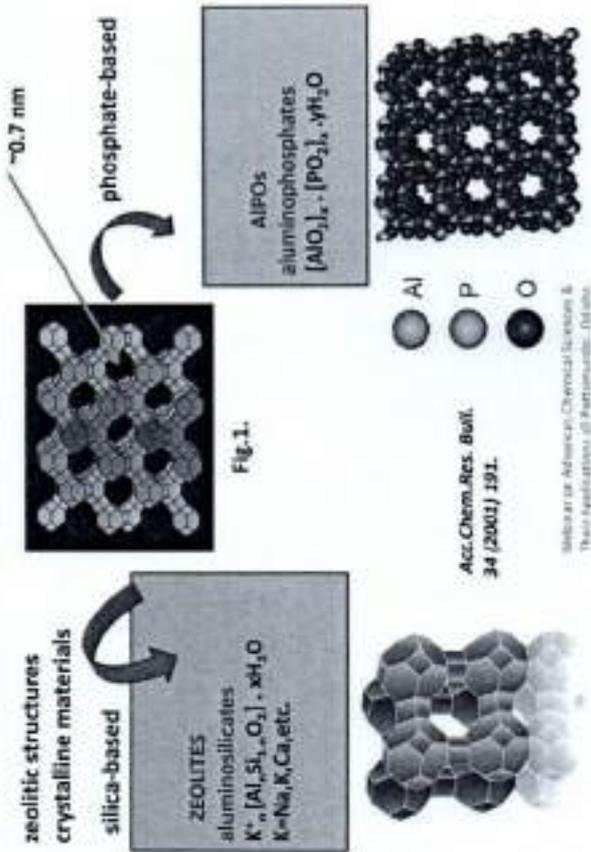
## Introduction to Different Molecular Sieve Materials

September, 2015  
 DOI:10.6000/1929.1016.201509.00003.2  
 ISSN:2474-5552  
 Science Link: 7-12  
 Sustainable Catalytic Processes



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## Most common microporous materials (< 2 nm)

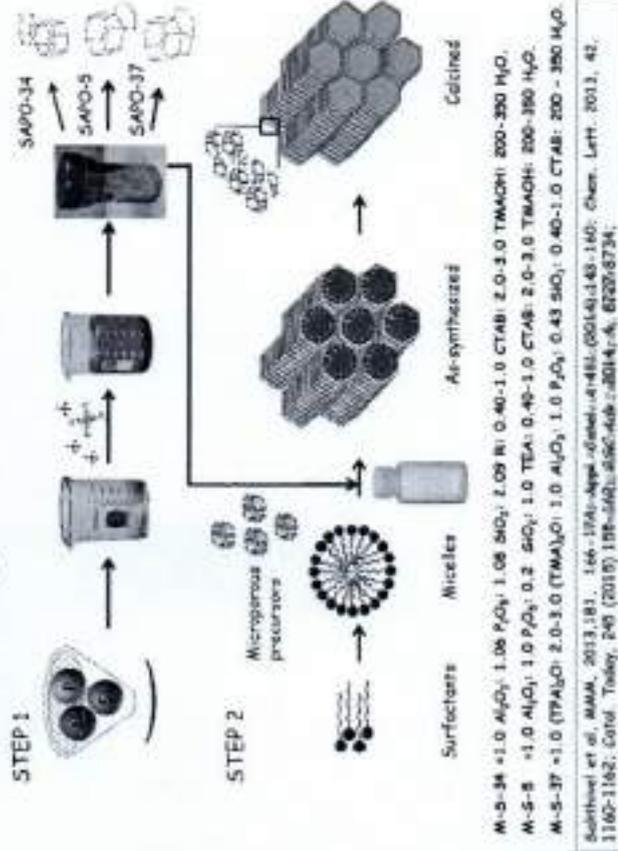


Acc.Chem.Rev. Bull. 34 (2001) 191.

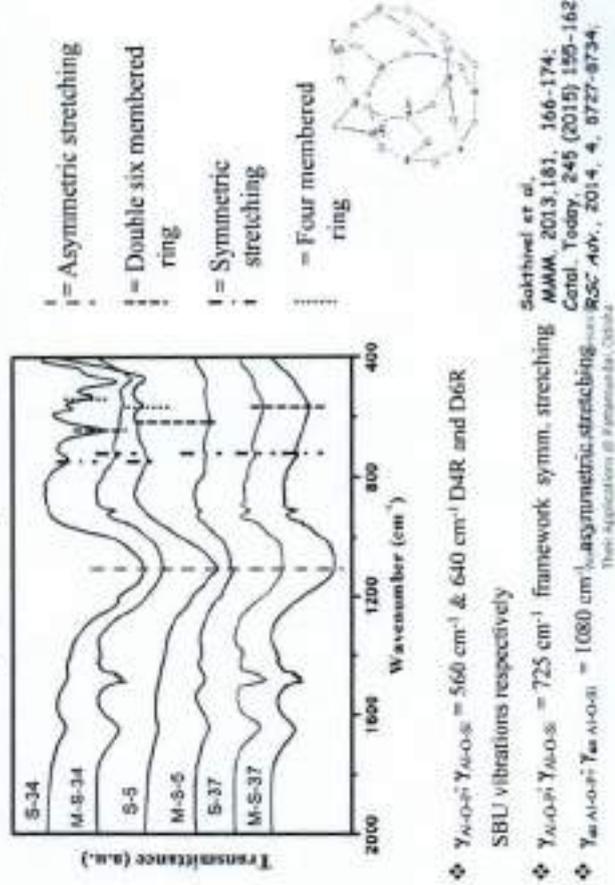
Website on Advances Chemical Sciences & Their Applications @ Pafnshankar Joshi's



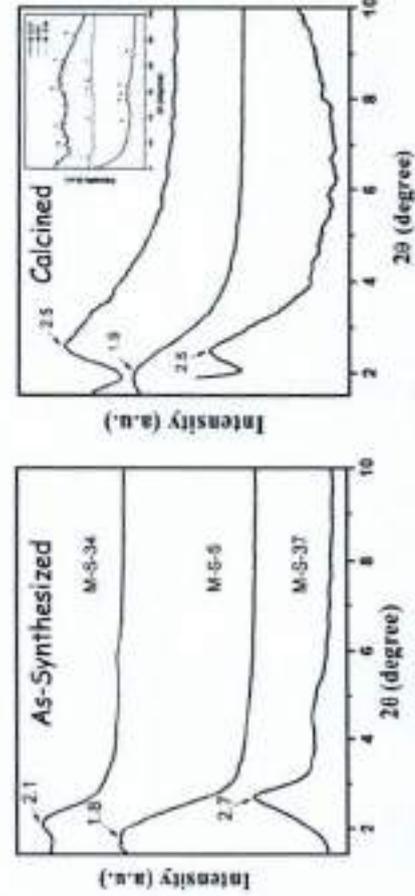
## Synthetic representation of MESO-SAPO-n



## Nature of microporous SAPO-n precursor

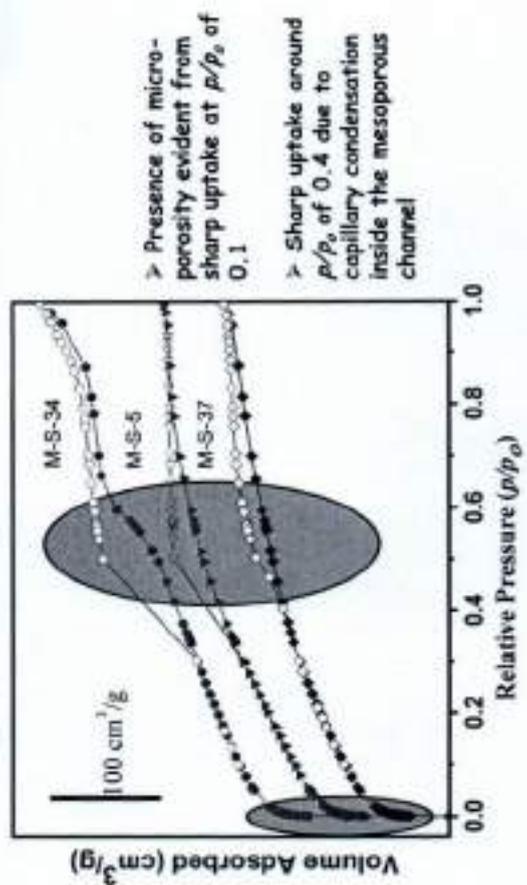


## Powder XRD Patterns of MESO-SAPO-n



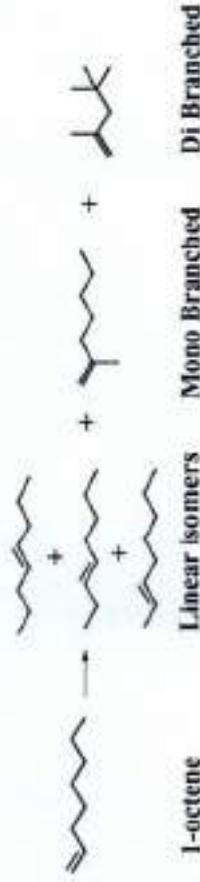
- > Microporous SAPO-n seed showed SBU between 4-5 h.
- > Preformed SAPO-n seed obtained was used for synthesis of MESO-SAPO-n.
- > XRD of calcined samples showed clear broad peak characteristic of mesoporous phase in all cases.
- > Higher angle XRD reveals presence of nano-size SBU in all cases.

## Nitrogen Adsorption/Desorption Isotherm



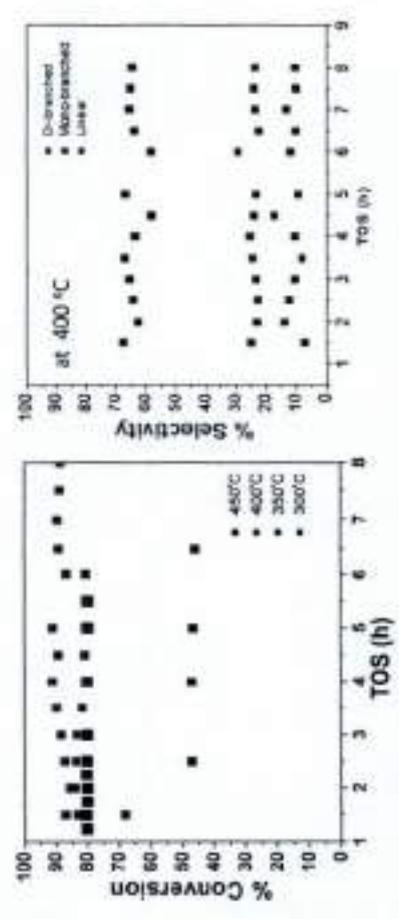
Reference: M. Jaroniec et al., Stud. Surf. Sci. Catal., 2000, p.128, 71

## Vapor Phase Isomerization of 1-Octene over MESO-SAPO-n



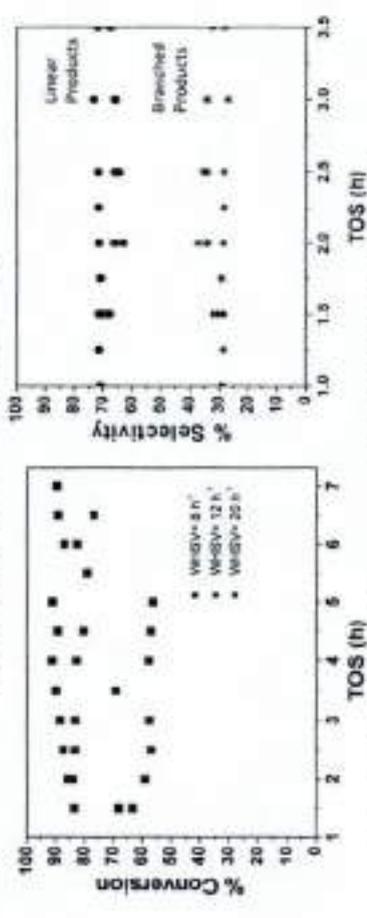
Website: [www.chemistry.chemicalsciences.in](http://www.chemistry.chemicalsciences.in)  
 Their Applications @ PatentsIndia, ©2014

## Effect of temperature on hydroisomerization over MESO-SAPO-37



Reaction Conditions : WHSV= 8 h<sup>-1</sup>  
 Reactant = 1-Octene  
 H<sub>2</sub> flow= 25 mL / min  
 Website: [www.chemistry.chemicalsciences.in](http://www.chemistry.chemicalsciences.in)  
 Their Applications @ PatentsIndia, ©2014

## Effect of WHSV on Hydroisomerization over MESO-SAPO-37



Reaction Conditions : Temperature = 400 °C, WHSV = 8,12,20 h<sup>-1</sup>  
 Reactant = 1-Octene; H<sub>2</sub> flow = 25 mL/min  
 > Decrease in WHSV increase in conversion was observed  
 > Change in WHSV do not have much effect on product distribution  
 Website: [www.chemistry.chemicalsciences.in](http://www.chemistry.chemicalsciences.in)  
 > Catal. Today, 249 (2015) 159-162; *Chem. Adv.*, 2014, 4, 8727-8734;

## Role of catalysts MESO-SAPO-n (M-S-n) # on 1-octene Hydroisomerization

Catalysts	Product Selectivity (%)							
	1-octene	Linear octenes	Branched octenes	2-Octene	3-Octene	4-Octene	Methyl-heptenes	Dimethyl-hexanes
MESO-SAPO-37-0.43.5	88.5	12.3	28.8	24.6	23.5	10.6		
MESO-SAPO-37-0.5.5	82.6	10.6	26.5	29.8	21.3	11.6		
MESO-SAPO-37-0.8.5	84.3	8.9	28.7	26.0	19.1	17.1		
MESO-SAPO-34	79.6	6.9	25.4	26.4	15.8	23.5		
MESO-SAPO-5	87.4	20.3	16.1	40.1	20.9	2.6		
SAPO-37	79.6	8.4	20.2	27.1	16.1	23.3		
SAPO-34	71.7	4.5	25.2	8.5	2.8	28.1		
SAPO-5	64.8	18.4	47.5	29.5	2.1	2.5		

# Reaction conditions: Temperature=400 °C; WHSV=8 h<sup>-1</sup>; Time on stream (TOS) = 3h  
 Their Applications @ PatentsIndia, ©2014

## Kinetic rate constants ( $k_i$ ) & Activation energy ( $E_a$ ) by LHHW(Langmuir-Hinshelwood-Hougen-Watson)model

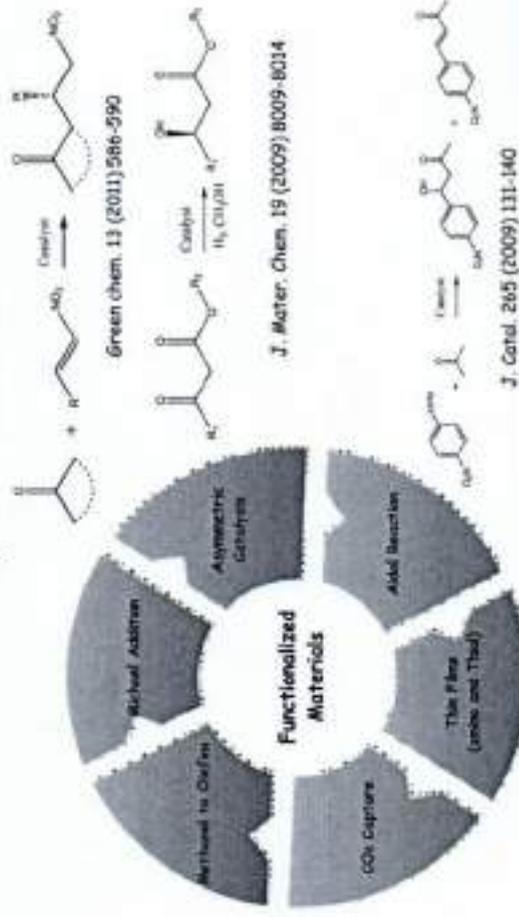
Kinetic rate constants ( $S^{-1}$ )	Activation Energy (kJ/mole)
$k_1$	$E_{a1}$
$k_2$	$E_{a2}$
$k_3$	$E_{a3}$
$k_4$	$E_{a4}$
$k_5$	$E_{a5}$
$k_6$	$E_{a6}$



- > At low temp. linear isomer favored
- > More branched feasible at high "T"
- > Amount of bi-branched isomer selectivity depends on mon-branch isomer formation

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## Importance of functionalized SAPO- $n$ composite materials



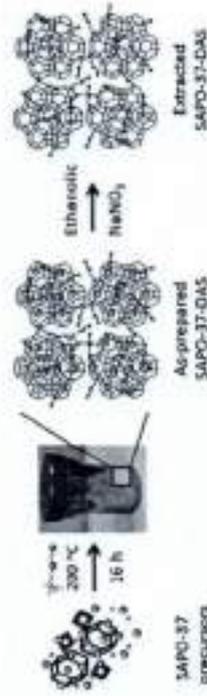
Green Chem. 13 (2011) 586-590

J. Mater. Chem. 19 (2009) 8009-8014

J. Catal. 265 (2009) 131-140

Website on Advances Chemical Sciences & Their Applications @ Pattanamudi, Odisha

## Functionalization of Microporous Molecular Sieve Materials & Its Applications



○ represents N-(3-(trimethacryloyl)propyl)ethylenediamine  
○ represents TMACH and TMAOH respectively

Website on Advances Chemical Sciences & Their Applications @ Pattanamudi, Odisha

## Framework structure of SAPO-37, SBA-15 and MCM-22 materials



- > SAPO-37 (FAU type).
- > 3D channel system
- > D6R SBU

Commercial applications on petrochemical cracking

- > MCM-22 (MWW zeolites)
- > Multidimensional channel system



- > Mesoporous SBA-15
- > 1D hexagonal pores

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## Elemental analysis and textural properties

SAPO-37 <sub>x</sub> DAS-x	Elemental Analysis (CHN)				Total active sites mmol/g	Accessible active sites mmol/g	(% of accessible active site)	BET Surface area (cm <sup>2</sup> g <sup>-1</sup> )	Micropore	
	As-prepared (%)			HK Pore width (nm)						
	N	C	H							
X=0.04	1.35	16.0	1.03	5.71	0.95	26.3	202	0.113	1.55	
0.08	1.56	15.2	1.38	6.55	1.22	27.8	211	0.076	1.24	
0.12	1.96	14.3	1.62	7.32	1.43	77.7	220	0.074	1.24	
0.16	2.43	14.2	1.92	7.94	1.46	96.1	219	0.066	1.24	
0.24	2.64	19.0	2.64	8.74	1.71	97.6	188	0.058	1.24	
0.32	2.90	16.0	3.31	10.30	2.05	99.0	146	-	-	

Website: [www.elsevier.com/locate/chemsci](http://www.elsevier.com/locate/chemsci)  
 Title: Applications of Zeolites, Oxides

## SEM images for different functionalized SAPO-37

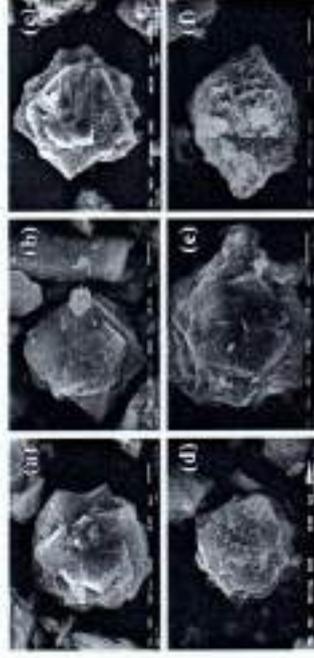
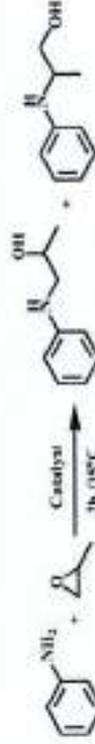


Figure. SEM images of as-prepared SAPO-37 (a) without organosilane and with organosilane (b) 0.04 (c) 0.08 (d) 0.16 (e) 0.24 and (f) 0.32 (Scale at bottom right side represents 2 μm).

- All the functionalized SAPO-37 showed inter-penetrated octahedral shape characteristic of FAU phase
- Increase in surface roughness with increase in organosilane can be clearly seen.

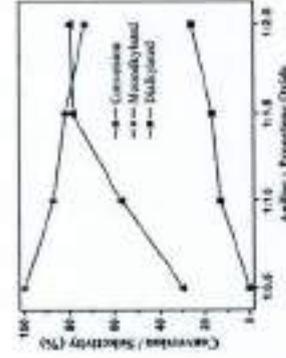
Website: [www.elsevier.com/locate/chemsci](http://www.elsevier.com/locate/chemsci)  
 Title: Applications of Zeolites, Oxides

## Catalytic Study on epoxide ring opening



Dialkylated products

- 1-(phenylamino)propan-2-ol and 2-(phenylamino)propan-1-ol major products
- Aniline conversion of 80% with 1.5 M propylene oxide
- The reaction does not proceed without catalyst
- The catalyst retained about 80% of its original activity after three recycle (EAT-SAPO-37-DAS-0.16).

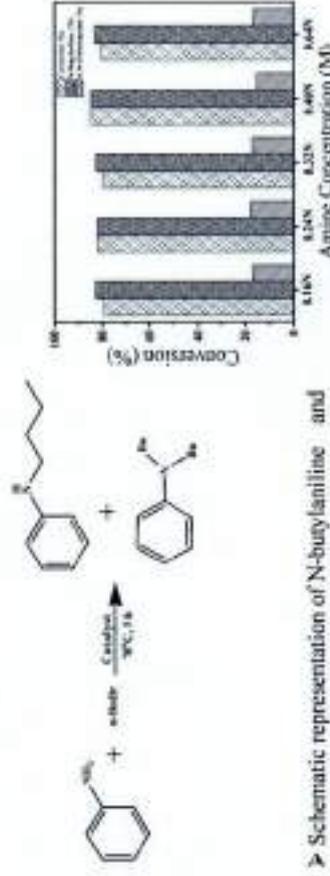


Reaction Conditions: room temperature, without solvents, Catalyst (100 mg)

Website: [www.elsevier.com/locate/chemsci](http://www.elsevier.com/locate/chemsci)  
 Title: Applications of Zeolites, Oxides

## Catalytic study of organo-functionalized SAPO-37

The functionalized SAPO-37 materials were studied for N-alkylation of aniline



➤ Schematic representation of N-butylaniline and N,N-dibutylaniline formation from aniline

- Material showed above 80% conversion and 84% selectivity of N-Butylaniline
- Sakthivel et al. *Microporous & Mesoporous Mater.* (under preparation)  
 Title: Applications of Zeolites, Oxides

## (a) Covalent grafting of cobalt carbonyl cluster on functionalized SBA-15

### Preparation of organosilane ligand

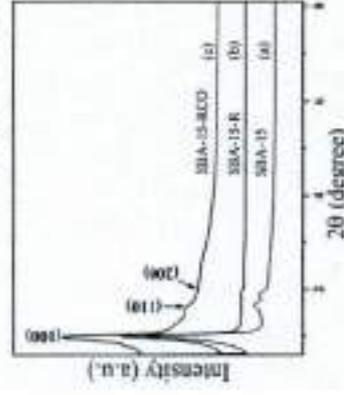


### [(2-propylcarbonate)propyl]triethoxysilane

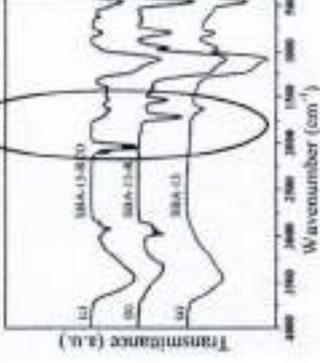
- SBA-15 is the mesoporous silica with hexagonal channels system.
- The organosilane ligand with terminal alkyne group was grafted via post synthetic approach.
- Di nuclear cobalt carbonyl  $[Co_2(CO)_8]$  coordinated to the terminal alkyne groups in  $\mu_2-\eta^2$  mode.

Journal of Applied Chemistry, Vol. 6, No. 1, 2016  
 Sakthivel et al., J. Mol. Catal. A: 2016 (accepted)

## Powder XRD pattern and FT-IR spectra of functionalized SBA-15



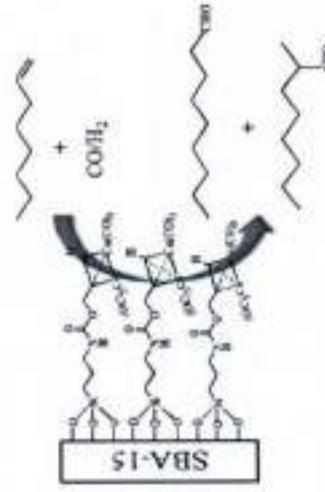
- There is only a slight decrease in the intensities of the peaks after grafting.
- well resolved reflections corresponding to (100), (110) and (200) planes of the SBA-15.



- Bands at 2848, 2927 and 2983  $cm^{-1}$  for the C-H stretching of the grafted organosilane ligand R
- The band at 2983  $cm^{-1}$  reduced case of SBA-15RCO
- Bands around 2029, 2060, and 2100  $cm^{-1}$  appeared in SBA-15-RCO are attributed to CO stretching of the grafted cobalt carbonyl.

Sakthivel et al., J. Mol. Catal. A: 2016 (accepted)  
 Sakthivel et al., J. Mol. Catal. A: 2016 (accepted)

## Catalytic Activity of SBA-15-RCO Towards Hydroformylation of 1-Octene



- Fresh catalyst showed 97% 1-Octene conversion (05 bar & 100 °C)
- 90 % selectivity for hydroformylated products.
- 53% selectivity for linear aldehydes.
- Increase in syn-gas pressure improve hydroformylated products.
- Catalyst showed better recyclability (83 % after 3 run)

Journal of Applied Chemistry, Vol. 6, No. 1, 2016  
 Sakthivel et al., J. Mol. Catal. A: 2016 (accepted)

## Effect of syn-gas pressure on hydroformylation of 1-octene

Catalyst	Conv. (%)	Pressure (bar)	Selectivity (%)			Distribution of Aldehydes (%)		
			CHO*	OH*	Isop*	Linear	Branched	
SBA-15-RCO	9.4	12	16.0	2.9	81.0	7.1	8.8	
SBA-15-RCO	48.0	35	72.3	23.0	4.7	36.5	35.7	
SBA-15-RCO	97.4	65	91.2	7.7	1.0	53.5	37.7	
SBA-15-RCO	96.4	85	86.2	17.7	0.0	54.4	31.8	

Reaction conditions: temperature = 100°C; 1-Octene; 0.0191 mol. (3ml); catalyst: 100 mg; Time 8h; CHO\* = hydroformylated products; OH\* = Alcoholic products; Isop\* = isomerized products of 1-Octene.

Journal of Applied Chemistry, Vol. 6, No. 1, 2016  
 Sakthivel et al., J. Mol. Catal. A: 2016 (accepted)

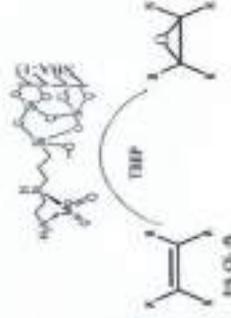
## Catalytic study

### Epoxidation of cyclooctene using SBA-DA-Mo

S. No	Catalyst	Con. (%)	Epoxide Sel. (%)
1	Without catalyst	18	15
2	SBA-15	22	17
3	Complex 1	10	43
4	SBA-DA-Mo	93	86
5 <sup>a</sup>	1 <sup>st</sup> recycled	96	87
6 <sup>a</sup>	2 <sup>nd</sup> recycled	97	92
7 <sup>a</sup>	3 <sup>rd</sup> recycled	94	90

<sup>a</sup>Reaction details: catalyst: Oxidant: substrate; 0.0363; 2.1. Temperature: 70 °C; Solvent: Mesitylene; a, b, c-1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>-recycled catalyst respectively

Publications @ Patents/India, Odisha



- ◊ Low conversion without catalyst and SBA-15.
- ◊ Better conversion and selectivity on SBA-DA-Mo
- ◊ Similar conversion on recycle study

## Effect of substrate on olefin epoxidation using SBA-DA-Mo

S. No	Reactant	product	Time (h)	Con. (%)	Epoxide Sel. (%)
1			4	93	96
2			4	91	78
3			24	96	95
4			24	89	70
5			24	89	91
6			24	77	86
7			24	60	86

<sup>a</sup>Reaction details: catalyst: Oxidant: substrate; 0.0363; 2.1; Temperature: 70 °C; Solvent: Mesitylene.

## Acknowledgement

Dr. Dhanjay Dr. Arvind Dr. Magsood



Dr. Baskaran

Dr. (Mrs.)  
Kalyani Yadav

DST- SERB INDIA  
Central University of Kerala (CUK)  
CSIR & UGC INDIA

Publications @ Patents/India, Odisha

## Summary

- Molecular sieve materials have great significant on various chemical processes
- *Meso-micro-composite materials are known as potential catalysts for various petrochemical processes and their properties can be tuned by synthetic conditions*
- *Introduction of functionality inside the channel of molecular sieve materials broaden their scope as support for heterogenization*
- *The heterogenization of homogeneous catalysts using functional molecular sieve have advantages of both homogeneous & heterogeneous Catalysts*

Publications @ Patents/India, Odisha

## Surface functionalized magnetic nanoparticles for catalytic applications

Prodeep Phukan, FRSC

Department of Chemistry,  
Gauhati University, Guwahati -781014



Advance Chemical Sciences and their Applications, Patramandari College, Sept 15, 2020

## IMPORTANT ASPECTS OF HETEROGENEOUS CATALYST

### DISADVANTAGE

- Requirement of large volume of the material
- Deactivation

### ADVANTAGE

- Reusability-cost effective chemical process
- Green

### PREREQUISITE for an active catalyst

- Active catalytic site
- Large surface area

## IMPORTANT ASPECTS OF HETEROGENEOUS CATALYST.....

### Factors affecting for activity of a catalyst.....

Size effects, i.e., the dependence of the global reaction kinetics on the size of the active particles.

Size effects are a common phenomenon and are typically taken advantage of in catalyst optimization.

Most common explanation:  
small particles expose specific sites with modified adsorption properties.

The reason for these modifications could either be of geometrical nature (e.g., edge, corner, or other irregular adsorption sites) or of electronic origin (e.g., electron confinement effects in small aggregates or interaction with the support).

## IMPORTANT ASPECTS OF HETEROGENEOUS CATALYST.....

However,.....

We simply cannot reduce the size of a heterogeneous catalyst in order to get a catalyst of highest merit

Because.....

This may leads to the collapse of the catalyst structure which finally deactivate the catalyst



### For CUBES of varying size

Side	Area of Face	Total Surface Area	Volume of Cube	Surface Area to Volume Ratio (or $\text{m}^2 \cdot \text{m}^{-3}$ )
1 m	1 m <sup>2</sup>	6 m <sup>2</sup>	1 m <sup>3</sup>	6.0 m <sup>-1</sup>
2 m	4 m <sup>2</sup>	24 m <sup>2</sup>	8 m <sup>3</sup>	3.0 m <sup>-1</sup>
4 m	16 m <sup>2</sup>	96 m <sup>2</sup>	64 m <sup>3</sup>	1.5 m <sup>-1</sup>
6 m	36 m <sup>2</sup>	216 m <sup>2</sup>	216 m <sup>3</sup>	1.0 m <sup>-1</sup>
8 m	64 m <sup>2</sup>	384 m <sup>2</sup>	512 m <sup>3</sup>	0.75 m <sup>-1</sup>
12 m	144 m <sup>2</sup>	864 m <sup>2</sup>	1728 m <sup>3</sup>	0.5 m <sup>-1</sup>
20 m	400 m <sup>2</sup>	2400 m <sup>2</sup>	8000 m <sup>3</sup>	0.3 m <sup>-1</sup>

**Surface-to-volume ratio** (denoted as  $\text{sa}/\text{vol}$  or  $\text{SA:V}$ ), is the amount of surface area per unit volume of an object or collection of objects

(Source: Wikipedia)

### Surface-to-volume ratio of objects of different shape

Shape	Length $l$	Area	Volume	SA/V ratio	SA/V ratio for unit volume
Tetrahedron	side	$\sqrt{3}a^2$	$\frac{\sqrt{2}a^3}{12}$	$\frac{6\sqrt{6}}{a} \approx \frac{14.697}{a}$	7.21
Cube	side	$6a^2$	$a^3$	$\frac{6}{a}$	6
Octahedron	side	$2\sqrt{3}a^2$	$\frac{4\sqrt{3}a^3}{3}$	$\frac{2\sqrt{6}}{a} \approx \frac{4.898}{a}$	5.72
Dodecahedron	side	$3\sqrt{25 + 10\sqrt{5}}a^2$	$\frac{1}{4}(15 + 7\sqrt{5})a^3$	$\frac{12\sqrt{25 + 10\sqrt{5}}}{(15 + 7\sqrt{5})a} \approx \frac{4.688}{a}$	5.31
Icosahedron	side	$5\sqrt{3}a^2$	$\frac{5}{12}(3 + \sqrt{5})a^3$	$\frac{12\sqrt{3}}{(3 + \sqrt{5})a} \approx \frac{3.970}{a}$	3.148
Sphere	radius	$4\pi r^2$	$\frac{4\pi r^3}{3}$	$\frac{3}{r}$	4.836

### Examples of Nanocatalyst

- Commercially well-established nanocatalysts:
  - Industrial enzymes, zeolites and transition metal nanocatalysts
- Newer types:
  - Transition metal oxide, metallocene, asymmetric, carbon nanotube and others

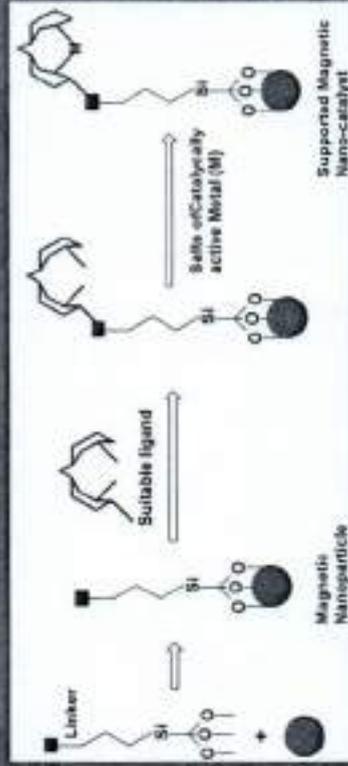
### Disadvantages of Simple NANO-CATALYST

- Recovery of the catalyst from the reaction mixture is difficult as they cannot be efficiently filtered out of the reaction medium
- Agglomeration of the nanoparticles during the reaction or separation process

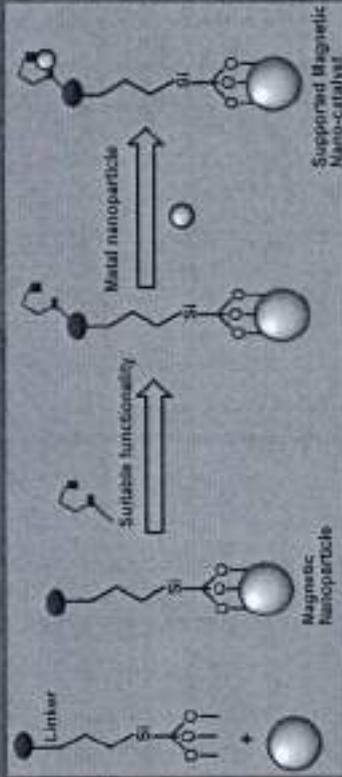
## Modification of magnetic nanoparticles

- **Modification I**  
With pre-synthesized nano-particles of catalytically active metals onto the magnetic nano-support
- **Modification II**  
In-situ generation of nano-particles during synthesis of magnetic nano-support

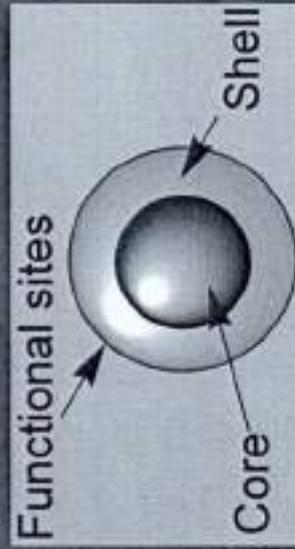
## Modification III Immobilization of catalytically active metals through a linker



## Immobilization of catalytically active nano particles onto a linker



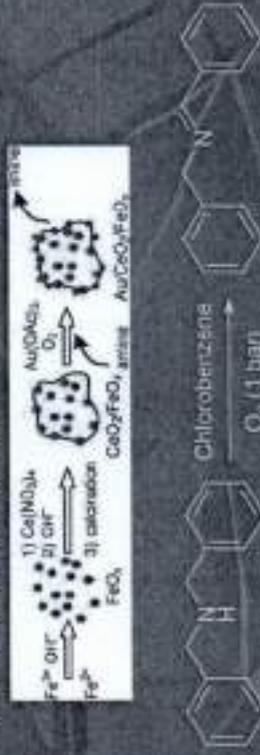
## Magnetic Polymer –Core-Shell Nanocomposites



The core contains the active ingredient, while the shell protects the core permanently or temporarily from the external environment

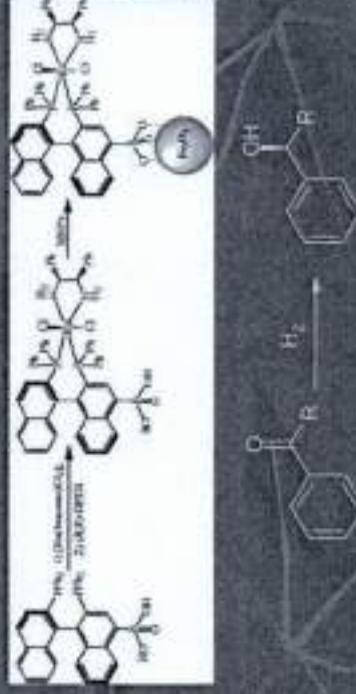
## Oxidation

Magnetically Separable Catalysis



A. Baker et al. *ChemCatChem* 2009, 1, 111

## Reduction



W. Lin et al. *J. Am. Chem. Soc.* 2005, 127, 12486

## Recent Reviews on the use of Magnetic Nanocatalysts

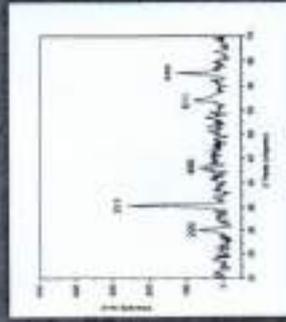
- Varma et al., *Chem. Soc. Rev.* 2013, 42, 3371-3393.
- Hosmane et al., *ChemCatChem* 2010, 2, 365-374.
- Reiser et al., *Acc. Chem. Res.* 2014, 47, 667-677.
- Varma et al., *Green Chem.* 2014, 16, 4493-4505.
- Xing et al. *J. Mater. Chem. A*, 2015, 3, 11157.
- Gu et al. *Molecules* 2015, 20, 17070-17092.
- Sharma et al. *RSC Adv.*, 2015, 5, 53381.
- Chem Rec. 2018 Oct;18(10):1409-1473.

## OUR WORK

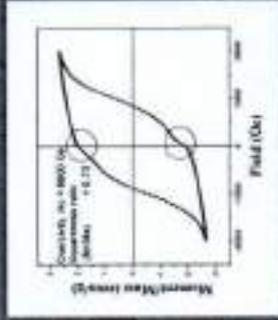
Interests of study

- High performance **MAGNETICALLY SEPARABLE** catalysts
- Study of effect of ultrasound during coprecipitation method of nanoparticle synthesis.
- Direct use of magnetic particles as catalyst.

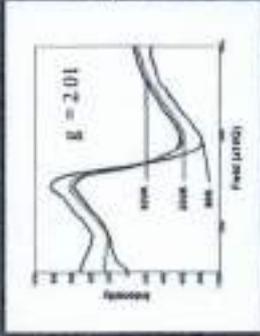
### Characterization of $\text{CoFe}_2\text{O}_4$ nanoparticle



X-ray diffraction pattern

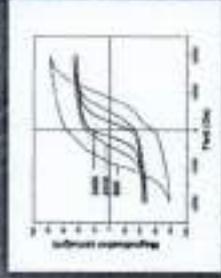


Hysteresis curve of  $\text{CoFe}_2\text{O}_4$  at 80 K



ESR spectra

Strong magnetocrystalline anisotropy



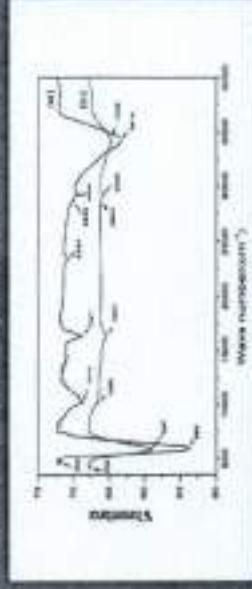
Field dependent coercivity

### Reason for stability

- Increase of surface polarity.
- Water molecule /or hydroxyl functionality might be entrapped in the magnetic nanoparticles, which act as the stabilizer/binder.

This is due to repetitive ultrasonic treatment

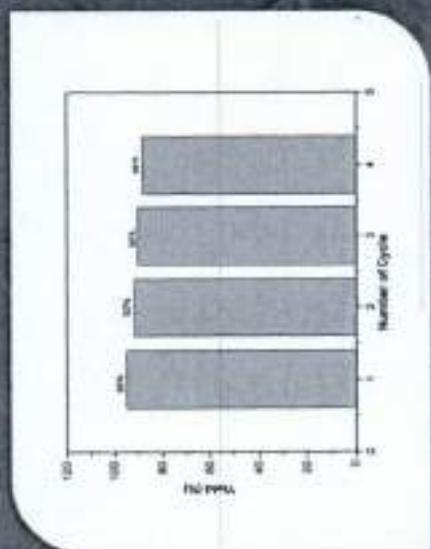
### IR of the nanoparticle



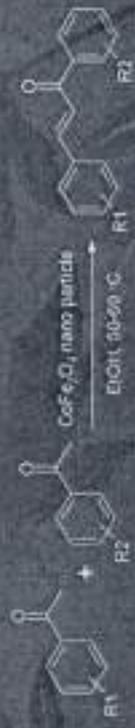
IR spectra of  
(a) as-synthesized  $\text{CoFe}_2\text{O}_4$   
(b)  $\text{CoFe}_2\text{O}_4$  synthesized by normal co-precipitation method



### Catalyst recovery & recyclability



### Aldol condensation catalyzed by cobalt ferrite magnetic nano particle



R1 = H, OCH3, NO2, Br, Cl, Ph, Me  
R2 = H, OCH3, NO2, Br, Cl, Ph, Me

Kula Kamal Senapati and Poojeep Phukan  
*Bull. Catal. Soc. Ind. 2011, 10, 19-26*

### Separation of the catalyst



### A new CoFe<sub>2</sub>O<sub>4</sub>-Cr<sub>2</sub>O<sub>3</sub>-SiO<sub>2</sub> fluorescent magnetic nanocomposite



Boroghain, C., Senapati, K.,  
K.; Mishra, D.; Sarma, K.  
C. and Phukan, P.  
*Nanoscale*, 2010, 2, 2250

# Synthesis of $\text{CoFe}_2\text{O}_4\text{-ZnS}$ photocatalyst



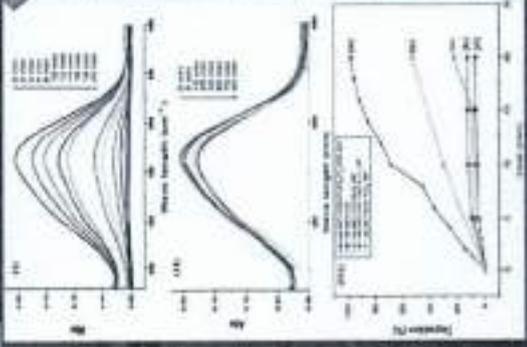
ZnS nanoparticles

Borah, J.P.; Borgohain, C.; Sarma, K. C.; Senapati, K. K.; Phukan, P.  
*Int. J. Nanosci.* 2011, 10, 237-240

Changes of UV-Vis spectra of methyl orange with irradiation time in presence of (I)  $\text{CoFe}_2\text{O}_4\text{-ZnS}$  NCs and (II) ZnS NPs and (III)  $\text{CoFe}_2\text{O}_4\text{-ZnS}$  NCs. (b) no catalyst, (c) ZnS NPs, (d)  $\text{CoFe}_2\text{O}_4$  NPs and (e)  $\text{TiO}_2$  NPs under UV light irradiation.

**Kinetics**  
 A pseudo first-order kinetic law, and can be expressed as  

$$-\ln\left(\frac{C}{C_0}\right) = kt$$
 where C and  $C_0$  are the reactant concentrations at time t and t = 0, respectively. k and t are the pseudo-first order rate constant and time respectively.



**Raman Spectra**

**EDS Spectra**

The  $\text{CoFe}_2\text{O}_4$  shows five Raman active modes ( $A_{1g}$ ,  $E_g$ ,  $T_{2g}$ ,  $T_{1g}$ ,  $A_{2g}$ ). Three modes of  $\text{CoFe}_2\text{O}_4$  438  $\text{cm}^{-1}$ , 600  $\text{cm}^{-1}$  and 665  $\text{cm}^{-1}$  can be seen in the Raman spectra along with the 228  $\text{cm}^{-1}$  and 345  $\text{cm}^{-1}$  modes from ZnS NPs (inset).

The NCS give IIC and M<sub>s</sub> of 1.2 kOe and 17.5  $\text{erg}^{-1}$  respectively which is only a negligible change from the  $\text{CoFe}_2\text{O}_4$  case (IIC: 1.0 kOe and M<sub>s</sub> 18  $\text{erg}^{-1}$ ) and that is an indication of the formation of nano-scale coating at the core-surface.

## Photo-degradation of Methyl orange by $\text{CoFe}_2\text{O}_4\text{-ZnS}$ NC

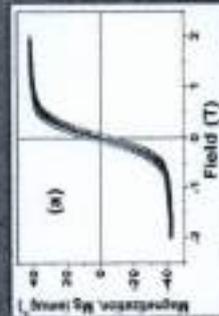
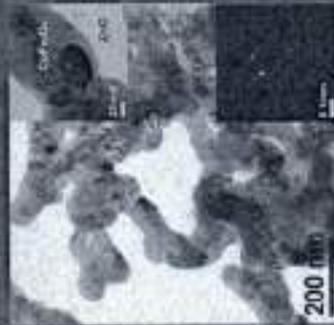
**Chemical Structure**

Main wave length: 400 nm, 12 mW

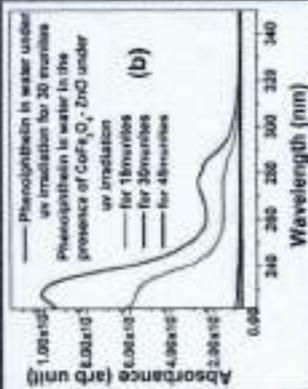
$\text{CoFe}_2\text{O}_4\text{-ZnS-NC}$  (0.02g) was placed into the tubular quartz vessel containing 100 ml. containing  $1 \times 10^{-3}$  M-MO aqueous solutions

Senapati, K. K.; Borgohain, C.; Phukan, P. *Anal. Sci. Technol.* 2012, 2, 2361-2366

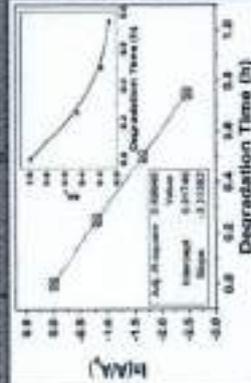
# CoFe<sub>2</sub>O<sub>4</sub> embedded one-dimensional ZnO hetero-structure



Magnetization-Hysteresis (M-H) curve



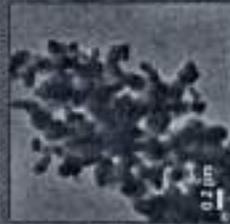
Phenolphthalein degradation



Editor's choice paper

A facile synthesis of nanocrystalline CoFe<sub>2</sub>O<sub>4</sub> embedded one-dimensional ZnO hetero-structure and its use in photocatalysis

Chandan Borgohain<sup>a,b</sup>, Kala Kamal Senapati<sup>a</sup>, K.C. Sarma<sup>a,\*</sup>, Prodeep Phukan<sup>a,c</sup>

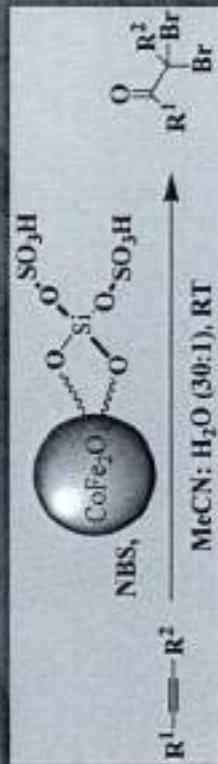


CoFe<sub>2</sub>O<sub>4</sub>-ZnO prior to annealing

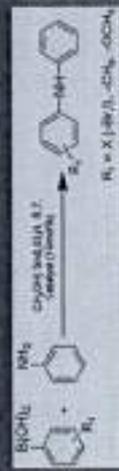


CoFe<sub>2</sub>O<sub>4</sub>-ZnO after annealing at 500°C

# CoFe<sub>2</sub>O<sub>4</sub>/SiO<sub>2</sub>-SO<sub>3</sub>H nano composite for oxidative bromination of alkenes



Reaction condition: Aryl boronic acid (1 mmol), acetic acid (1 mmol), amine source (1.1 mmol), Et<sub>3</sub>N (1 mmol), methanol (5 ml), rt.



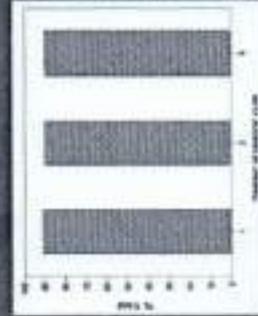
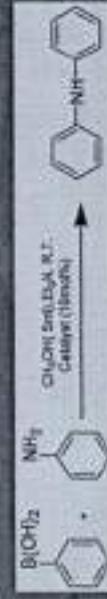
Entry	Boronic Acids	Amines	Product	Time (h)	Yield (%)
1				5	90
2				5	86
3				6	84
4				5	75
5				5	78
6				3	88

Dutta, M. M.; Phukan, P. *Catal. Commun.* 2018, 109, 38-42.

Reaction condition: Aryl boronic acid (1 mmol), acetic acid (1 mmol), amine source (1.1 mmol), Et<sub>3</sub>N (1 mmol), methanol (5 ml), rt.

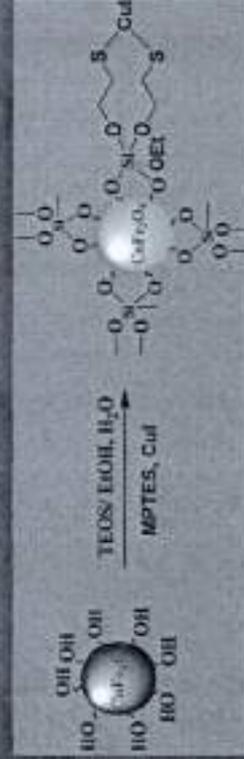
Entry	Boronic Acids	Amines	Product	Time (h)	Yield (%)
7				3	90
8				3	80

## Catalyst Recovery



Bar diagram showing yield of 3 recycles of the catalyst.

## CuI functionalized CoFe<sub>2</sub>O<sub>4</sub> nanoparticles as catalyst for oxidative amination reaction



## Conclusion:

- Magnetic nanoparticles were used directly as be used as catalyst as well as support
- Stable Cobalt ferrite nanoparticles were prepared without capping agent
- Functionalisation of cobalt ferrite could be achieved by incorporating Cr, Pd etc.
- The as prepared  $\text{CoFe}_2\text{O}_4\text{-Cr}_2\text{O}_3\text{-SiO}_2$  nanocomposite exhibits photoluminescence property

## Conclusion:

- The cobalt ferrite nanoparticles can be dispersed in ethanol and are stable in ethanolic or aqueous solution.
- However, in DCM no stable dispersion is possible.
- Nanocatalyst could be separated by magnetic decantation.
- Cobalt ferrite nanoparticles are basic in character
- Cobalt ferrite nanocatalyst could be used for various carbon carbon bond and carbon-heteroatom bond forming reactions.

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Application of  
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for green  
chemical  
synthesis

# THANK YOU

# National Level Webinar on "Advance Chemical Sciences and their Applications"

Organised by Department of Chemistry in association with IQAC, Pattamundai College ,

Pattamundai Date:16.09.2020

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### Certificate of Participation

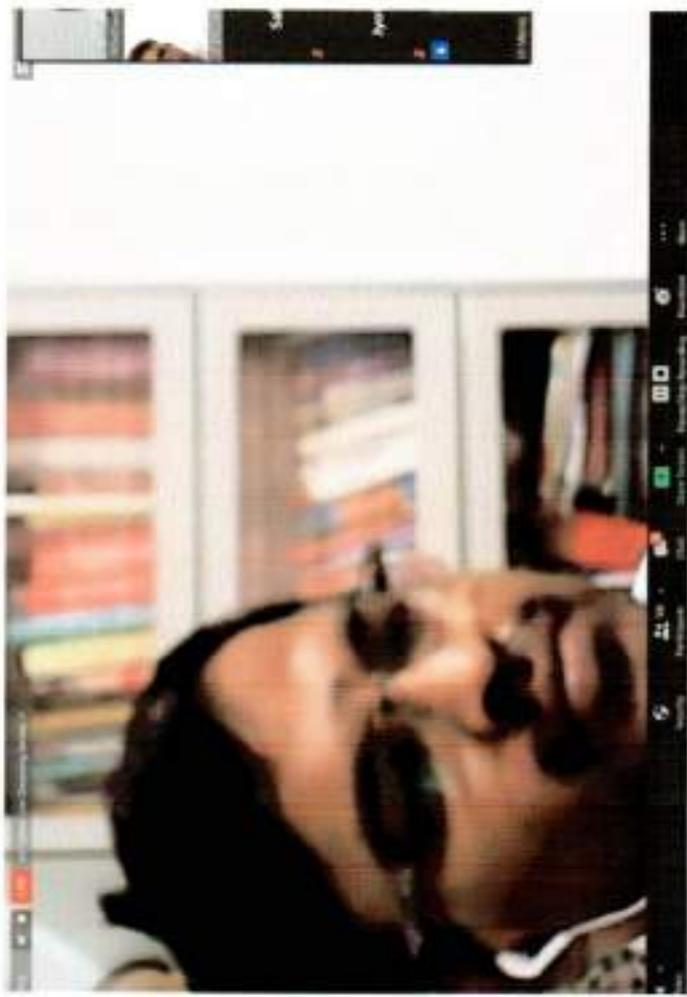
This is to certify that Mr./Ms./Mrs. <<full name>>, <<Designation>> of <<college name>> has actively participated in the National level Webinar on "ADVANCE CHEMICAL SCIENCES AND THEIR APPLICATIONS" organized by Department of Chemistry in association with Internal Quality Assurance Cell (IQAC), Pattamundai College, Pattamundai, Kendrapara, Odisha on 16th September 2020.

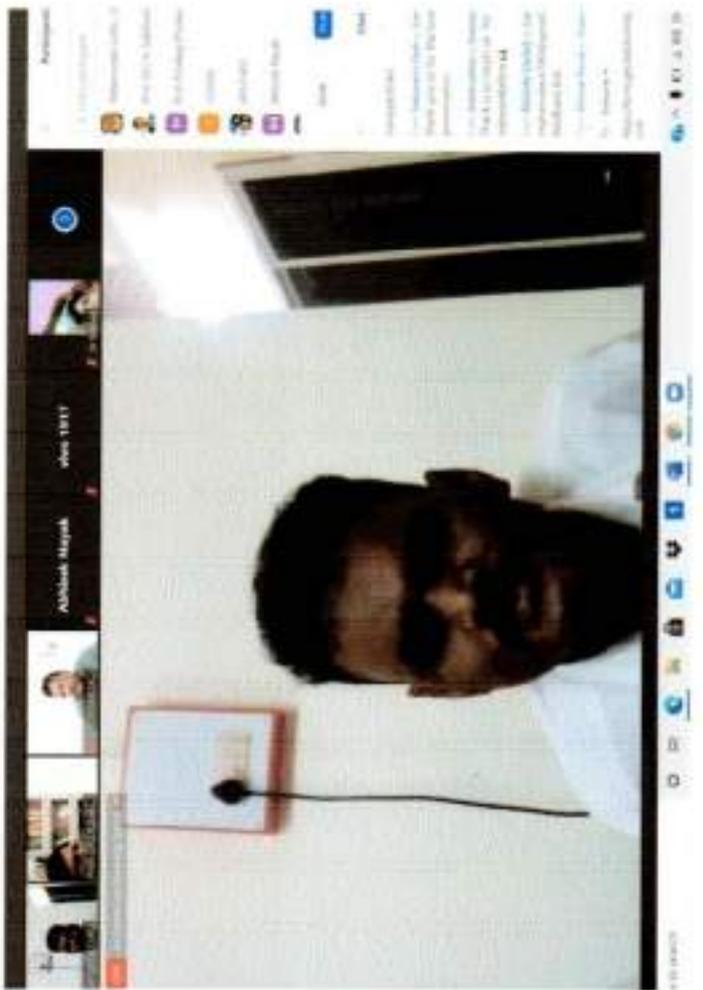
Dr. D. Parida  
Convener

Prof. A. Sakthivel  
Resource Person

Prof. P. Phukan  
Resource Person

Prof. A.L.N Dash  
Principal







## ପଞ୍ଜାମୁଣ୍ଡାଇ କଲେଜ ରସାୟନ ବିଭାଗର ଜାତୀୟସ୍ତରୀୟସ୍ତେବିନାର

ପଞ୍ଜାମୁଣ୍ଡାଇ, ୧୨।୯ (ବି.ପ୍ର): ପଞ୍ଜାମୁଣ୍ଡାଇ କଲେଜ ରସାୟନ ବିଭାଗ ପକ୍ଷରୁ ଆଜକାରୁ ଦେଶିକୀୟ ସ୍ତରରୁ ଆଜ ଦେଶର ଆଧୁନିକତର ଶ୍ରେଣି ଜାତୀୟ ସ୍ତରୀୟ ସ୍ତେବିନାର ଆରମ୍ଭ ହୋଇଯାଇଛି । ଏଥିରେ କେନ୍ଦ୍ରୀୟ ବିଶ୍ୱବିଦ୍ୟାଳୟର ସ୍ୱଳ୍ପ ଅଫିସରୀୟ ସ୍ତରରୁ ମୁଖ୍ୟ ପ୍ରଫେସର ଏ ଶକ୍ତିଶାଳୀ ଓ ଆତ୍ମଜ୍ଞାନ ସୌଧୀ ବିଶ୍ୱବିଦ୍ୟାଳୟର ରସାୟନ ବିଭାଗ ପ୍ରଫେସର ପ୍ରଫାପ ଦୁବୀଙ୍କ ଯୋଗଦେଇ ଆଜକାରୁ ଦେଶିକୀୟ ସ୍ତରରୁ ଆଜ ଦେଶର ଆଧୁନିକତର ସ୍ତରରେ ମହାନ ବେଳା ସହିତ ଏକ ଆଧୁନିକ ସମାଜ ପାଇଁ କେତେ ଉପଯୋଗୀ ସେ ସଫଳତର ବିଷୟରେ କହିଥିଲେ । ବିଭିନ୍ନ ଅଧ୍ୟାପକ ପଞ୍ଜାମୁଣ୍ଡାଇ କଲେଜ ଅଧ୍ୟାପକ ପ୍ରଫେସର ଅଧିକାରୀ ଉପାଧ୍ୟକ୍ଷଙ୍କ ସହ ଅଧିକ ଓ ଆଗ୍ରହପୂର୍ଣ୍ଣତା ସହ ସମସ୍ତେ ପଞ୍ଜାମୁଣ୍ଡାଇ କଲେଜର ବିଭାଗ ଓ ସାମ୍ପ୍ରତିକ ସ୍ଥିତି ସଫଳତର ସୂଚନା ଦେଇଥିଲେ । ପଞ୍ଜାମୁଣ୍ଡାଇ କଲେଜ ରସାୟନ ବିଭାଗ ମୁଖ୍ୟ ଓ ସ୍ୱାଶାସନ ପରିଚା ଅଧିକାରୀ ପରିଚା ପ୍ରଦାନ କରିଥିଲେ । ଅଧିକାରୀ ରାଜକରୁଣାର ଯୋଗ ପ୍ରାୟ ୩୦୦ ଜଣର ସାମ୍ପ୍ରତିକ ସଫଳତର କରିଥିଲେ । ଏହି କାର୍ଯ୍ୟକ୍ରମ ପ୍ରାୟତଃ ଡା. ନୀଳମଣି କେରା, ଡା. ପ୍ରମୋଦକରୁଣାର ସମ୍ପର୍କ, ବିଦାପ ବୁର୍ଲା, ପ୍ରମୋଦ ସର୍ମା, ଅଜିତ ଦାଶ, ବିଭୁବନା ସାହି, ମନୋଜ ପରିଡା, ଅଧ୍ୟାପକ ବିଶେଷ ମହିଳା ପ୍ରମୁଖ ପରିଚାଳନା କରିଥିଲେ । ଏଥିରେ ବିଭିନ୍ନ ଦେଶର ୩୦ ଜଣ ଆଗ୍ରହପୂର୍ଣ୍ଣତା ସହ ୩୦୦ ପ୍ରଫେସର, ଆଜକାରୁ ପ୍ରଫେସର, ସହକାରୀ ପ୍ରଫେସର, ବିଭିନ୍ନ ସ୍ତରର ଓ ବିଭିନ୍ନ ବିଶ୍ୱବିଦ୍ୟାଳୟ କଲେଜର ଛାତ୍ରଛାତ୍ରୀ ଆଗ୍ରହପୂର୍ଣ୍ଣତା କରିଥିଲେ ।



THE SAMAJ : 18.09.2020



## ରସାୟନ ବିଜ୍ଞାନ ବିଭାଗରେ ଡ୍ରେବିନାର

ପଟ୍ଟାମୁଖା, ୧୮୮୯ (ଆପ୍): ପଟ୍ଟାମୁଖା କଲେଜ ରସାୟନ ବିଜ୍ଞାନ ବିଭାଗ ପକ୍ଷରୁ ଆଡଭାନ୍ସ କେମିକାଲ ସାଇନ୍ସ ଆଣ୍ଡ ଦେୟାର ଆପ୍ଲିକେସନ ଶାସ୍ତ୍ରୀୟ ଜାତୀୟତା ଡ୍ରେବିନାର ଅନୁଷ୍ଠିତ ହୋଇଯାଇଛି । ଏଥିରେ କେନ୍ଦ୍ରୀୟ ବିଶ୍ୱବିଦ୍ୟାଳୟ ସ୍କୁଲ ଅଫ୍ ପିଜିକାଲ ସାଇନ୍ସର ମୁଖ୍ୟ ପ୍ରଫେସର ଏ. ଶକ୍ତିଚେଳ ଓ ଆସାମର ଗୌହାଟି ବିଶ୍ୱବିଦ୍ୟାଳୟର ରସାୟନ ବିଜ୍ଞାନ ବିଭାଗ ପ୍ରଫେସର ପ୍ରଦୀପ ପୂଜାର ଯୋଗଦେଇ ଆଡଭାନ୍ସ କେମିକାଲ ସାଇନ୍ସ ଆଣ୍ଡ ଦେୟାର ଆପ୍ଲିକେସନ ଉପରେ ମତାମତ ଦେବା ସହିତ ଏହା ଆଧୁନିକ ସମାଜ ପାଇଁ କେତେ ଉପଯୋଗୀ ସେ ସଂପର୍କରେ ବିଶ୍ଳେଷଣ କରିଥିଲେ । ଡ୍ରେବିନାର ଅଧ୍ୟକ୍ଷ ତଥା ପଟ୍ଟାମୁଖା କଲେଜ ଅଧ୍ୟକ୍ଷ ପ୍ରଫେସର ଅଧିକାରୀ ଲକ୍ଷ୍ମୀନାରାୟଣ ଦାଶ ଅତିଥି ଓ ଅଂଶଗ୍ରହଣକାରୀକୁ ସ୍ୱାଗତ କରି ପଟ୍ଟାମୁଖା କଲେଜର ବିକାଶ ଓ ସାଂପ୍ରତିକ ସ୍ଥିତି ସଂପର୍କରେ ସୂଚନା ଦେଇଥିଲେ । ବିଭାଗୀୟ ମୁଖ୍ୟ ଡ. ଦୁଃଶାସନ ପରିଡା ଅତିଥିପରିଚୟ ପ୍ରଦାନ କରିଥିବାବେଳେ ଅଧ୍ୟାପକ ରଞ୍ଜନ କୁମାର ଗାହାଣ ପ୍ରଶ୍ନ ଉତ୍ତର କାର୍ଯ୍ୟକ୍ରମ ସଂଯୋଜନା କରିଥିଲେ । ପ୍ରାଧ୍ୟାପକ ଡ. ନୀଳମଣି ଲେଙ୍କା, ଡ. ପ୍ରମୋଦ କୁମାର ସାମଲ, ଦିଲ୍ଲୀପ କୁର୍ମା, ପ୍ରମୋଦ ସ୍ୱାଇଁ, ଅଞ୍ଜଳି ଦାଶ, ନିରୁପମା ସ୍ୱାଇଁ, ମନୋଜ ପରିଡା, ଅଧ୍ୟାପକ ଜିତେନ୍ଦ୍ର ମଲ୍ଲିକ ପ୍ରମୁଖ କାର୍ଯ୍ୟକ୍ରମକୁ ପରିଚାଳନା କରିଥିଲେ ।

THE PRAMEYA : 19.09.2020