COUNCIL OF SCIENTIFIC RESEARCH / NATIONAL CHEMICAL LABORATORY , PUNE : AN OVERVIEW

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May 17, 2010

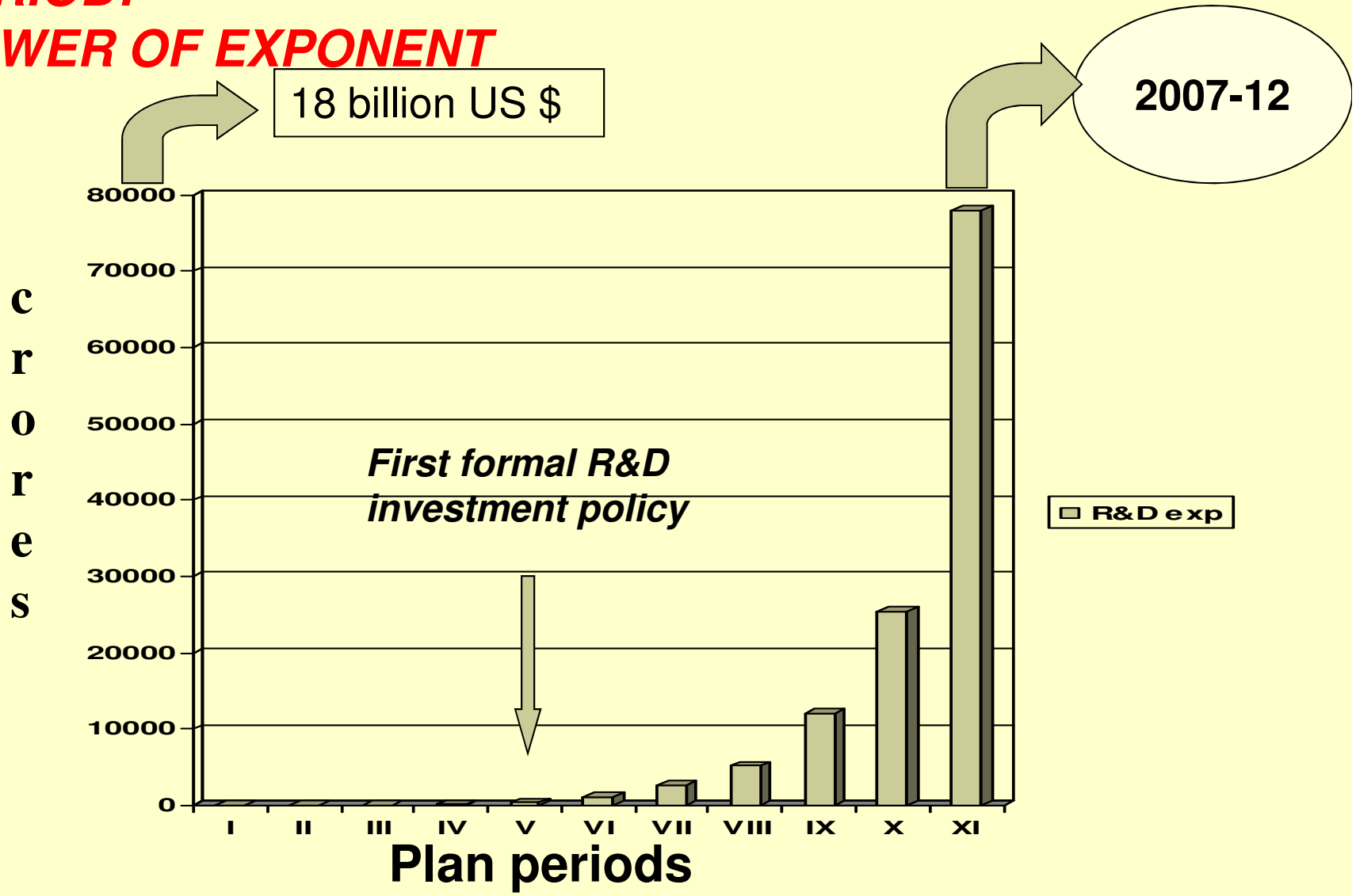
SCIENCE, TECHNOLOGY AND INNOVATION : AN EVOLVING LANDSCAPE

- India is poised to play a key and distinctive role in the emerging global economy
- A long national tradition of scholarship in arts and sciences and a burning desire among the young to be educated against all odds
- A strong and growing educational infrastructure to cater to the aspiring millions of young men and women
- Generous state support to science & technology
- India is becoming attractive for Indian S&T professionals to either stay back or return back
- India's ensuing demographic profile will make available more educated and qualified professional in the age group of 20 to 35, the youngest work force in the world

CHANGING R&D STRUCTURE IN INDIA

- Ten fold increase in universities (5 IIT`s, 5 IISER`s, 14 Central Universities and 16 world class universities)
- Specialized national laboratories from a few to 300
- R&D expenditure as a percentage of GDP from 0.9% (2008) to 1.5% (2012)
- R&D centres within industries from practically nil to over 1000
- Annual output of PhDs in science and engineering ~ 6000 targetted to increase to 15,000 by 2015
- Full time equivalent researchers : 136 scientists per one million people

R&D INVESTMENTS OF INDIA : SINCE IST PLAN PERIOD:
POWER OF EXPONENT



COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH)

Mission

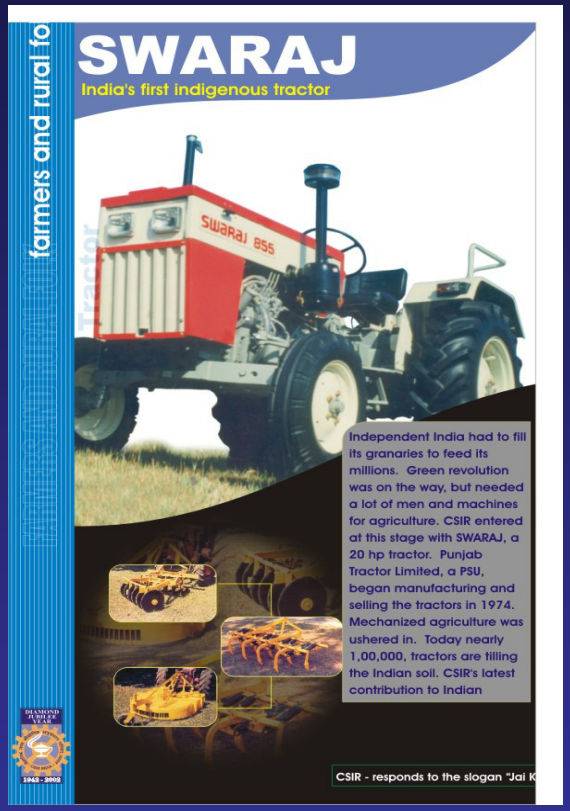
To provide scientific industrial Research & Development that maximizes the economic, environmental & societal benefits for the people

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR)

- A 64 year young, not-for-profit R&D organization
- 37 laboratories ; several outreach centers
- 22,000 strong work force, 5000 scientists / technologists
- 2,500 Ph. D`s
- CSIR's R&D areas :

  Aerospace and aeronautics, Bio-sciences and bio-technology, Chemicals and chemical technology, Coal, gas and petroleum, Construction technology, Drugs and pharmaceuticals, Earth and ocean resources, Ecology and environment, Electronics and instrumentation, Food processing, Leather and leather goods, Machinery and equipment, New materials, Mining and metallurgy

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR)



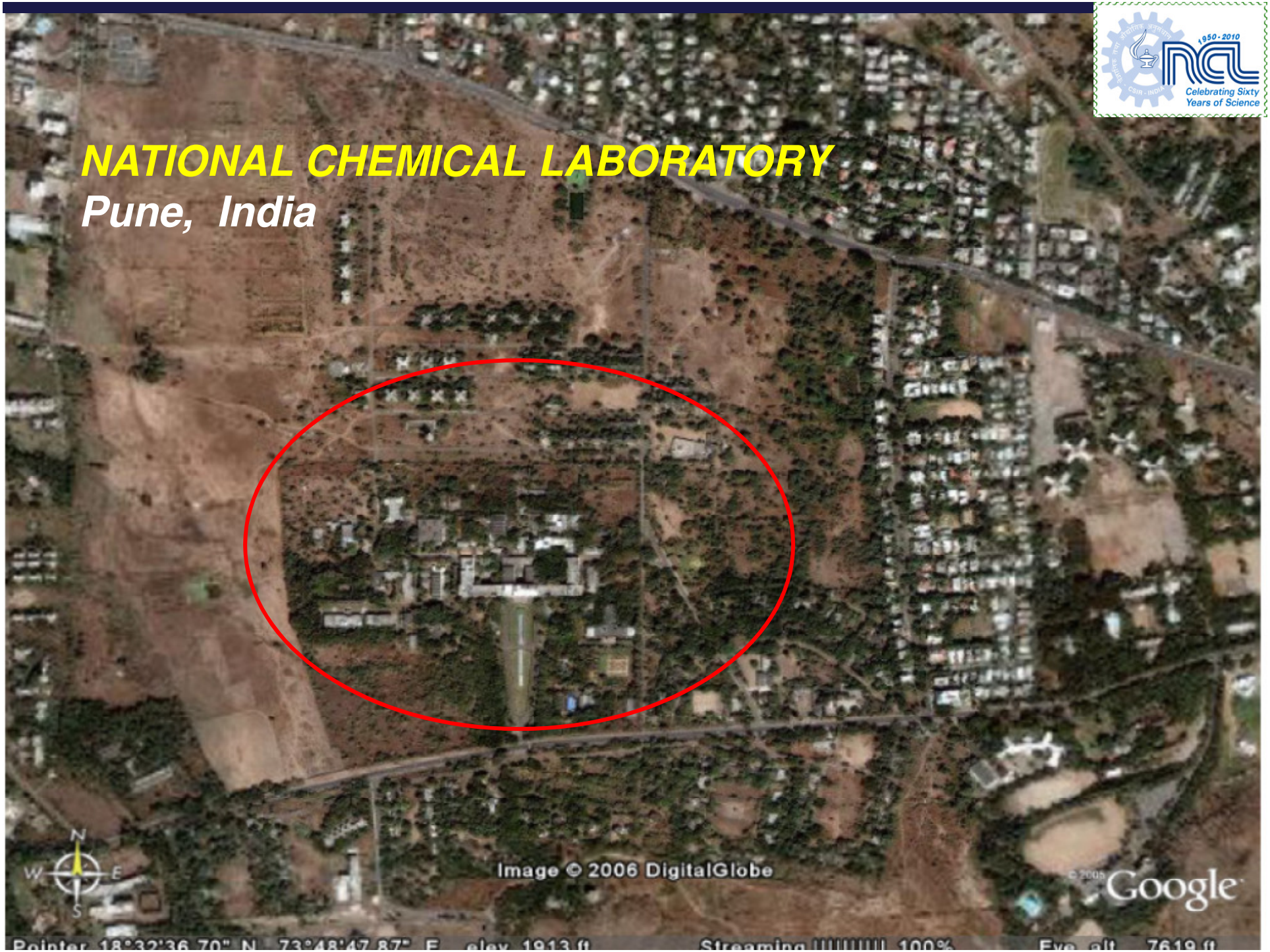
ESTD. 1942

Aerospace
Life and Plant Sciences
Chemical Sciences
Drugs & Pharmaceuticals
Material Science
Leather Science
Engineering Sciences
Food Science
Earth , Ocean & Physical Sciences….

Multi-disciplinary multi-location chain of 37 research laboratories
Largest chain of publicly funded laboratories
Total staff strength of 18000 ; scientific and technical staff : 13000

COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH (CSIR)

- **Value of R&D infrastructure : > US $ 1 billion**
- **Annual budget : US$ 250 million**
- **Over 1000 CSIR technologies commercially exploited**
- **US$ 1 billion worth of industrial production per year in India**
- **4000 scientific papers published per year with an average impact factor > 2.5 (2005)**
- **450 Indian and 500 foreign patents filed per year; About 250 patents granted to CSIR worldwide every year**


NATIONAL CHEMICAL LABORATORY
Pune, India
Image © 2006 DigitalGlobe
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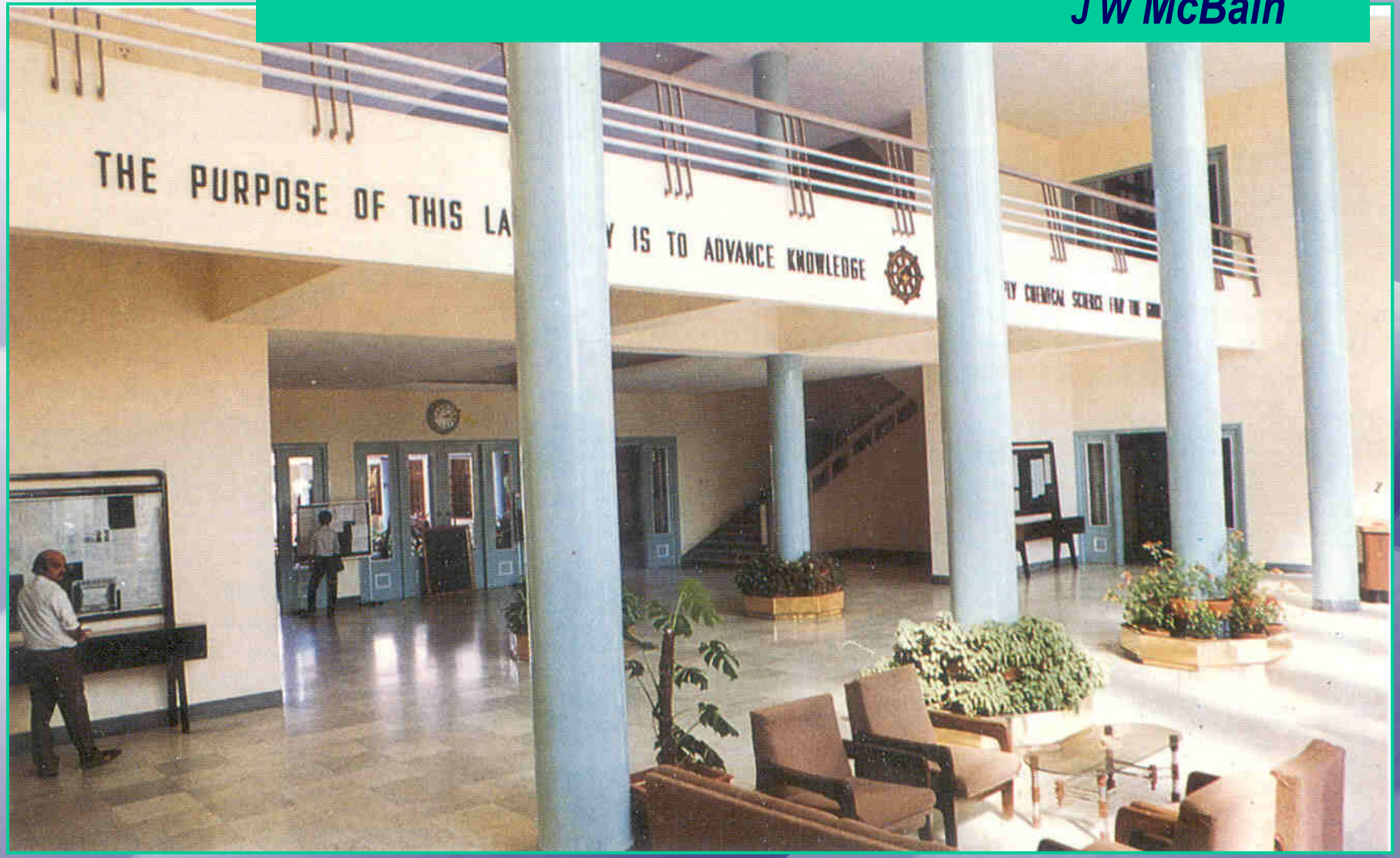
1950-2010 ncl Celebrating Sixty Years of Science

THE PURPOSE OF THIS LABORATORY IS TO ADVANCE KNOWLEDGE AND TO APPLY CHEMICAL SCIENCE FOR THE GOOD OF THE PEOPLE

J W McBain



NATIONAL CHEMICAL LABORATOR : MISSION

- **To carry out R&D in chemical and related sciences with a view to eventually deliver a product, process, intellectual property, tacit knowledge or service that can create wealth and provide benefits to NCL's stake holders**

- **To build and maintain a balanced portfolio of scientific activities as well as R&D programs to enable NCL to fulfill the demands of its stakeholders, present and future**

- **To create and sustain specialized knowledge competencies and Resource Centres within NCL which can provide support to all stakeholders of NCL**

LINKING SCIENCE TO SOCIETY

- Learning to connect principles of science to the concerns of society ; emphasis on application and functions
- Balance breadth with depth, creation of knowledge with delivery of solutions to the stakeholders
- Integrate disciplines : Chemistry-biology, material science – physics, earth and atmospheric science and engineering
- Communication : ability to “sell” the solution, not merely “solve” the problem
- Globally competitive and yet be locally relevant

S&T VISION FOR NCL

- **Encourage excellence in core areas of science and technology**
- **Nurture new fields of research at the intersection of disciplines**
- **Advance cross-functional collaborations**
- **Define and execute a few large mission mode programs that will energise the organization and demonstrate its collective strength**

The most exciting developments in science are occurring at the intersection of disciplines

NCL : A SNAP SHOT

- Established : 1950
- Location : Pune, India
- Total personnel
  - Permanent Staff : 730
    - Scientific : 206
    - Technical : 330
    - Administrative : 194
  - Research Fellows (CSIR, UGC) : 440
  - Project Staff (M.Sc's) : 382
  - Post doctoral fellows : 24

One of the largest publicly funded research institution in India
One of the oldest research institutions of independent India

NCL AT A GLANCE

- Over 220 scientific staff with PhD
- Interdisciplinary research centre with interests in polymer science, organic chemistry, catalysis, materials chemistry, chemical engineering, biochemical sciences and process development
- Excellent infrastructure for measurement science and chemical information
- 400 + graduate students pursuing research towards doctoral degree; about 80 students awarded Ph.D. degree by the University of Pune every year; a strong and young talent pool which renews every few years
- Publish the second largest number of peer reviewed papers in chemical sciences (~ 450) , file the largest number of patents, both in India and overseas (> 50) and produce the largest number of Ph.Ds in chemical sciences in India

SCIENTIFIC DIVISIONS

- BIOCHEMICAL SCIENCES
  - PLANT MOLECULAR BIOLOGY
  - MICROBIAL AND ENZYME SCIENCE
  - PLANT TISSUE CULTURE
- CATALYSIS
- CHEMICAL ENGINEERING AND PROCESS DEVELOPMENT
  - CHEMICAL ENGINEERING SCIENCE
  - CATALYSIS, REACTORS AND SEPARATION
  - PROCESS DEVELOPMENT
  - BIOCHEMICAL ENGINEERING
- PHYSICAL AND MATERIALS CHEMISTRY
  - MATERIALS CHEMISTRY INCLUDING NANO MATERIALS
  - THEORY AND COMPU-TATIONAL SCIENCE

SCIENTIFIC DIVISIONS

- POLYMER SCIENCE AND ENGINEERING
  - POLYMER CHEMISTRY
  - POLYMER PHYSICS
  - COMPLEX FLUIDS AND POLYMER ENGINEERING
- ORGANIC CHEMISTRY
  - SYNTHETIC METHODOLOGIES
  - CHEMICAL BIOLOGY
  - PHOTOCHEMISTRY
  - CARBOHYDRATE CHEMISTRY
  - SUPRAMOLECULAR CHEMISTRY
  - PROCESS R&D

NCL : RESOURCE CENTRES

- National Repository of Molecules (2007)
- NCL Innovations (2006)

– Digital Information Resource Centre (2003)
– Combi Chem Bio Resource Centre (2002)
– Centre for Materials Characterization (2002)
– Central NMR Facility (1998)
– Catalyst Pilot Plant (1995)
– National Collection of Industrial Microorganism (1950)

RESEARCH PLATFORMS

- Clean Technology
  - Solid catalysts
  - High specificity / atom economy
  - Green solvents

- Chemistry in Unusual Media
  - Supercritical CO2 and water
  - Aqueous media
  - Ionic liquids
  - Reaction in dispersions, suspensions and emulsions
  - Solid state reactions

- Industrial (white) Biotechnology
  - Bio-catalysis and bio-transformations
  - Bio-based building blocks for performance chemicals
  - Fermentation processes

Contd….

RESEARCH PLATFORMS

- **Chemistry Toolboxes**
  - **Chiral switches / single enantiomers**
  - **Microencapsulation**
  - **Synthetic chemistry tool boxes (e.g. Suzuki coupling, catalytic hydrogenation, metathesis, click chemistry etc.)**
  - **Crystal engineering and polymorphmism**

- **Unusual Reaction Conditions**
  - **Photochemistry / photocatalysis**
  - **Electrochemistry**
  - **Microwave**
  - **Sono-chemistry**
  - **Plasma**

Contd….

RESEARCH PLATFORMS

- **New Processes / Product Strategies**

  - **Chemical product engineering**
  - **Micro-reaction engineering**
  - **Novel reactor and mixer designs**
  - **Novel separation processes especially membrane based processes**
    - **Computational modeling, simulation and visualization**
  - **Process intensification / smaller footprint of process plants**
  - **Modular and mobile manufacturing**
  - **Energy and water use efficiency**
  - **Effluent and waste minimization**

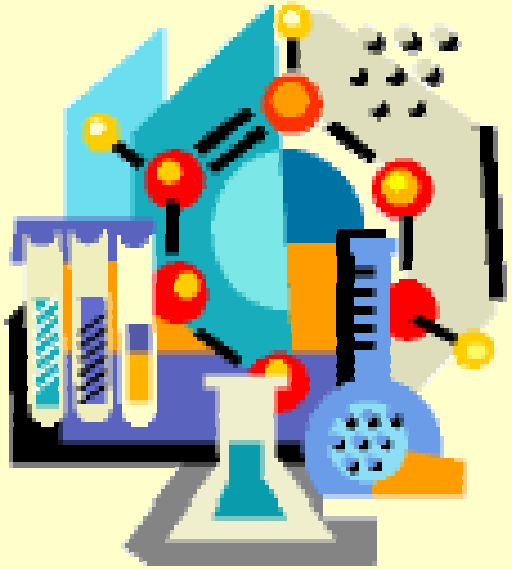
CENTERS OF EXCELLENCE

- Nano-science and Nano-technology (2005)
- Chemical Biology (2007)
- Scientific Computing (2008)
- Micro-reactor Engineering(2008)
- Materials for Solar Energy and Fuel Cells (2010)
- Clean Coal Technologies (2010)

NANOSCIENCE, NANOTECHNOLOGY & ADVANCED MATERIALS

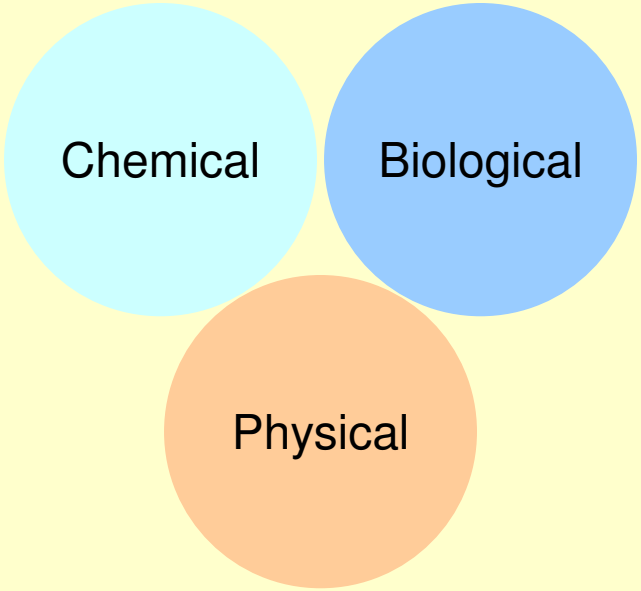
- **Nanoparticle Synthesis By Different Routes**
- **Self Assembly, Templated Assembly and Directed Assembly of Nanoparticles**
- **Nanocomposites**
- **Thin Films & Coatings**
- **Surface Nano and Micro Engineering, Surface Functionalization**
- **Biocompatibility of Processed Surfaces and Coatings**
- **Biomedical Applications of Nanoparticles and Nanosystems**
- **Advanced Electronics, Spintronics and Optics applications of Thin Films and Nanosystems**

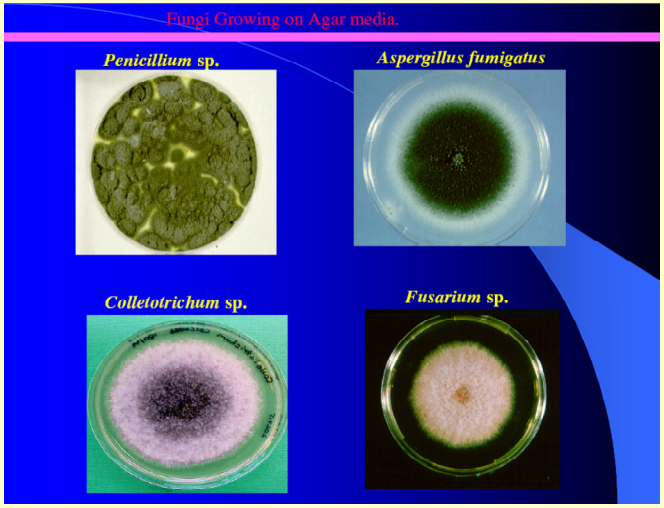
NANOPARTICLE SYNTHESIS AND MATERIALS PROCESSING BY DIFFERENT ROUTES



Sol-Gel
Co-precipitation
Hydrothermal

Materials
Metals
Metal Oxides
Semiconductors

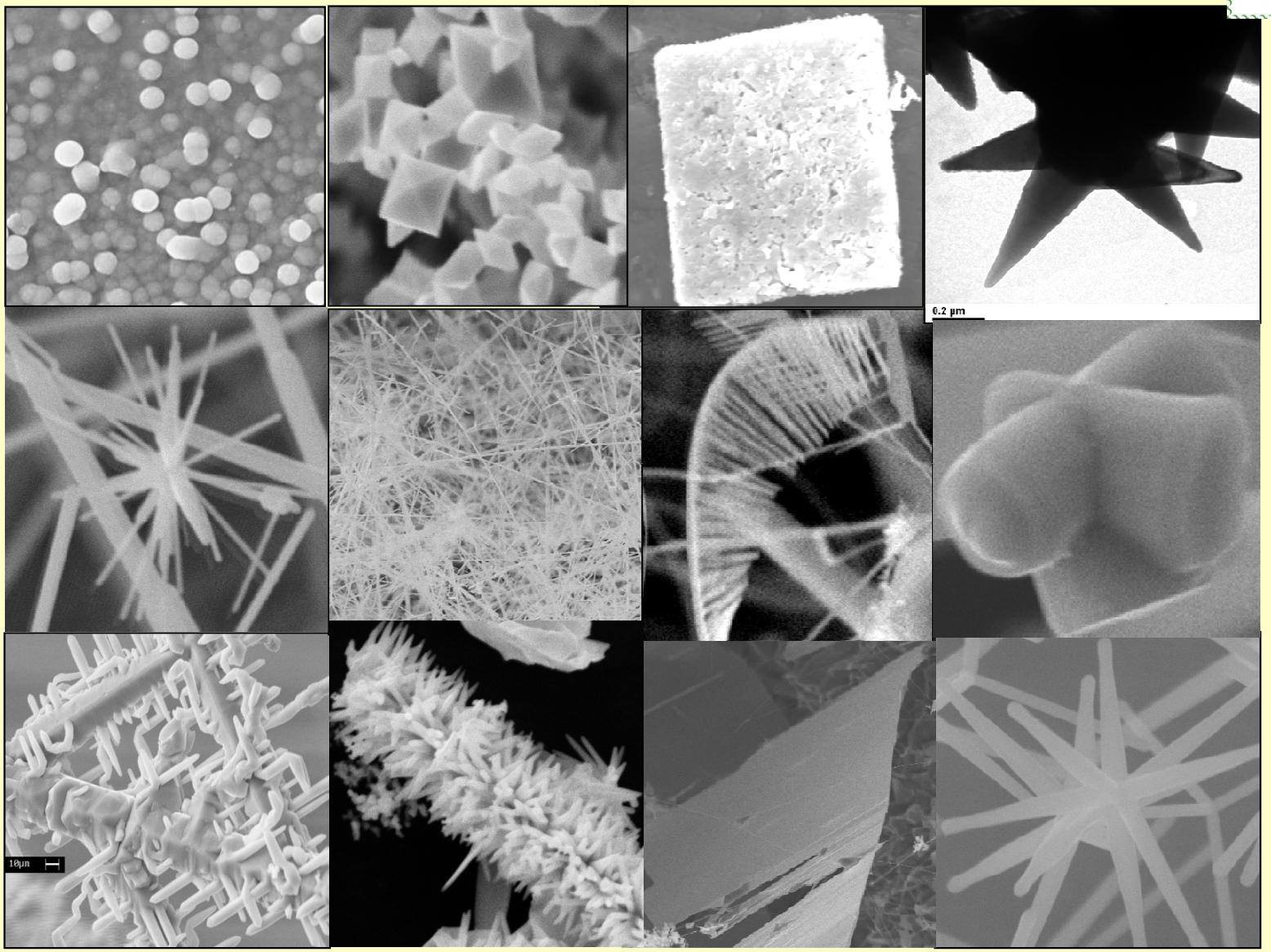




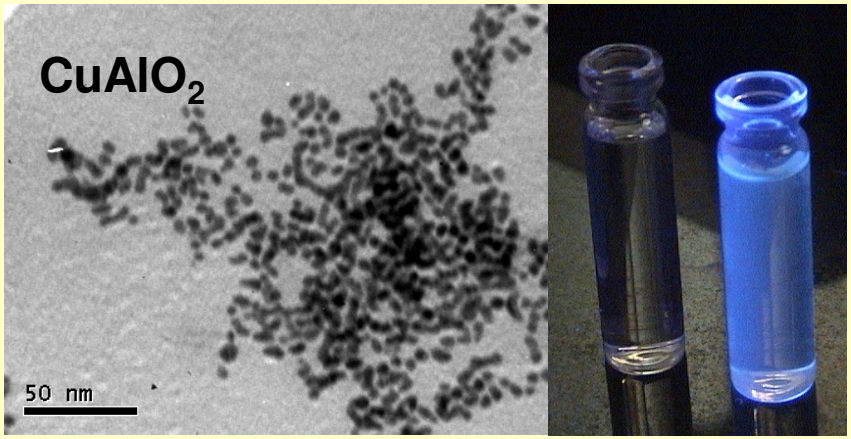
Fungal, Bacterial Processes

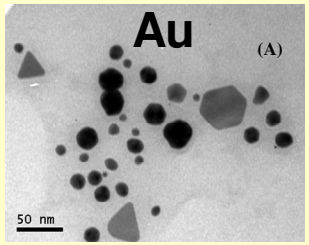
Pulsed Laser Deposition
Chemical Vapor Deposition
Surface Treatment
Etching

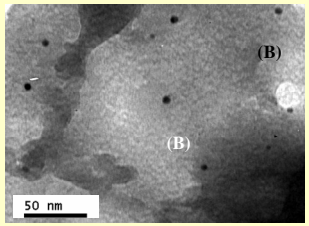
SnO_2 nanostructures

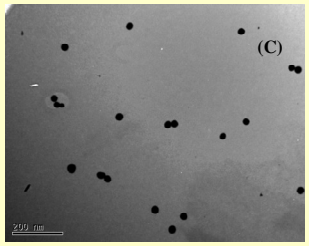


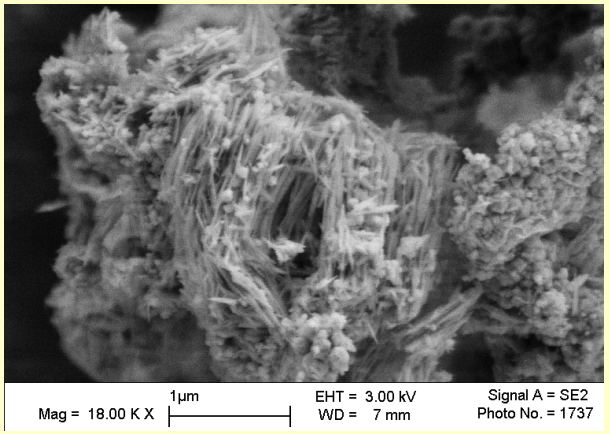
NANOPARTICLES OF DIFFERENT SHAPES, SIZES & FUNCTIONALITIES

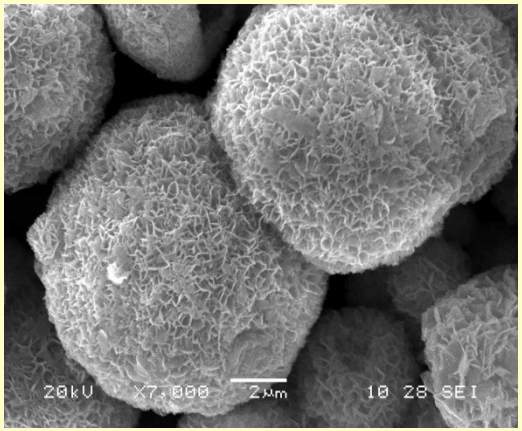




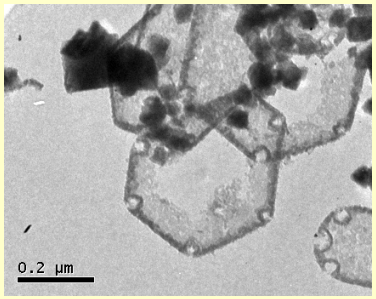


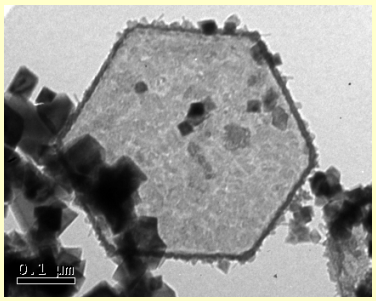






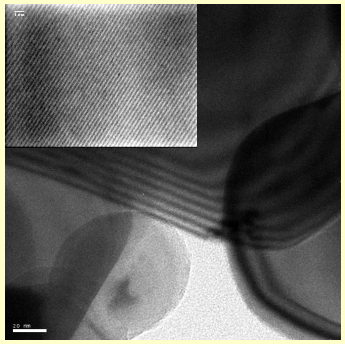
In_2S_3

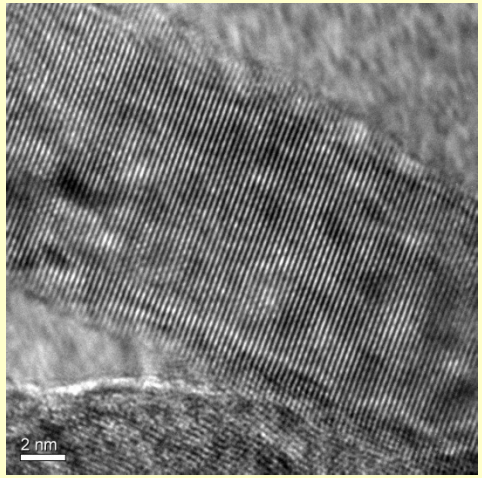




Mn_3O_4

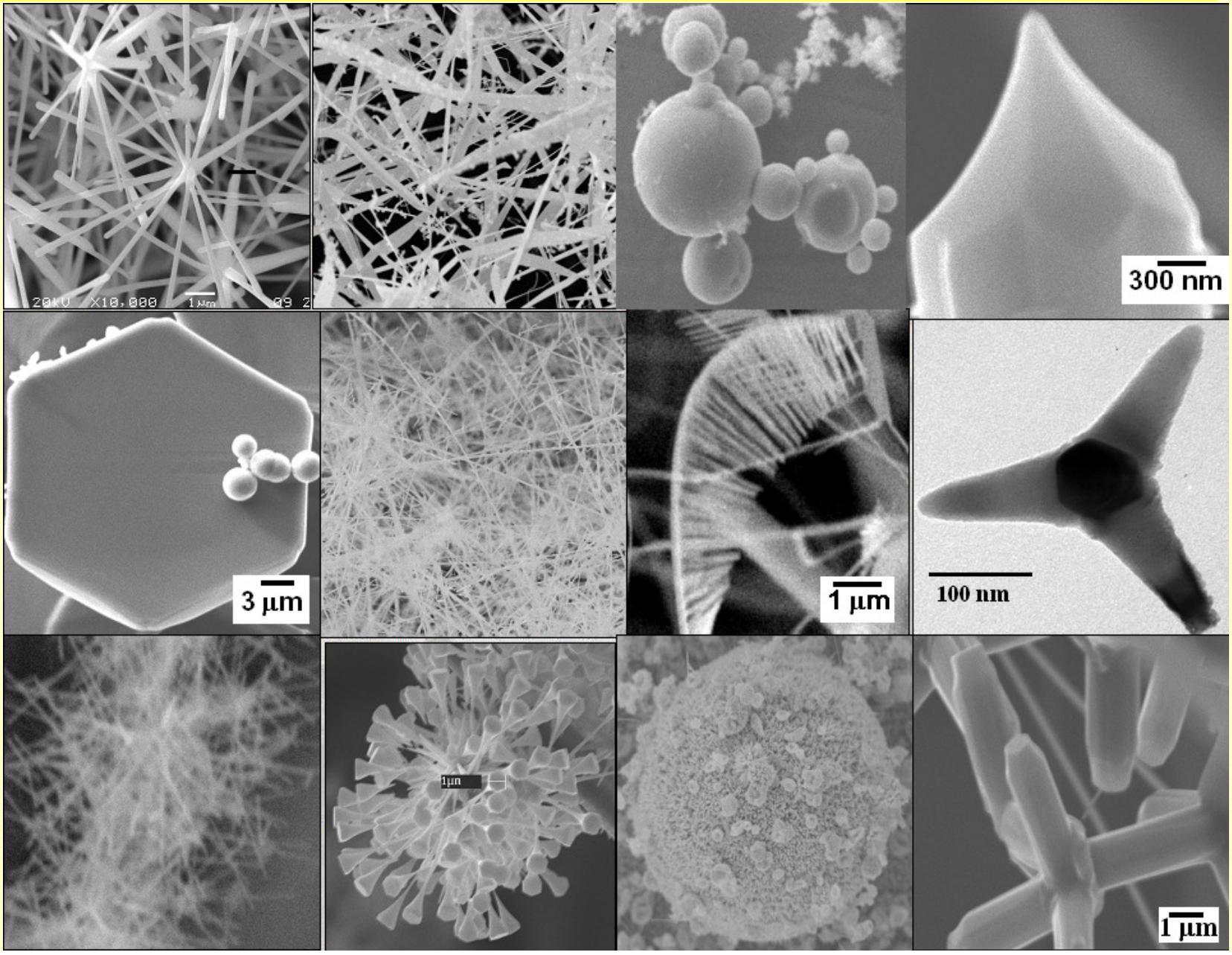
TiO_2 Nanodisks





Fe_3O_4

GROWTH AND STRUCTURE EVOLUTION OF NANOSTRUCTURES OF ZNO



MICRO REACTOR ENGINEERING FOR FINE AND SPECIALITY CHEMICALS

- **Establish continuous reaction facility using micro reactors and other micro components: Demonstrate continuous synthesis/develop and characterize the performance of new micro devices**
- **Establish facilities for kinetics and thermal studies (micro-calorimeter), flow and mixing characterization facilities (μ-PIV, ….), micro fabrication**
- **Expand applications horizons in areas such as Catalysis/coating techniques, process control, integrated processes, numbering of micro plants, fuel cell energy generation, nano particle synthesis**

NCL-INDUSTRY CONSORTIUM ON MICROREACTOR TECHNOLOGY

L&T Ltd

Tata Chemicals Ltd

GMM Pfaudler Ltd

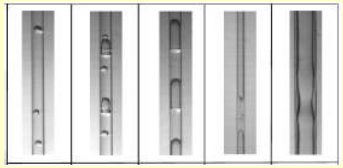
Ranbaxy Ltd

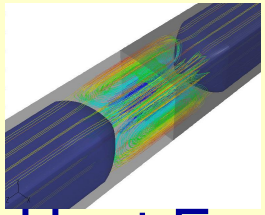
Gharda Chemicals Ltd

Reliance Industries Ltd

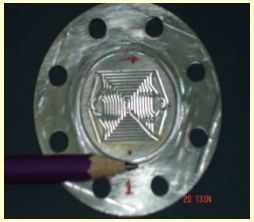
MICRO-REACTORS

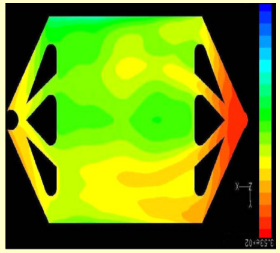
- Multiphase Flow and Mixing in Micro-reactors





- Developed Cross-flow Reactor cum Heat Exchanger





- Established Micro-reactor Rig

  Can handle two gases and

  two liquids

ENHANCING ENERGY EFFICIENCY (FE August 31, 2009)

• Outlay	Rs. 75,000 crore (Rs. 300 crore 2009-12)
•Target	• Reduce energy use by 5% 2015 (reduce energy use by 10 GW by 2012) • Redce CO_2 emissions by 100 million tonnes/year • Create an energy efficiency market worth Rs. 75,000 crore • Set energy efficiency targets and earning of "Escerts" for industry; Industry consumes 42% of energy and emits 31% CO_2 in the country • Venture capital for energy efficient products and services
• Implementing agency	• Bureau of Energy Efficiency

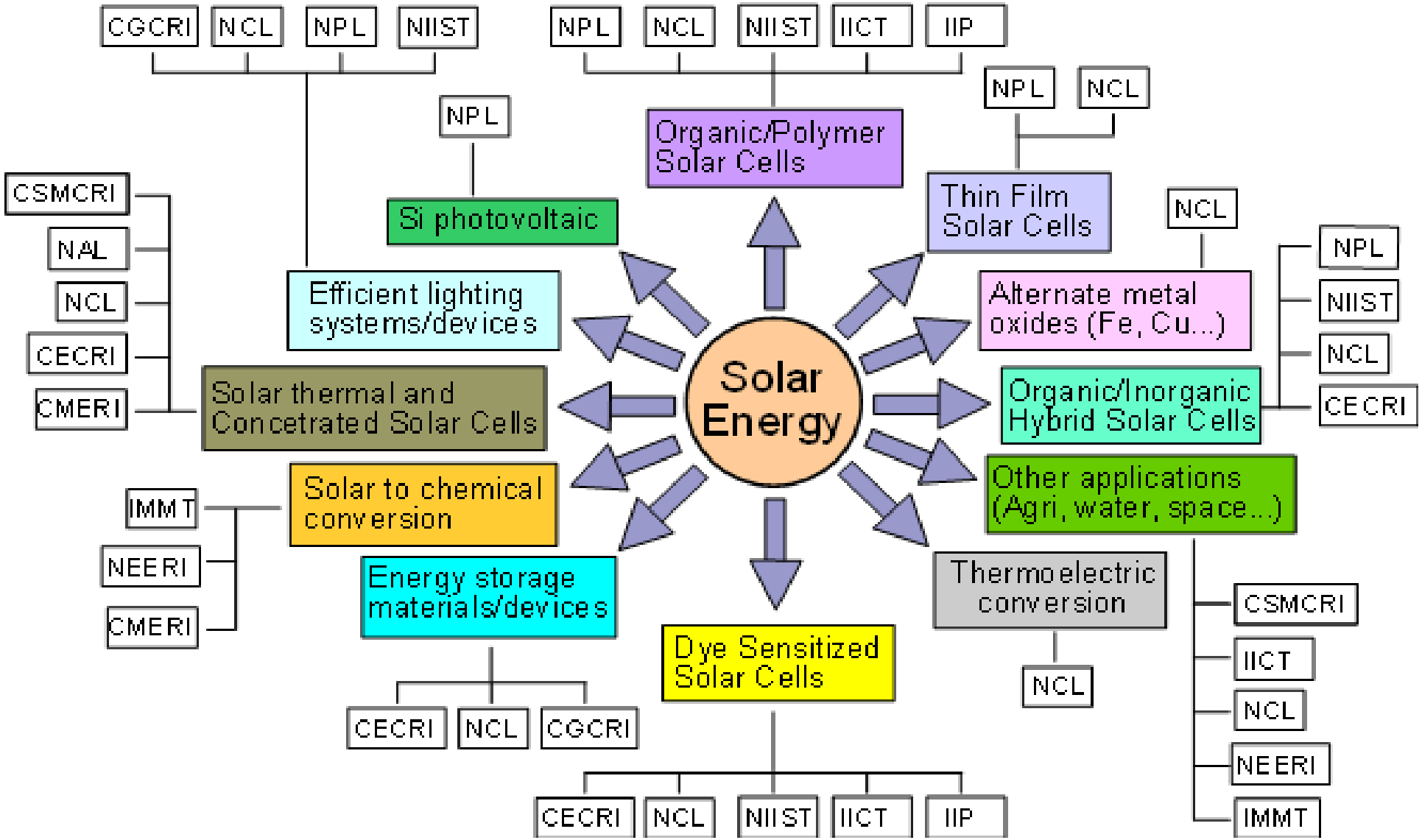
NATIONAL SOLAR ENERGY MISSION
(Source : Financial Express, August 17, 2009)

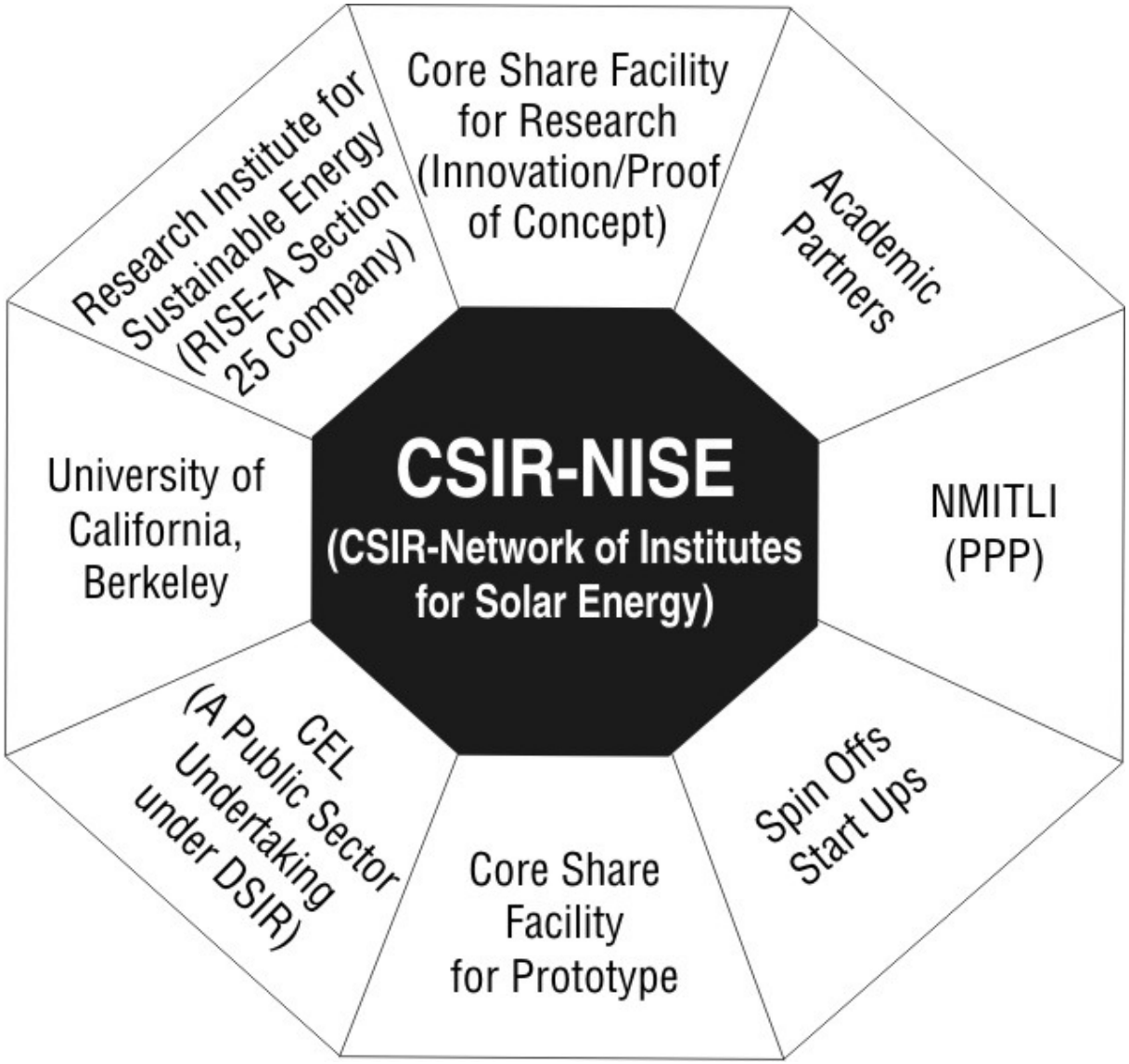
Launch	**November 14, 2009**
Outlay	**91,684 crores (US $ 19 billion)** **- Investment incentives 70,000 crore** **- Subsidies 7,000 crore**
Target	**• 20 GW by 2020** **– 1.5 GW (2012)** **– 6 GW (2017)** **– 20 GW (2020)** **• Rs. 18/Kwh (2009) – Rs. 6 Kw h (2020) – Rs. 2 Kw h (2030 (Griod parity with coal)** **• Light 3 billion house holds by 2030** **• CO_2 reduction by 42 million tons** **• 50 million sq.ft. area for solar thermal power**

NATIONAL SOLAR ENERGY MISSION
(Source : Financial Express, August 17, 2009)

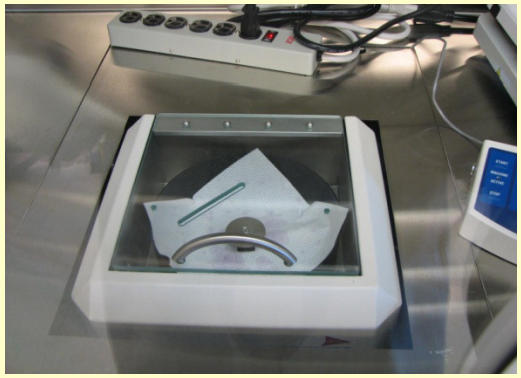
System	• **Statutory Solar Authority** – **Finance** – **Tariff** – **Technology** – **Special projects**

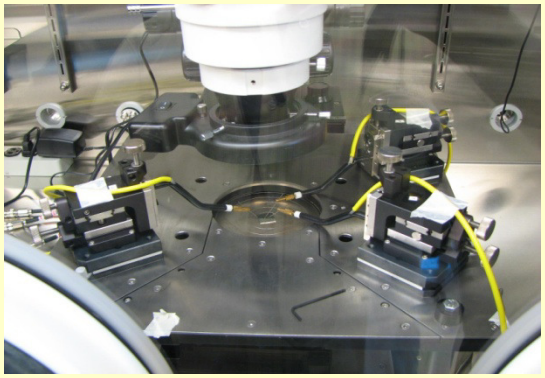
CSIR in solar energy

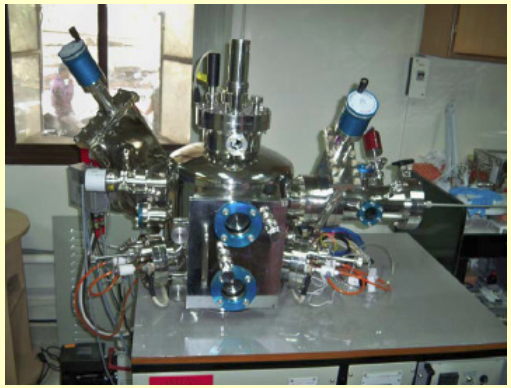



Core Share Facility for Research (Innovation/Proof of Concept)
Academic Partners
NMITLI (PPP)
Spin Offs Start Ups
Core Share Facility for Prototype
CEL (A Public Sector Undertaking under DSIR)
University of California, Berkeley
Research Institute for Sustainable Energy (RISE-A Section 25 Company)
CSIR-NISE
(CSIR-Network of Institutes for Solar Energy)

Mini FAB for Organic Solar Cells



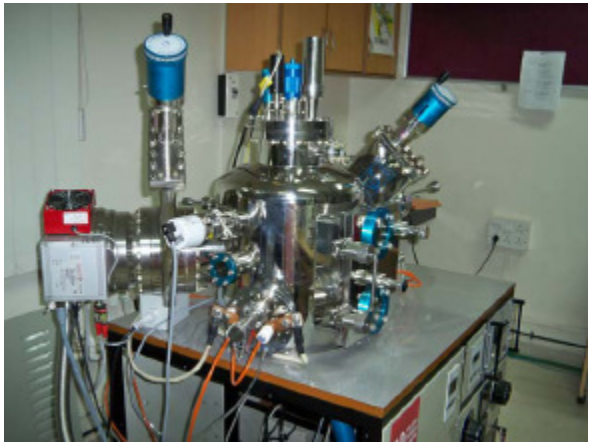




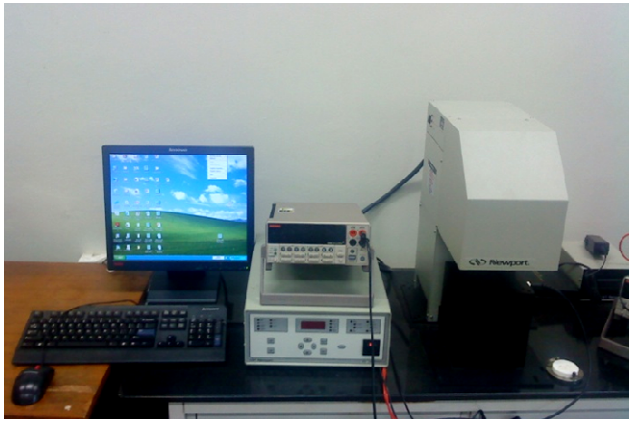

50 YEARS TURBO PUMPS
PLD-STD-12


50 YEARS TURBO PUMPS


START SYNTH




Veeco
Dektak 150



CLEAN COAL TECHNOLOGY

- India will generate 800 GW of power from coal in 2030 (50% of total)
- India consumes 8% of world total coal consumption (China 39%, US 16%)
- India coal reserve 250 billion tons / Extractable potential = 50 billion tons
- Global coal consumption slated to increase by 50% between 2006 – 30
- Coal's share of world's energy consumption will be approximately 30% by 2030
- To maintain 8% GDP growth, India has to increase its primary energy supply by at least 3-4 times
- Even at the most optimistic projections, renewables will contribute 6% of our total energy demand by 2030
- Therefore, superior coal based technologies is a necessity for India. 1% increase in efficiency in a coal based power plant leads to 2% reduction in CO_2.
- Objective : Improved efficiency, better heat and material integration, minimize CO_2, carbon sequestration technologies; combine energy production with chemicals

RICH TRADITIONS OF ACADEMIC RESEARCH FOR OVER FIVE DECADES

- **A recognized center for excellence for academic research in chemical and related sciences**
- **A distinguished tradition of scholarship for over six decades**
- **An institution that has nurtured world class scientists in diverse areas of chemical and related sciences**
- **Significant contributions to human resource development for both academia and industry. NCL alumni occupy positions of distinctions in both academic / corporate world, Indian and global**

WORLD CLASS RESEARCH INFRASTRUCTURE

- 24 X 7 access to research laboratories; The laboratory doors have never been locked since founding of NCL!
- Access to the world of digital information sources to every member of the staff
- Access to state of the art research infrastructure – analytical facilities, glass blowing, engineering workshops etc.
- Excellent computational resources ;connectivity to Grid computing facility, 1000 node high performance computational cluster
- Access to open-source computational and proprietary math tools

ANALYTICAL FACILITIES

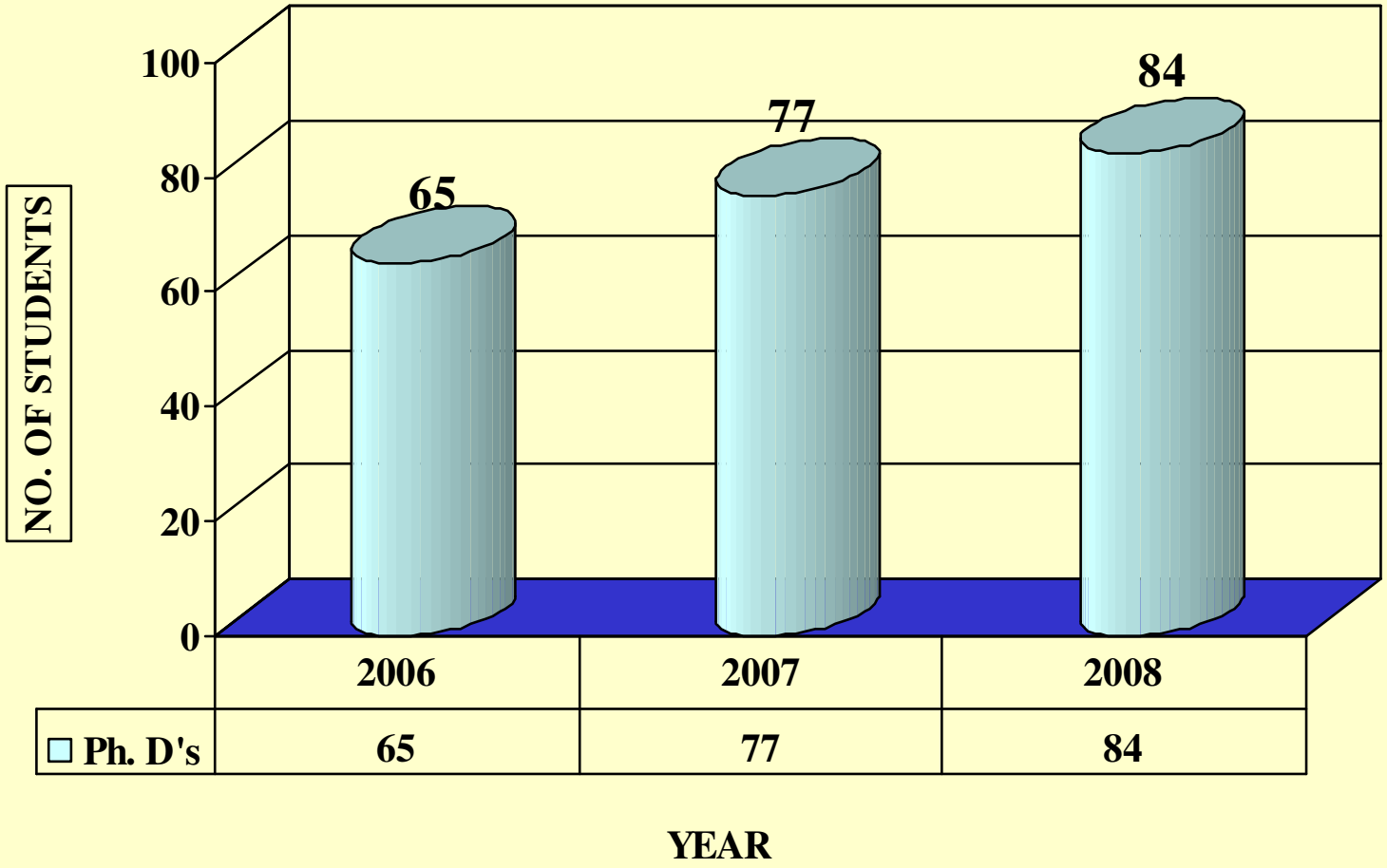
- NMR (solid, liquid state) : 200 / 300 / 400 / 500 MHz (4 machines)
- Mass Spectrometry : LC-MS-MS, MALDI-TOF, HR-Mass Spectrometer
- Microscopy : FE - SEM, HR-TEM
- X-Ray : Powder XRD, Single Crystal XRD, Biomacromolecular XRD, Rotating Anode XRD, SAXS
- Chromatography – GC-MS, HPLC, GC, Flash Chromatography, Chiral Chromatography, Simulated Moving Bed Chromatography (SMBC), Ion Chromatography
- Surface Analytical Techniques : XPS, AFM, FTIR Microscopy
- Spectroscopic Techniques : ESR, UV-Visible, Fluorescence, FT-IR

ANALYTICAL FACILITIES

- **Elemental Analysis Techniques : AAS, X-Ray Fluorescence, EDXA, Microanalytical Techniques**
- **Thermal Analytical Techniques : DSC, TGA, DMA, Photocalorimeter, Titration Calorimeter**
- **High Throughput Facilities : Parallel Synthesizer, High Throughput Extraction, SEPBOX, High Throughput Screening**
- **Rheological Analysis Techniques : Controlled Stress / Strain Rheometer, High Shear Capillary Rheometer**
- **Electrochemical Techniques : Polarography, Scanning Electrochemical Microscope Dielectric Spectrometer**
- **Biochemical Techniques : Automatic DNA Sequencer, Pulsed Field Electrophoresis, PCR 2D Electrophoresis, DNA / PNA/ Peptide Synthesizer, CD Spectrometer. Microarray Spotter**

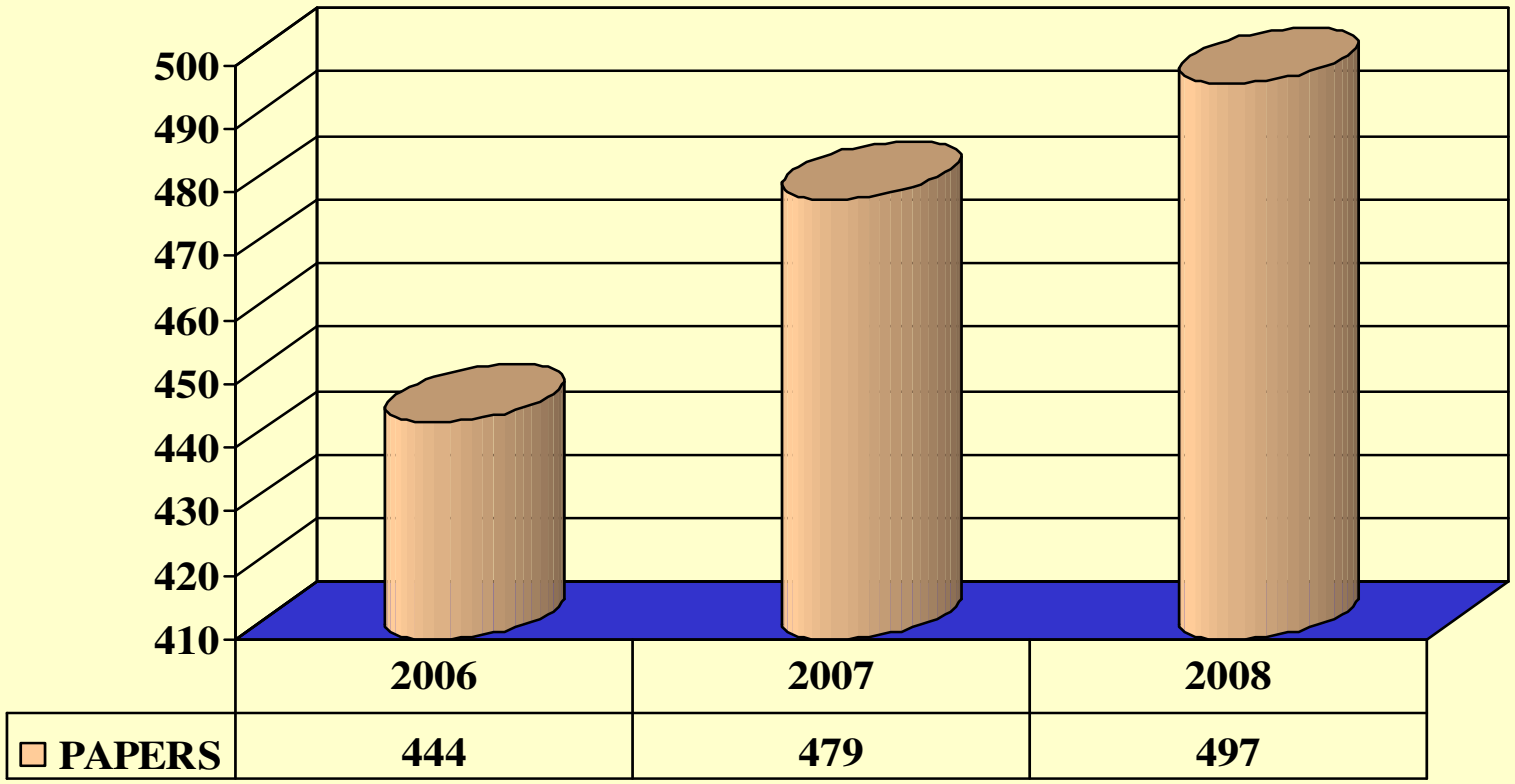
Ph.D's AWARDED (2006-2008)

TOTAL PhD's AWARDED : 1720



RESEARCH OUTPUTS : PUBLICATIONS

TOTAL PUBLICATIONS : 10,527



INTERNATIONAL ACADEMIC COLLOBORATIONS

NIMS

Hanyang University

Tokyo University of Science

KRICT
Korea Research Institute of Chemical Technology

UFPR
UNIVERSIDADE FEDERAL DO PARANA

Gwangju Institute of Science and Technology

INSA LYON

UNIVERSITA' degli STUDI di ROMA TOR VERGATA

Hochschule Anhalt (FH)

RMIT UNIVERSITY

UNIVERSITÀ DEGLI STUDI DI TORINO
ALMA UNIVERSITAS TAURINENSIS

USTL
LILLE 1

THE OHIO STATE UNIVERSITY

The University of Nottingham

TECHNOLOGY AND INDUSTRIAL RESEARCH

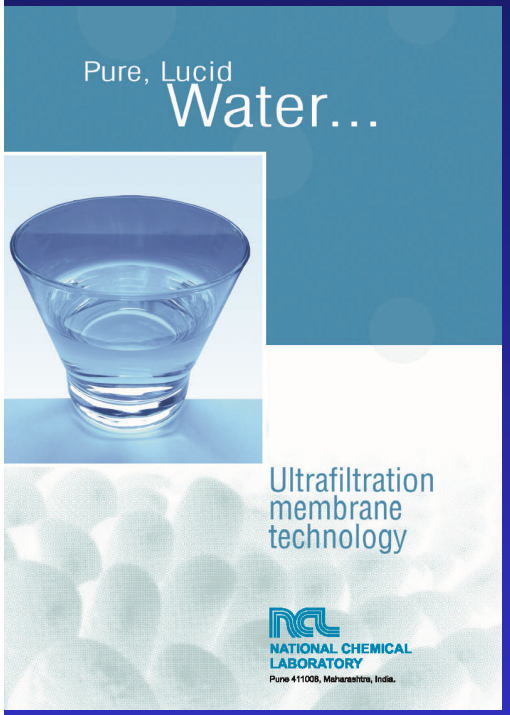
PROCESS CHEMISTRY AND TECHNOLOGYAT NCL

- Strong process chemistry / process design and engineering skills
- High degree of competence in homogeneous and heterogeneous catalysis
- Excellent analytical support facilities
- Ability to experiment with several reactors (batch, CSTR, fixed bed , trickle and fluid bed) at high temperatures and pressures
- Strong domain knowledge in process modeling, simulation, advanced process control strategies and flow modeling
- Over three decades of close association with Indian Chemical Industry
- NCL is recognized as a credible partner, especially, for new technologies knowledge, skills and facilities

CREATING VALUE TO CUSTOMERS

- **NCL' s portfolio of programs include process and product development, reaction engineering, pilot plant experiments, process design and engineering, process simulation and modeling, computational modeling, technical consulting and continuing education**
- **NCL has the capability to deliver solutions to customers across the full spectrum , from laboratory scale development to design and operation of batch and continuous pilot plants and preparation of basic engineering packages for chemicals , polymers and materials**
- **NCL is focused on creating value to customers through innovations, IP, development of non-infringing processes and science based understanding of complex phenomena**

TECHNOLOGY AND INDUSTRIAL RESEARCH : PRODUCTS IN MARKET (2002-)



Membrane Filters (I) Ltd.

Ocular implants (Biopore)

Fine chemicals

•THPE (Excel Industries)

•ATBS (Vinati Organics)

Emcure Pharmaceuticals

EXAMPLE: THPE, GE PLASTICS/ EXCEL

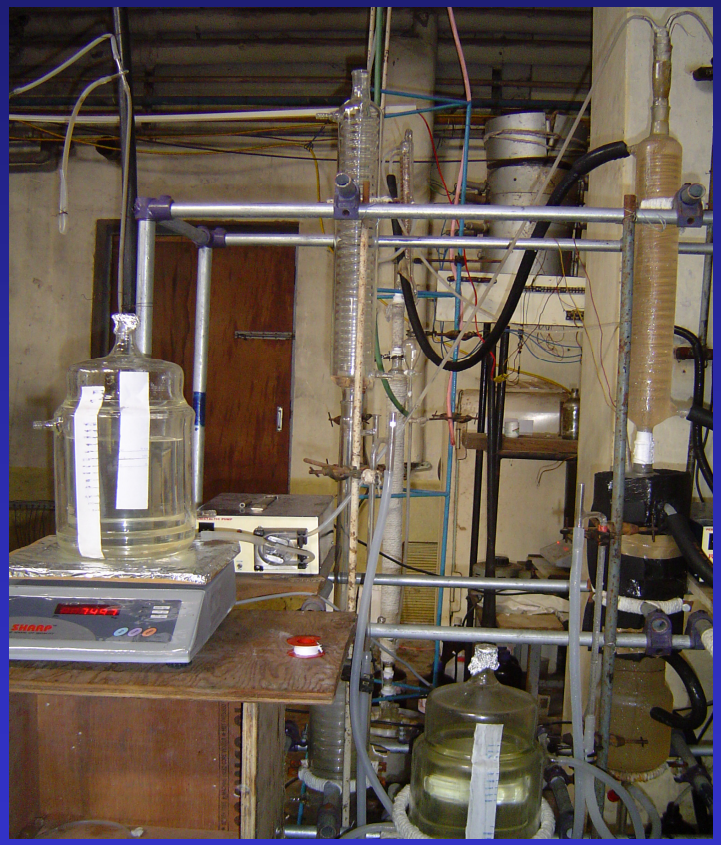
THPE: 1,1,1-tris-(4-hydroxyphenyl) ethane

THPE is used as a branching agent in polycarbonates. The branching agents employed are tri-functional or higher molecules which can incorporate within a linear aromatic carbonate polymer chain and have a functional group left for further reaction which provides the branched molecule. Branched polycarbonates are widely used in film, fibers, sheets, tubes, rods and in particular blow molding applications such as bottles and containers.

A non-infringing, patented process for making THPE. NCL also developed a toll manufacturer for THPE in India for GE Plastics. Till then, THPE was produced by a single manufacturer in the world who could charge monopolistic prices.

TRANSLATING CHEMICAL PROCESSES FROM BENCH TO MANUFACTURING

2005



Bench scale Epichlorohydrin facility at NCL

2008

3000 tpa Epichlorohydrin plant at Rayong, Thailand

CATALYTIC PROCESS FOR THE MANUFACTURE OF EPICHLOROHYDRIN FROM ALLYL CHLORIDE

- **An improved and patented TS-1 catalyst**
- **Cold extraction as a basis for downstream separation of aqueous and organic layer to minimise hydrolysis of ECH at high temperature**
- **Overall conversion of > 99 % and yield of > 95 % achieved**
- **Basic and detailed engineering package for a 3000 tpa plant completed for a plant to be located at Rayong, Thailand IAditya Birla Group)**
- **Two tons of catalyst (first charge) produced at NCL for supply to the plant**
- **Commissioning in progress**
- **First plant of its kind in the world**

View of 3000 tpa Epichlorohydrin plant at Rayong, Thailand

FROM BENCH SCALE TO DEMONSTRATION PLANT

2003

2007

VALUE ADDITION TO BIOMASS DERIVED FROM SUGARCANE : AN INTEGRATED BIOREFINERY

- ***Pre-fractionation of bagasse for the recovery of cellulose, hemi-cellulose and lignin***

Cellulose recovery : 85% of theory; α-Cellulose : 94%;
β- and γ-cellulose : 2%;Hemi-cellulose : 3%
Kappa number: 0.8 max (0.1% lignin)
Viscosity : 14 cP (from cupric ethylene diamine solution)

	Mw (SEC)	[η] dl/g	Ash, %	Mois-ture, %	Hexane soluble %	Bright-ness %
Bagasse (NCL)	700,000	10.3	0.08	4.2	0.11	80
Wood pulp	765,000	10.2	0.44	5.3	1.03	83

In addition, hemi-cellulose is recovered in >65% yield and lignin in >80% yield. Lignin is sulfur free

Demonstration plant installed at Godavari Sugars, 100 kg feed bagasse per batch

VALUE ADDITION TO BIOMASS DERIVED FROM SUGARCANE : AN INTEGRATED BIOREFINERY

- ***Fermentative conversion of sugarcane juice to polymer grade L(+)-lactic acid***

- **Developed a new mutant strain capable of high lactic acid productivity**
- **Developed a batch fermentation process for production of L-(+) Lactic acid with a sp.lactic acid productivity of 3.75 g/L/h; process demonstrated in a 8000 L fermenter located at Godavari Sugars Mills Ltd.**
- **A novel downstream process for recovery of Lactic acid with a purity of 99.80% has been developed. A 1 kg per hour continuous facility in operation at NCL**

Downstream processing facility at NCL

FROM LABORATORY FERMENTOR TO COMMERCIAL SCALE FERMENTORS

- Two fermentation trials conducted in 8000 L fermentor at Godavari Sugar Mills Ltd.,
- Specific productivity of 5.5 g /L/h Lactic acid achieved
- The fermentation process scaled upto 35,000 L fermentor
- GSML decides to adapt NCL`s process for calcium Lactate manufacturing

L(+) LACTIC ACID FROM SUGAR CANE JUICE

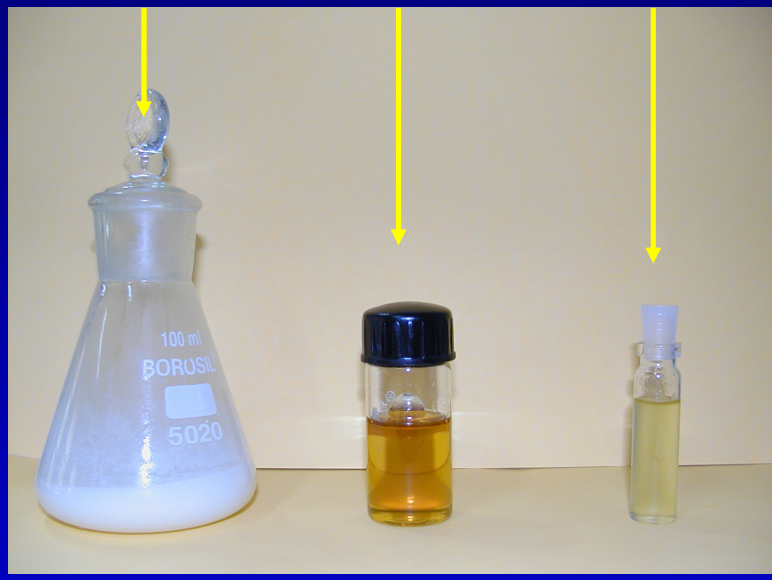
- **A 300 tpa continuous demonstration plant for L(+) Lactic acid (LA) has been designed by M/s Texol Engineering Limited , Pune based on the Basic Engineering Package prepared by NCL**
- **Equipments for plant and machinery are on order**
- **The plant is expected to be mechanically complete by June 2010 and will be located at Godavari Sugar Mills Limited, Sameerwadi, Karnataka**
- **GSML has identified customers for poly (L+) Lactic Acid (PLLA) , a biodegradable polymer. NCL is currently working on a process to manufacture PLLA downstream of the LA facility coming up in Sameerwadi**

When commissioned , this will be the first sugar cane based L(+) Lactic acid plant in the world with product quality matching food and polymerization grades

SOLID CATALYSTS FOR BIODIESEL MANUFACTURING

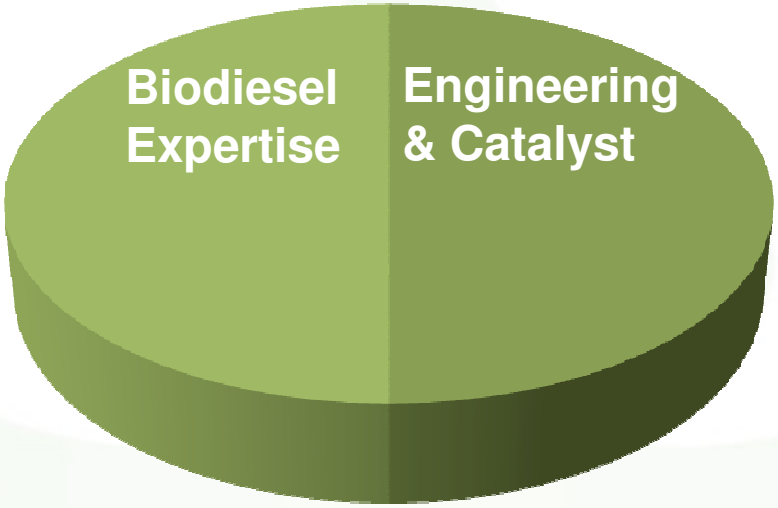
- **A range of fresh, used, edible and non-edible oils can be used**
- **Non aqueous process; no aqueous effluent; anhydrous glycerol obtained as byproduct**
- **Transesterification with methanol as well as octanol**
- **No leaching of catalyst into the reaction mixture**
- **Catalyst is reusable and easily separable.**
- **Can tolerate high levels of free fatty acids**
- **Continuous, fixed bed process**
- **Biodiesel quality meets desired specifications for fuel applications**

Veg. Oil Biodiesel Glycerol



- ***Several issued and applied patents to NCL/CSIR have been licensed***
- ***A demo-plant (20 tons per day) is expected to start up by second quarter 2010***

Management Expertise



Strategic Partners

- One of largest catalyst producers in world
- 5,000 person, publically traded company
- Global production capacity

- Market leader for crude oil dewatering using electrostatic separation
- Co-developed novel method for separating biodiesel & glycerin

- One of the world's largest catalytic research institutes
- Government backed institute with over 200+ PhD's
- Focus on catalysis since 1980

Ravi Randhava, PhD. – CTO
- Founder of Xytel – 700+ world wide process engineering company
- Focus on solid catalyst technology development

PATENT PORTFOLIO

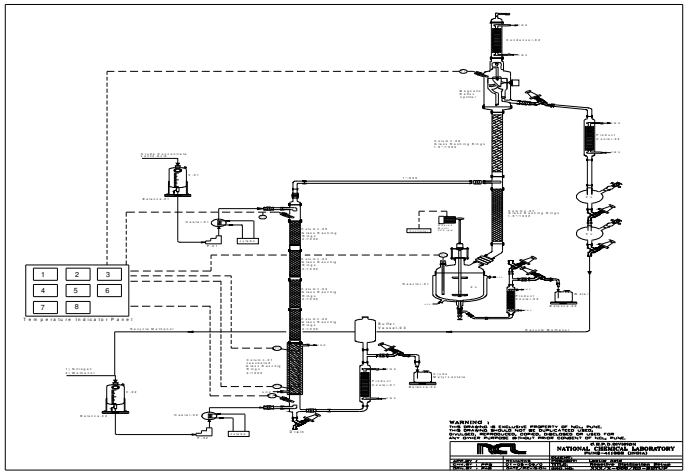
- **7 patent applications filed**
  - **2 on compositions of matter**
  - **5 on process and use of catalysts**
  - **2 patents – GRANTED by EPO and USPTO**
- **1 patent filed on electro-static biodiesel/glycerin separation with NATCO**
- **1 new composition of matter patent application pending**

BIODIESEL PILOT PLANT

A PROCESS FOR VINYL BENZOATE & VINYL-2-ETHYL HEXANOATE

VINYL ESTERS

- Transition metal complex catalyzed transvinylation of carboxylic acid with vinyl acetate monomer is of significant interest to industry
- The existing transvinylation processes are carried out in a batch type reactor with low catalyst turn-over number, equilibrium constraints poses problem during product isolation



Pilot plant schematic experimental setup for continuous synthesis of vinyl ester at NCL

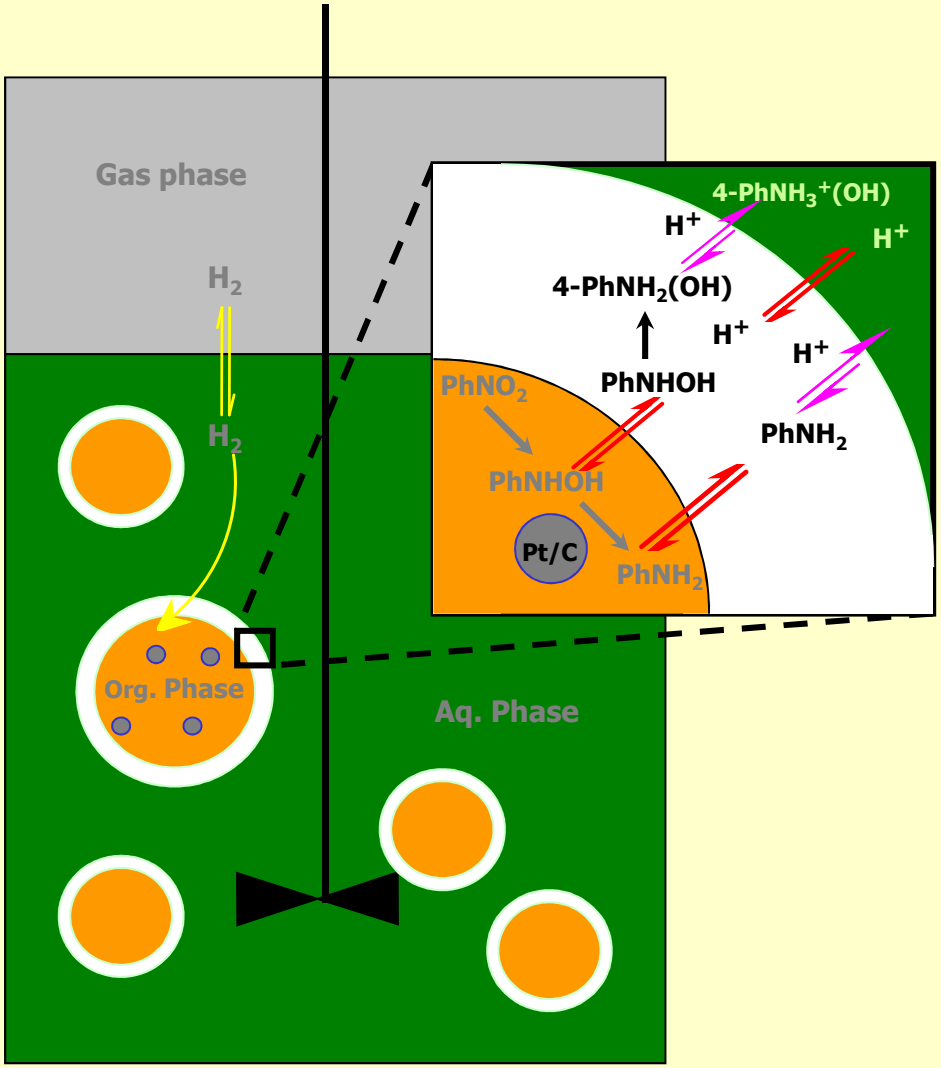
SALIENT FEATURES

- ❑ New continuous esterification process has been developed based on transvinylation
- ❑ A zero effluent process i.e. green process
- ❑ Total recycle and recovery of catalyst
- ❑ A large turn-over of about 20-25 kg/gm of catalyst
- ❑ The purity of product obtained in the commercial unit was found to be more than 99.95%
- ❑ A unique reactive distillation (RD) facility created

Semi-commercial plant(350 tpa) for production of vinyl esters at MEHIK Chemicals Pvt. Ltd, Thane

p-AMINOPHENOL FROM NITROBENZENE

A four phase catalytic reaction



- Developed a single step process for PAP via catalytic hydrogenation of nitrobenzene
- A conversion of nitrobenzene >99% with ≥ 65% selectivity to PAP and ≅ 33% selectivity to aniline successfully demonstrated on a 2 liter scale
- Designed a loop recycle slurry reactor for pilot scale operation
  - BEP completed for 100 liter capacity (12-15 kg/day) continuous hydrogenation with downstream processing

PARA-AMINO PHENOL PILOT PLANT (100 KG/HR)

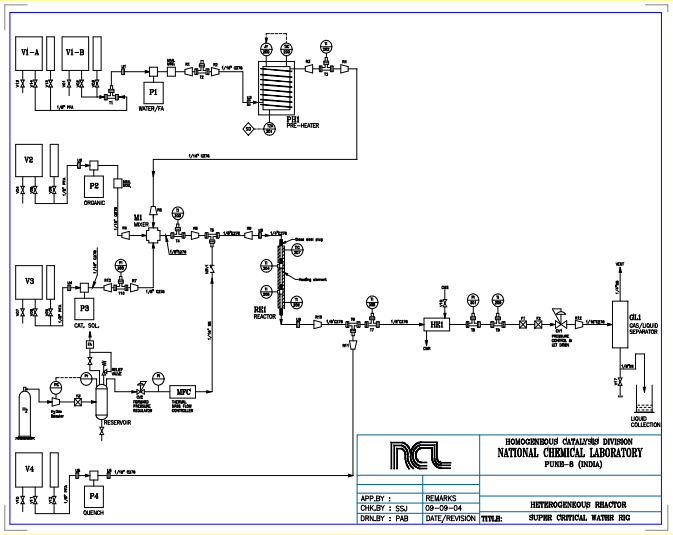
Continuous Hydrogenation Reactor

Pilot Plant site at Vinati Organics Limited, Lote Parshuram

A single step continuous hydrogenation reactor involving four phases (G-L-L-S) with complete recycle of catalyst and hydrogen and separation/recovery of products

DESIGN AND DEVELOPMENT OF SUPERCRITICAL REACTION UNIT

- Design temperature: 500 °C and Pressure: 400 bars
- Liquid Flow rate: 0.1 to 10 ml/min and Gas flow rate: 15-15000 ml/min
- Homogeneous and Heterogeneous Reactions can be studied
- Control loops: Temperatures, Pressure, Liquid and Gas flow rate
- Phase angle control for precise temperature control
- Data acquisition:16 channels data acquisition system
- High pressure and Temperature cut off Safety and Alarm Circuit
- LabView based Data Acquisition System and software

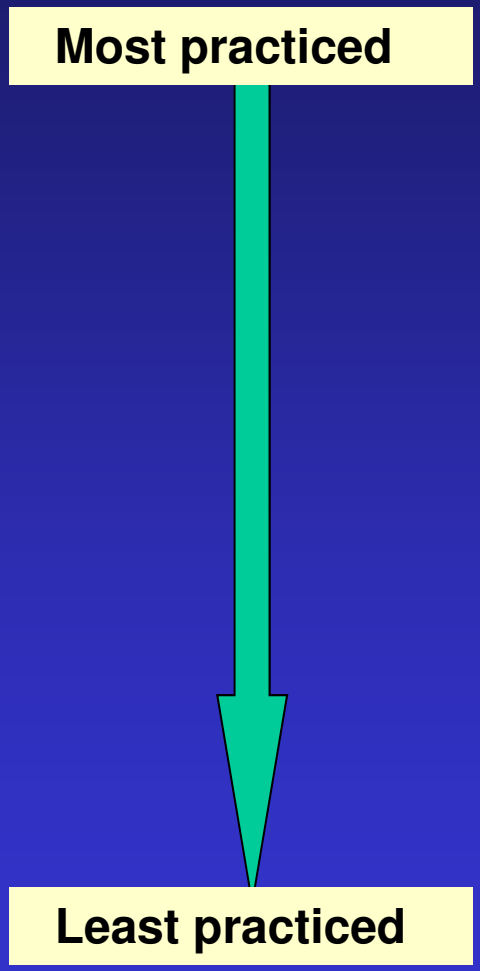


EXTERNAL RESEARCH PARTNERSHIP

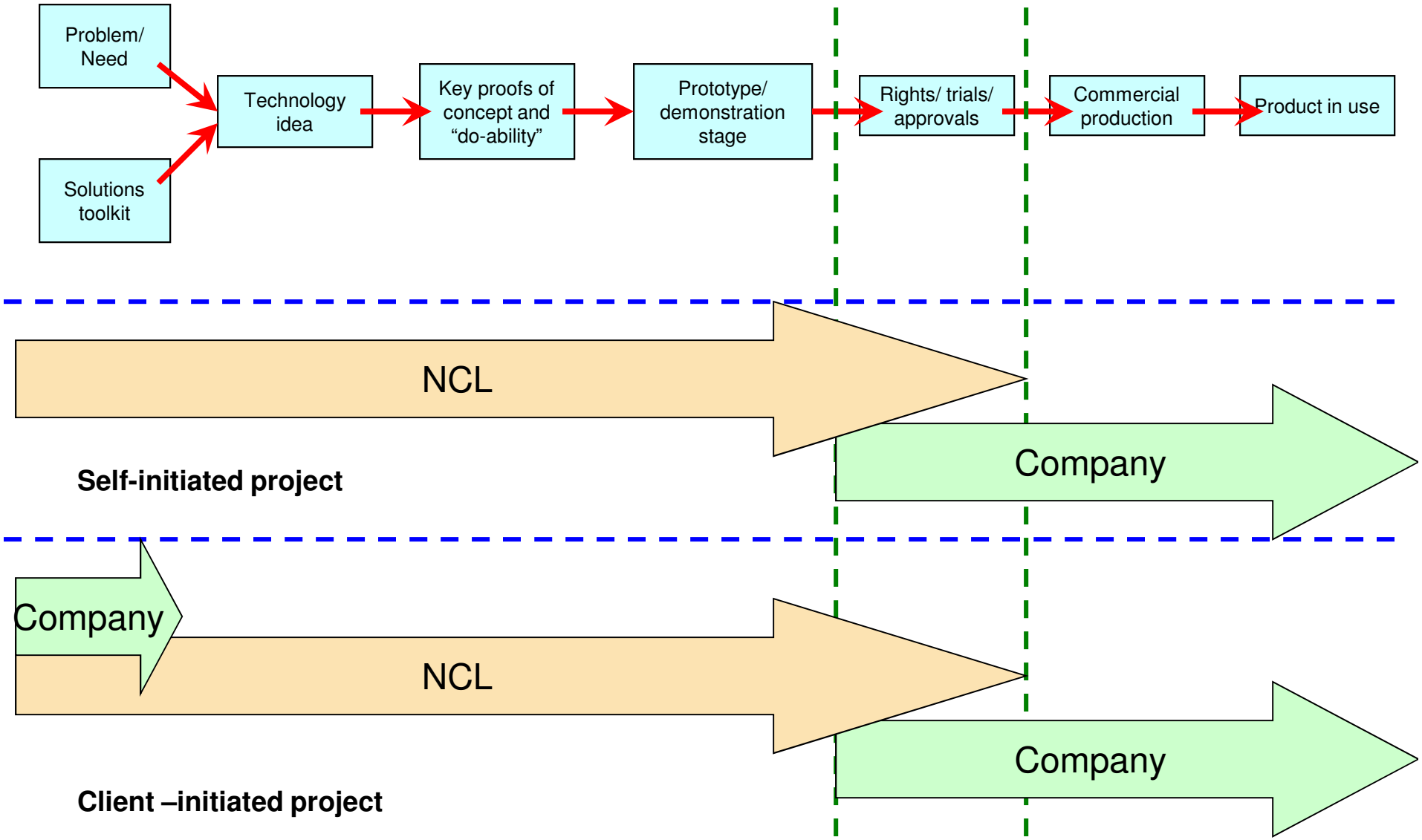
- **Substantial cumulative experience of working with Indian (medium and large) and global companies**
- **Partnership aimed at building long term relationships**
- **Substantive experience in CSIR in crafting research and legal agreements (Technology Transfer, IP Licensing , Shared risk and reward collaborative projects)**
- **Deep understanding of what contributes to a sustainable win-win situation**

EXISTING BUSINESS MODELS

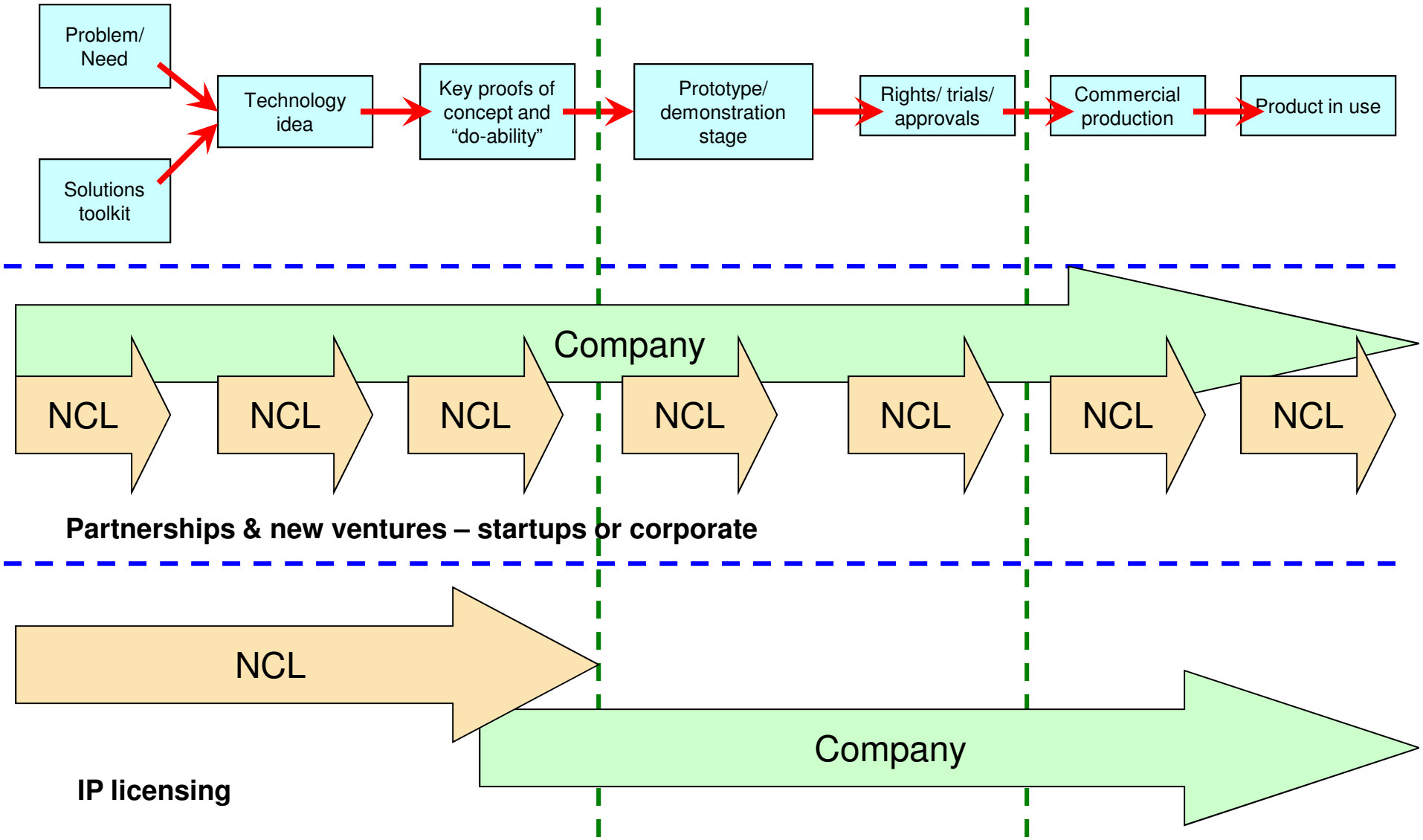
- Sponsored /contract research
- Technical service
- Consultancy
- In-house development of processes and products followed by licensing (with or without IP)
- Collaborative research
- IP licensing



Technology development & transfer: Conventional models



Technology development & transfer: Newer models



NEW INITIATIVES

- Mission mode programmes through public private partnership (NMITLI)
- Knowledge alliances through public-private partnership
- Strategies for converting knowledge to wealth
  - Setting up of incubation centres
  - Setting up of companies by CSIR scientists / CSIR
- Off-shore acquisition of early stage knowledge / IP
- Co-locating industrial R&D centers proximate to CSIR laboratories / co-sharing resources with industry
- Mobility of scientists
- Off-shore business entities

PUBLIC-PRIVATE PARTNERSHIP : CONSORTIUM MODEL

- **Areas of common interest to a few companies – access to generic knowledge**
- **Consortium agreements with service modules**
- **Project Advisory Boards with company participation**
- **Benefit sharing and possibility of bilateral projects**
- **Ownership of IP and proprietary knowledge vests with NCL/CSIR**
- **Rights of first refusal to consortium partners**

PROMOTING KNOWLEDGE BASED ENTREPRENEURSHIP IN CSIR

- **To encourage scientist to spin-off knowledge based enterprises to demonstrate early stage innovation through a robust business plan and venture funding**
- **To allow scientists to retain their services in the Council *while* promoting venture companies based on their discoveries**
- **To enable scientists/CSIR to use knowledge as equity in such start up ventures, with assigned notional value.**
- **To allow scientists to reap personal rewards at the time of acquisitions or IPO**


NCL
INNOVATION
PARK
www.innovationpark.org


NCL
INNOVATION PARK
100, 200
300, 400, 500
600, 700
800
designed by : kwality arts

NCL Innovation Park

The planned home for technology innovations and public-private partnerships

Venture Center

100- Reception, Admin block

100A -Learning center, NIP office

200- Office block for companies

Exhibition area

400- Lab block

Others at NIP

300 - DRDF

500

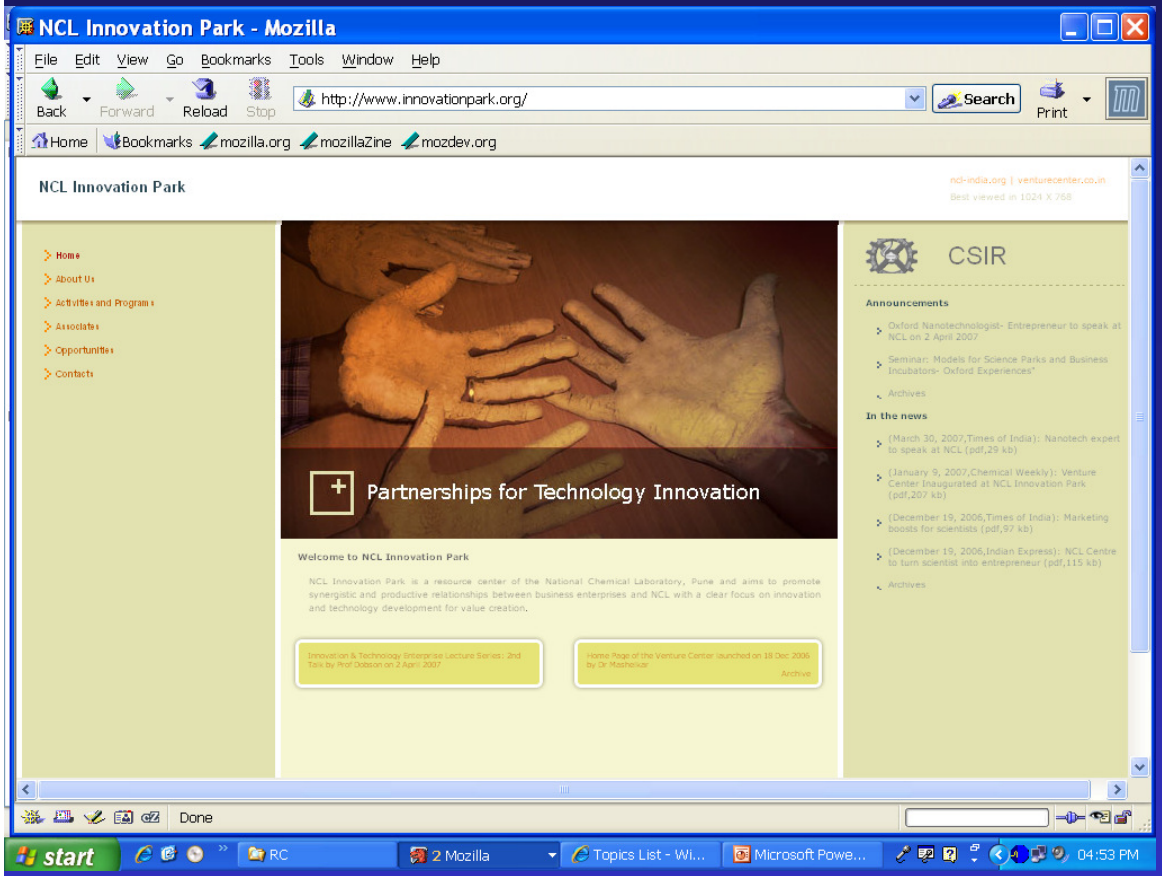
600 - DRDF

700 - NRM

800

900 - IISER

NCL INNOVATIONS



To develop a campus sharing the "mind space" (intellectual environment and knowledge competencies) of NCL that would help nucleate start-up technology enterprises and/or research and technology development entities (divisions, subsidiaries, JVs) of established companies

Activities

- *Venture Center, a Section 25 Company promoted by NCL as a Technology Business Incubator and venture creation program*
- *Technology acceleration and stewardship program*
- *Inspiration and learning program*

VENTURE CENTER

www.venturecenter.co.in

Seeding Tomorrow's Enterprises Today

To become the hub for nucleating innovation focused entities of Indian companies, and thus give birth to innovation-focused companies in the chemical and allied disciplines for India

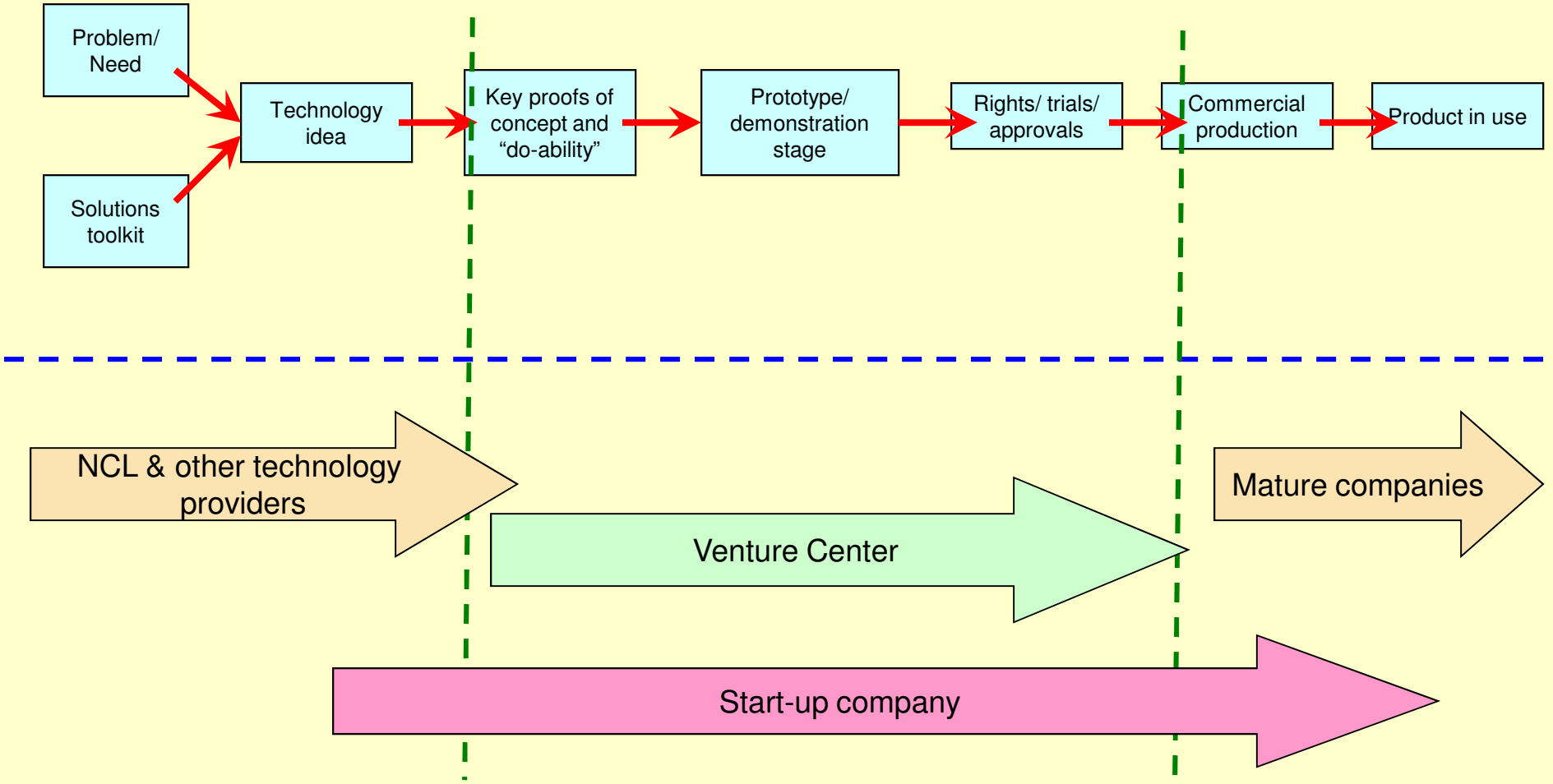
Introduction

- The Venture Center is a ***technology business incubator*** specializing in technology enterprises providing products and services exploiting scientific expertise in the areas of ***materials, chemicals and biological sciences & engineering***.
- The Venture Center is the trademark of Entrepreneurship Development Center, a ***not-for-profit independent company*** floated by the National Chemical Laboratory, Pune.
- The Venture Center will initially occupy ***10-15,000 sq ft of built up area*** within the **NCL Innovation Park** and will consist of lab, office and hot-desking space for start-up companies, shared laboratories, analytical facilities, an information and learning center, and other supporting resources and services.

Key aspects of our incubation model

- Focus on areas of strength of *NCL*; leverage NCL expertise, know-how, facilities, resources and networks
- Specialized in-house facilities to support:
  - Material science- centric products
  - Products leveraging biology (and the interface with materials/ chemicals)
  - IP portfolio planning
- Emphasis on companies with *potential global markets; IP-based companies*
- *Open to anybody* with a strong business plan but terms more favorable for NCL-related start-ups

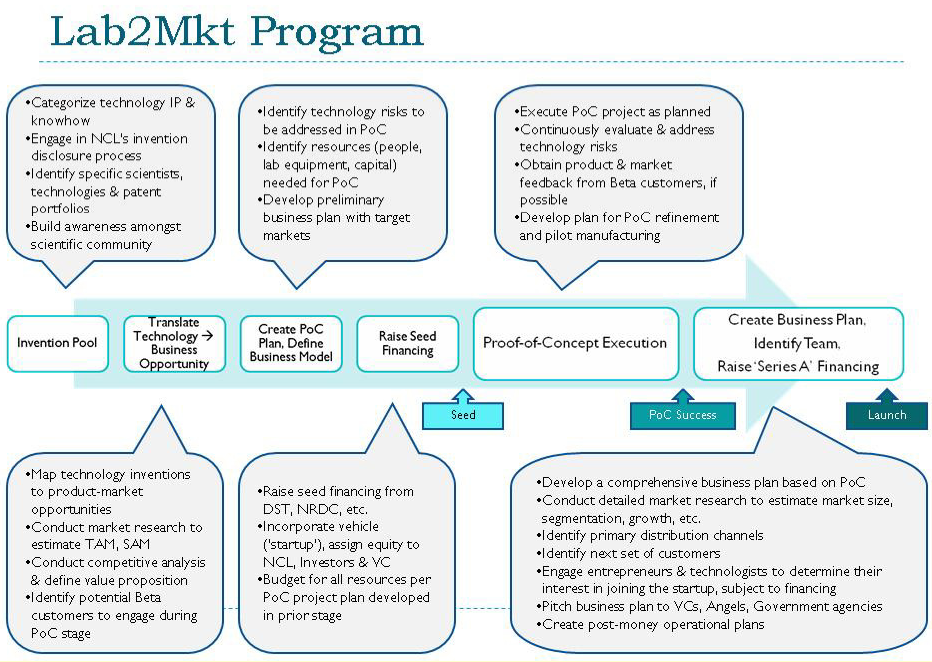
VENTURE CENTER BRIDGES A CRITICAL GAP



Venture Center seeks to address the lack of resources & capital required for the high-risk stage of proof-of-concept development and initial customer trials.

Programs

Our flagship program



Programs, services, resources

Planned Programs	Components			
Commercialization program	Lab2Mkt program		MSME accelerator	Validation fund
Infrastructure services	Address	Meeting/ event spaces	Office space, Hot desks	Lab space, Work benches
Mentoring, advisory services	Advisory services (Business planing, IP, ops, science & tech, finance, referrals, leads)			"Hand-holding" services
Networks and clubs	Networks of entrepreneurs, inventors, technologists		Investors	NCL-TEC
Resources	Library	Information search services	Analytical & lab services	Extended resources: NCL
Events	Talks	Workshops	Networking meetings	Competitions
With NCL	NCL Academy		NIP maintenance	

Launched | Soon to open | Planned for future

RC-42-190609

VENTURE CENTER

Seeding Tomorrow's Enterprises Today

Reception

Board room; Meeting room

Hot-desking facility

E-Class Room; Training Room

Training Room

Library

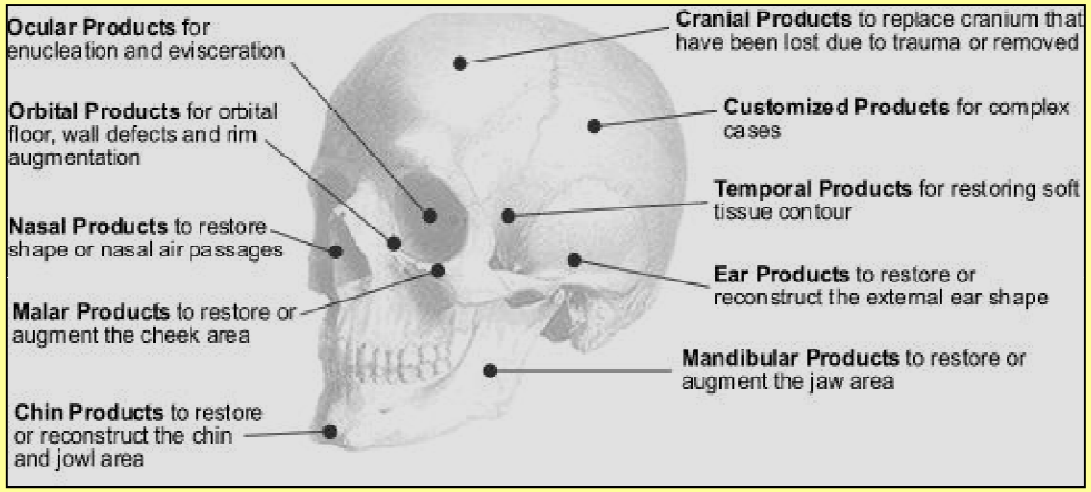
Lab block

RC-42-190609

Porous Polyethylene Implants

Project goal

- **To develop platform technology for porous polyethylene maxillofacial implants.**
- **To develop the technology for porous polyethylene ocular implants.**



Porous polyethylene implants

– many products from a platform technology

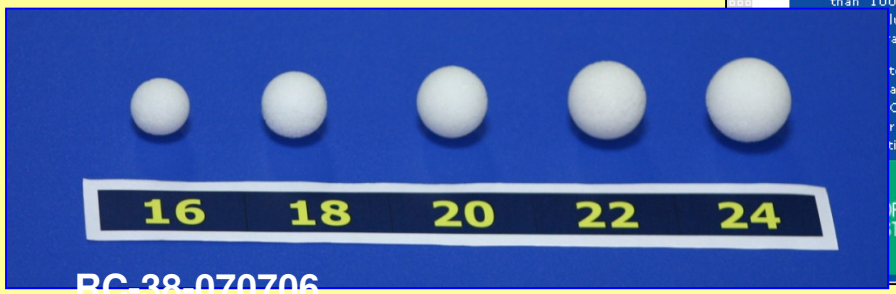
Ocular implants – volume filling application

Porous polyethylene implants: Controlled porous morphology with interconnecting pores allowing tissue in-growth and suturing. Has 40-50% porosity and still not fragile. Has 25 year history of clinical use. Monopoly product of Porex Surgicals, USA. Ocular implant sells for $400-650 per piece – a price that makes the product inaccessible to many in India

RC-38-070706

Porous Polyethylene Implants

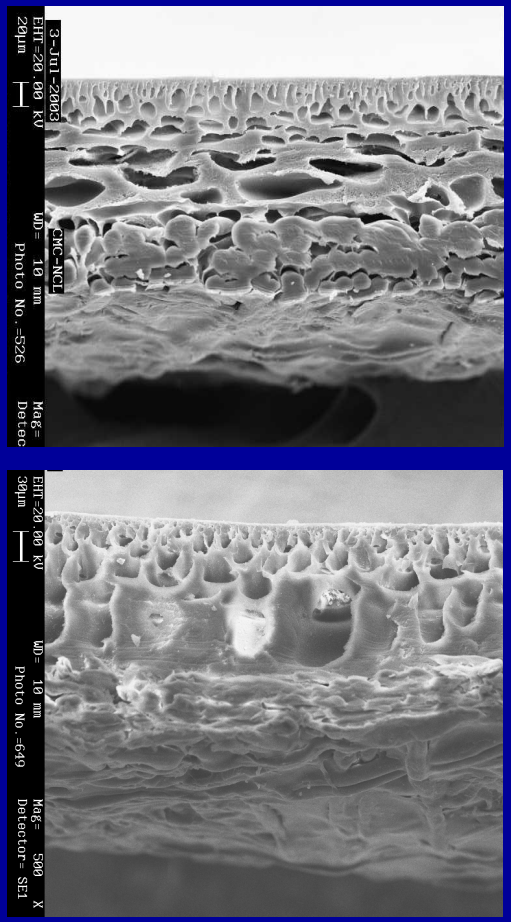
- **Technology (proprietary know-how) licensed (June 2005) to a start-up company called Biopore Surgicals, Mumbai run by an ophthalmic surgeon. Handholding support by NCL for 1) equipment specification and trials, 2) samples for trials, marketing and test marketing, 3) recruitment & training.**
- **Clinical trials completed and successful. Web site launched (www.biopore.in). First sale in Dec 2005. Pick-up slow but repeat orders are coming in.**
- **Two new products in pipeline at NCL. Expected release date: 1 Sept 2006**



RC-38-070706

CHARACTERISTICS OF UF MEMBRANE

- Membrane Preparation: By Phase Inversion
- Average water flux: 50 lmh at 0.5 bar
- 5 log reduction for viruses
- 7-9 log reduction for bacteria
- Molecular Weight Cut Off : ~ 60 k Dalton
- BSA rejection > 90 %
- Total membrane thickness : 9 - 11 mil



Membrane Cross Section (SEM)

UF MEMBRANE TECHNOLOGY : FROM CONCEPT TO MARKET

- **Discovery of a unique process to control membrane porosity using a substrate polymer manufactured in India**
  - **Invention protected by patents globally**
  - **Reject smallest known pathogenic species (virus);**
  - **Still be able to operate at tap water pressure (0.4 bar)**
- **Prototype preparation, demonstration & performance evaluation**
  - **Designed various easy to use prototypes**
  - **Demonstration & rigorous performance evaluation**
- **Technology transfer**
  - **Technology licensed to M/s. Membrane Filters India Ltd., Pune, a start up incubated at NCL**


1950-2010
Celebrating Sixty Years of Science
UF Membrane, New Delhi 140806

MODELS INTRODUCED IN THE MARKET

Purioin - Plus – Manual Flushing…..60 LPH at 1bar
Purioin -Deluxe – Auto Flush …..60 LPH at 1bar
Purioin XL- With Hand Pump ….125 LPH at 1bar
Purioin XL- With Electric Pump .... 250 LPH at 1bar

UF Membrane, New Delhi 140806

PROTOTYPES DEVELOPED AT NCL

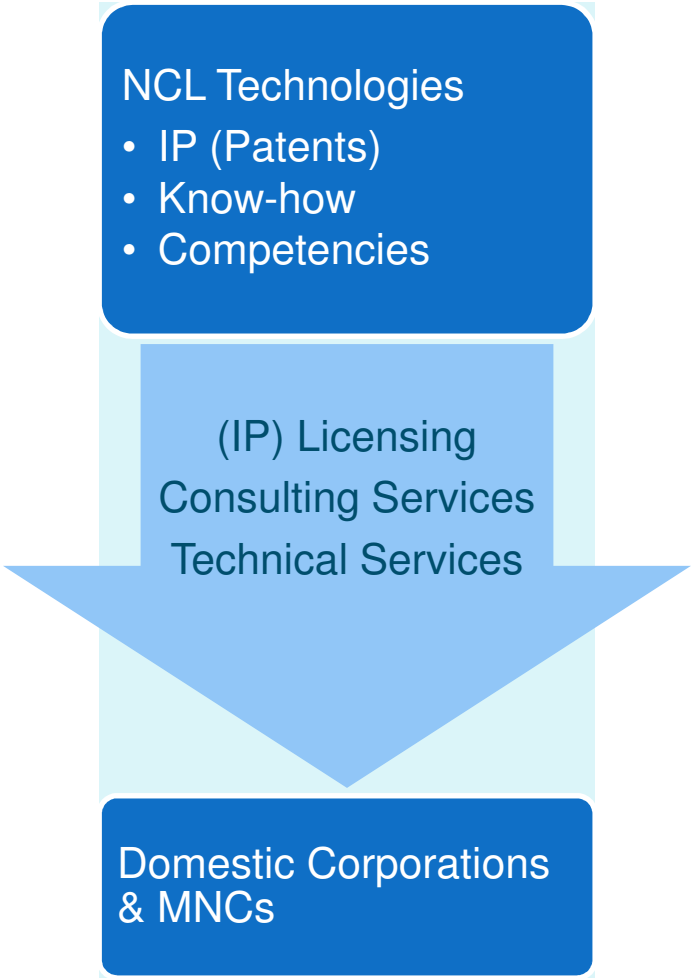
Hand Operated

Foot operated

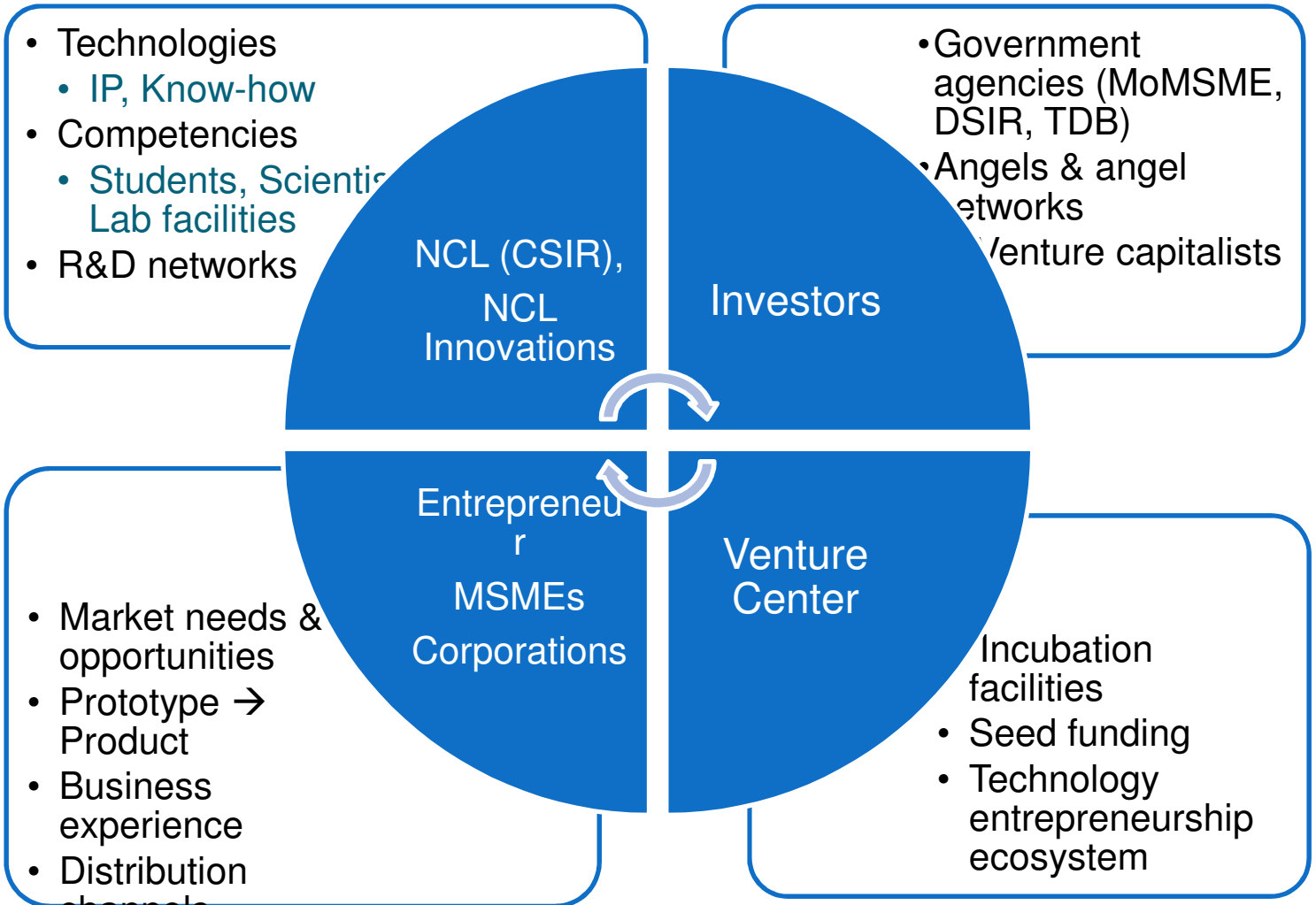
Online

Cycle operated

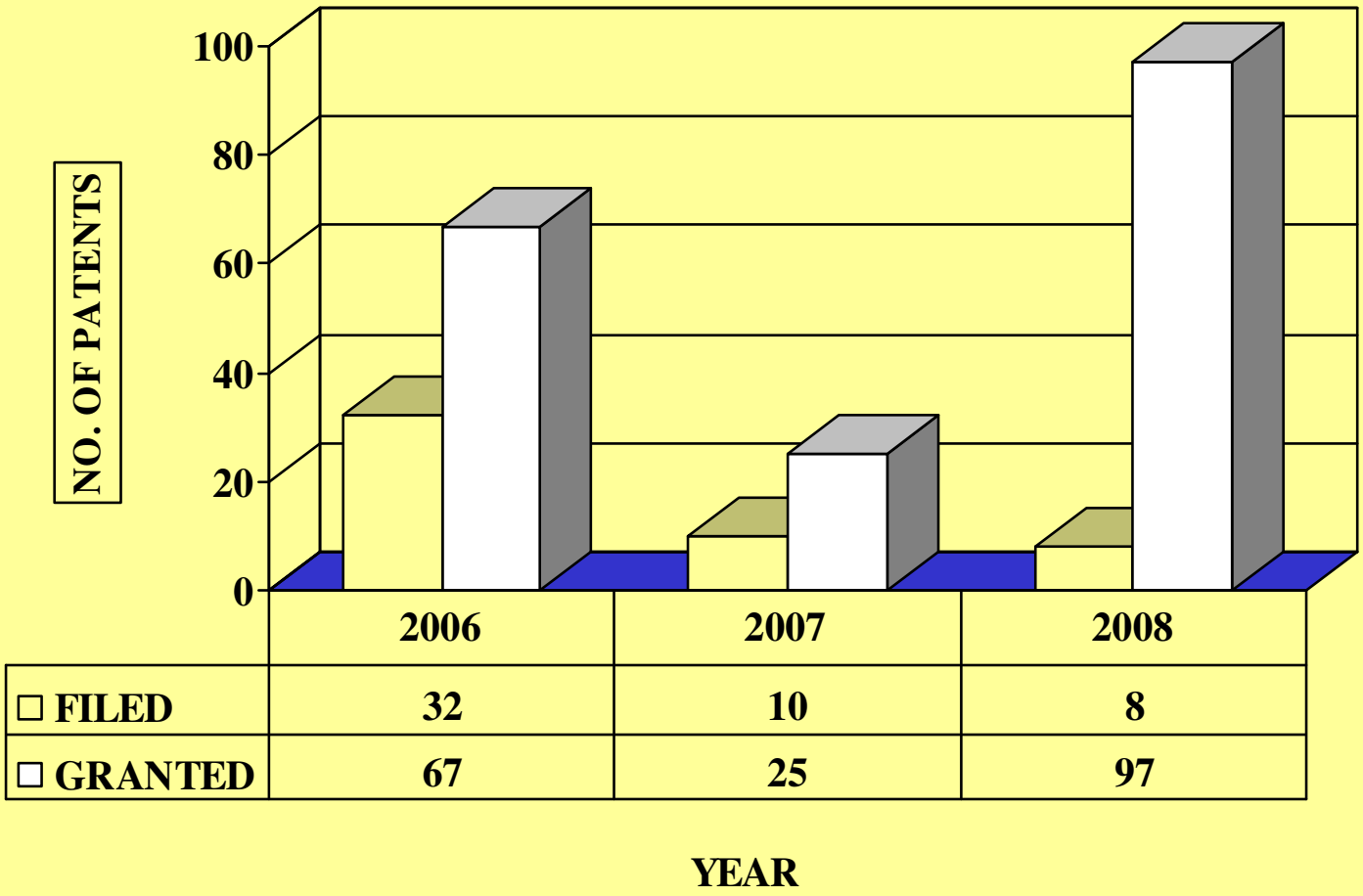
Technology Commercialization v1.0



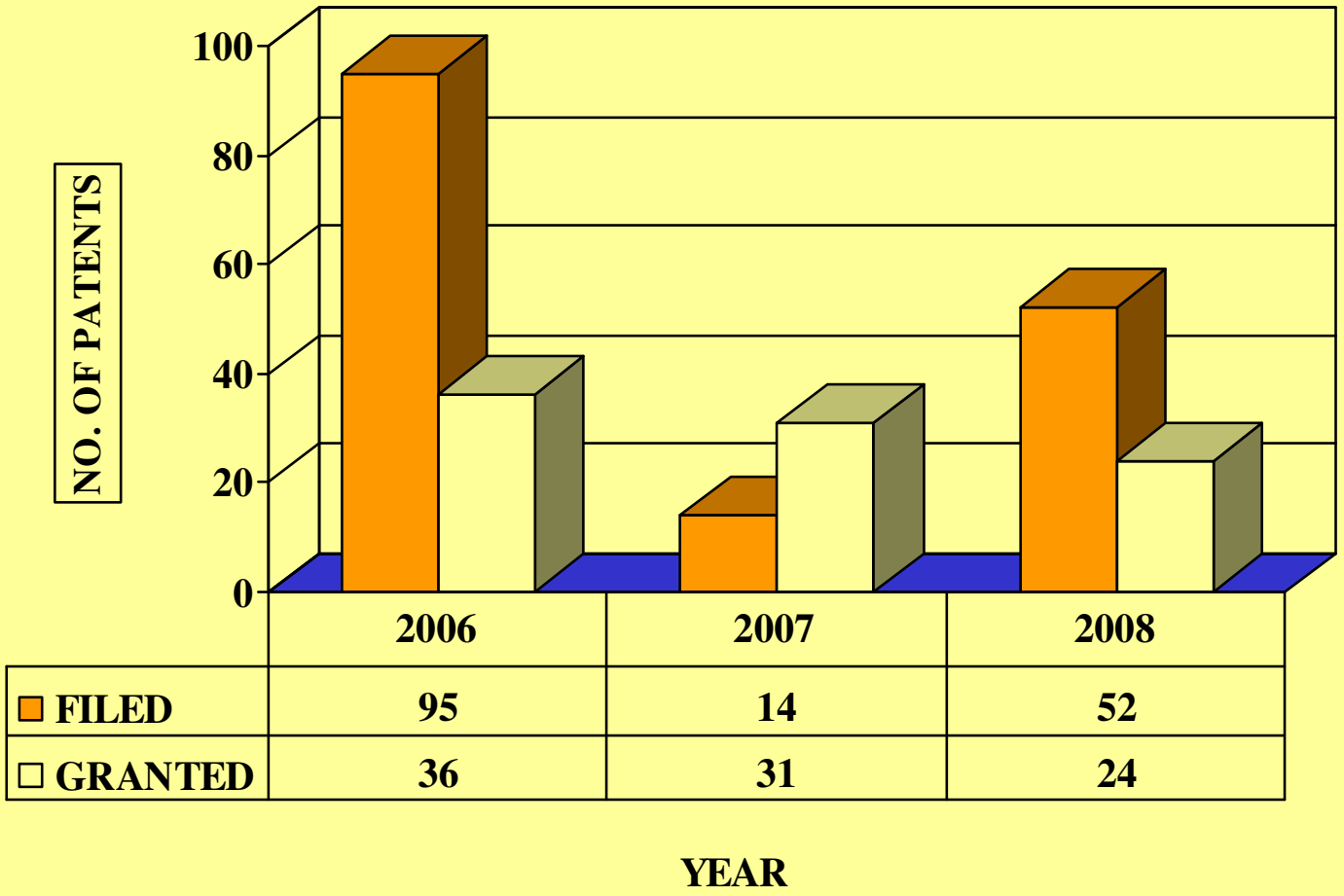
Technology Commercialization v2.0



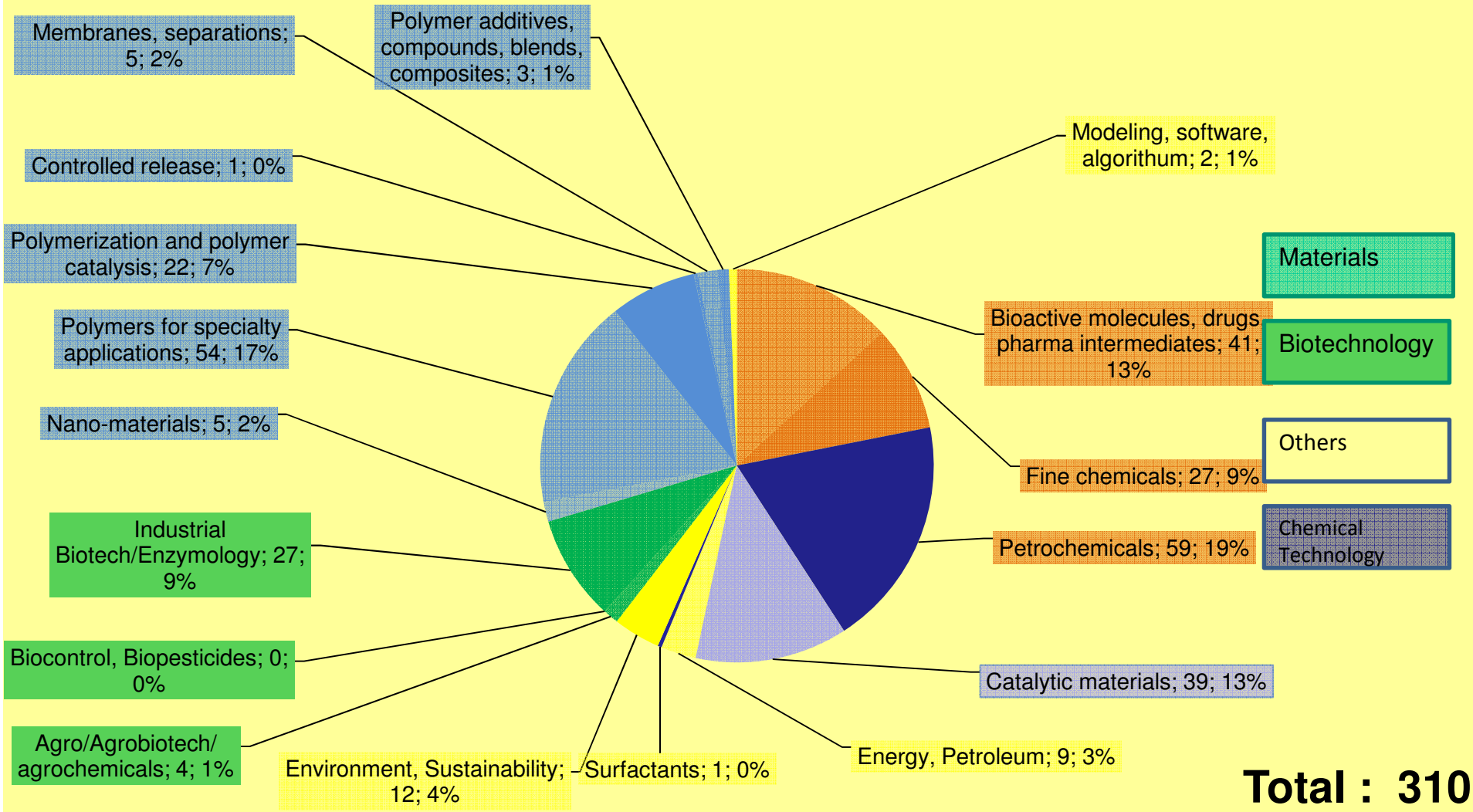
INDIAN PATENTS FILED & GRANTED (2006-2008)



FOREIGN PATENTS FILED & GRANTED (2006-2008)



FOREIGN PATENTS IN FORCE : BY MARKETS



Total : 310

US005969167A

United States Patent [19]

Sivaram et al.

[11] Patent Number: 5,969,167

[45] Date of Patent: *Oct. 19, 1999

[54] METHOD FOR MAKING TRIS (HYDROXYPHENYL) COMPOUNDS USING ION EXCHANGE RESINS

[75] Inventors: **Swaminathan Sivaram**; **Vishnu R. Ranade**; **Srinivasan Chakrapani**; **Prakash P. Wadgonkar**, all of Pune, India; **Paul D. Sybert**; **Gaylord N. Kissinger**, both of Evansville, Ind.; **Ashok K. Mendiratta**, Westlake, Ohio

[73] Assignee: **General Electric Company**, Pittsfield, Mass.

[*] Notice: This patent is subject to a terminal claimer.

[21] Appl. No.: **08/953,057**

[22] Filed: **Oct. 17, 1997**

Related U.S. Application Data

[62] Division of application No. 08/536,575, Sep. 29, 1995, Pat. No. 5,756,781.

[51] **Int. Cl.**[6] **C09B 11/04**

[52] **U.S. Cl.** **552/115**

[58] **Field of Search** 552/115

[56] **References Cited**

US005969167A

United States Patent

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[54] METHOD FOR MAKING TRIS (HYDROXYPHENYL) COMPOUNDS USING ION EXCHANGE RESINS

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[52] **U.S. Cl.** **552/115**

[58] **Field of Search** 552/115

[56] **References Cited**

(12) **United States Patent**

Gurjar et al.

(10) **Patent No.: US 7,109,353 B2**

(45) **Date of Patent: Sep. 19, 2006**

(54) **PROCESS FOR PREPARING 5,6-DIHYDRO-4-(S)-(ETHYLAMINO)-6-(S) METHYL-4H-THIENO[2,3B]THIOPYRAN-2-SULPHONAMIDE-7,7-DIOXIDE HCL**

(75) Inventors: **Mukund Keshao Gurjar**, Pune (IN); **Madhusudan Nagorao Deshmukh**, Pune (IN); **Vincent Paul**, Pune (IN); **Venkatasubramaniam Radhakrishnan Tarur**, Mumbai (IN); **Dhananjay Govind Sathe**, Mumbai (IN); **Santosh Pratap Pardeshi**, Mumbai (IN); **Sanjay Janardhan Naik**, Mumbai (IN); **Tushar Anil Naik**, Mumbai (IN)

(73) Assignee: **Council of Scientific and Industrial Research**, New Delhi (IN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 134 days.

(21) Appl. No.: **11/024,029**

(22) Filed: **Dec. 28, 2004**

(65) **Prior Publication Data**

US 2006/0142595 A1 Jun. 29, 2006

(51) **Int. Cl.**
C07D 335/04 (2006.01)

(52) **U.S. Cl.** **549/23**

(58) **Field of Classification Search** 549/23
See application file for complete search history.

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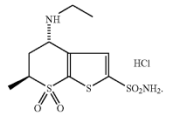
Primary Examiner—Deborah C. Lambkin
(74) *Attorney, Agent, or Firm*—Ladas and Parry LLP

(57) **ABSTRACT**

The present invention relates to an improved process for the preparation of 5,6-dihydro-4-(S)-(ethylamino)-6-(S)methyl-4H-thieno[2,3b]thiopyran-2-sulphonamide-7,7-dioxide hydrochloride of formula (I) commonly known as Dorzolamide Hydrochloride useful as an agent to reduce intraocular pressure by inhibiting carbonic anhydrase enzyme

(I)



34 Claims, No Drawings

(19) **United States**

(12) **Patent Application Publication**

Darbha et al.

(10) **Pub. No.: US 2007/0004599 A1**

(43) **Pub. Date: Jan. 4, 2007**

(54) **PROCESS FOR THE PREPARATION OF LUBRICANTS**

(76) Inventors: **Srinivas Darbha**, Pune (IN); **Rajendra Srivastava**, Pune (IN); **Paul Ratnasamy**, Pune (IN)

Correspondence Address:
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700 LAVACA, SUITE 800
AUSTIN, TX 78701 (US)

(21) Appl. No.: **11/442,651**

(22) Filed: **May 26, 2006**

(30) **Foreign Application Priority Data**

Jun. 16, 2005 (IN)..... 1561/DEL/2005

Publication Classification

(51) **Int. Cl.**
C10M 173/02 (2006.01)

(52) **U.S. Cl.** **508/216**

(57) **ABSTRACT**

The present invention provides an improved process for the preparation of lubricants from vegetable oil or fat obtained from animal source. The present invention involves a reaction of vegetable oil or fat with an alcohol in the presence of a double metal cyanide catalyst, at a temperature in the range of 150° to 200° C. for a period of 3-6 hrs to obtain the desired bio-lubricant.

US006208951B1

(12) **United States Patent**

Kumar et al.

(10) **Patent No.: US 6,208,951 B1**

(45) **Date of Patent: Mar. 27, 2001**

(54) **METHOD AND AN APPARATUS FOR THE IDENTIFICATION AND/OR SEPARATION OF COMPLEX COMPOSITE SIGNALS INTO ITS DETERMINISTIC AND NOISY COMPONENTS**

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US006504050B1

(12) **United States Patent**

Barve et al.

(10) **Patent No.: US 6,504,050 B1**

(45) **Date of Patent: Jan. 7, 2003**

(54) **PROCESS FOR THE PREPARATION OF 2-ACRYLAMIDO-2-METHYL-1-PROPANESULFONIC ACID**

(75) Inventors: **Prashant Purushottam Barve**, Maharashtra (IN); **Sunil Shankar Joshi**, Maharashtra (IN); **Ravindra William Shinde**, Maharashtra (IN); **Milind Yashwant Gupte**, Maharashtra (IN); **Chandrashekhar Narayan Joshi**, Maharashtra (IN); **Shrikant Madhukar Ghike**, Maharashtra (IN); **Raghavendra Venkatrao Naik**, Maharashtra (IN); **Rajendra Anantrao Kulkarni**, Maharashtra (IN); **Aruna Narayan Bote**, Maharashtra (IN)

(73) Assignee: **Council of Scientific and Industrial Research**, New Delhi (IN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/096,070**

(22) Filed: **Mar. 13, 2002**

(51) **Int. Cl.**[7] **C07C 309/00**

(52) **U.S. Cl.** **562/105**

(58) **Field of Search** 562/105

(56) **References Cited**

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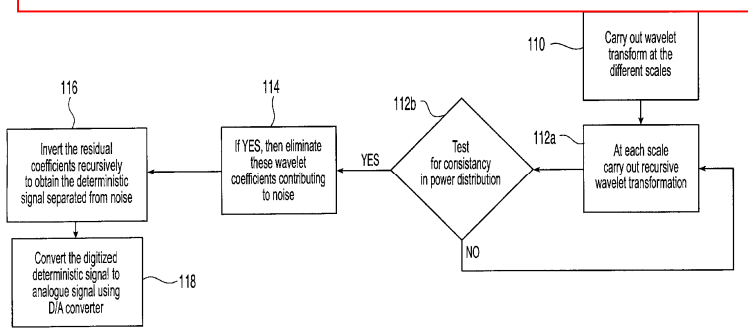
Primary Examiner—Michael L. Shippen
(74) *Attorney, Agent, or Firm*—Nixon & Vanderhye P.C.

(57) **ABSTRACT**

The present invention provides a process for the preparation of highly pure 2-acrylamido-2-methyl-1-propanesulfonic acid in high yield, with improved appearance, by the reaction of acrylonitrile with more than 98% sulfuric acid or oleum and liquefied isobutylene in presence of weak inorganic acids or organic sulfonic acids.

12 Claims, 1 Drawing Sheet



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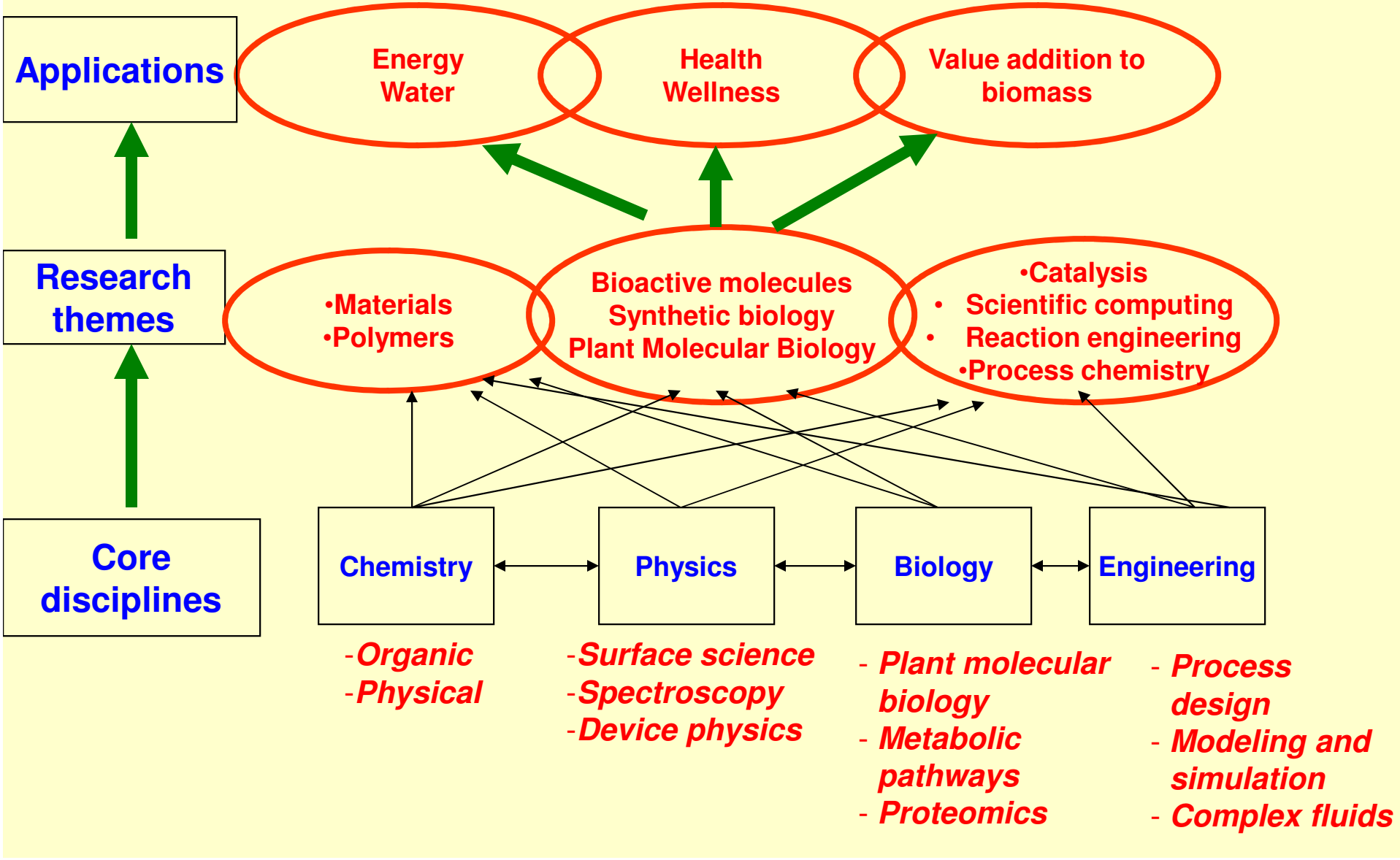

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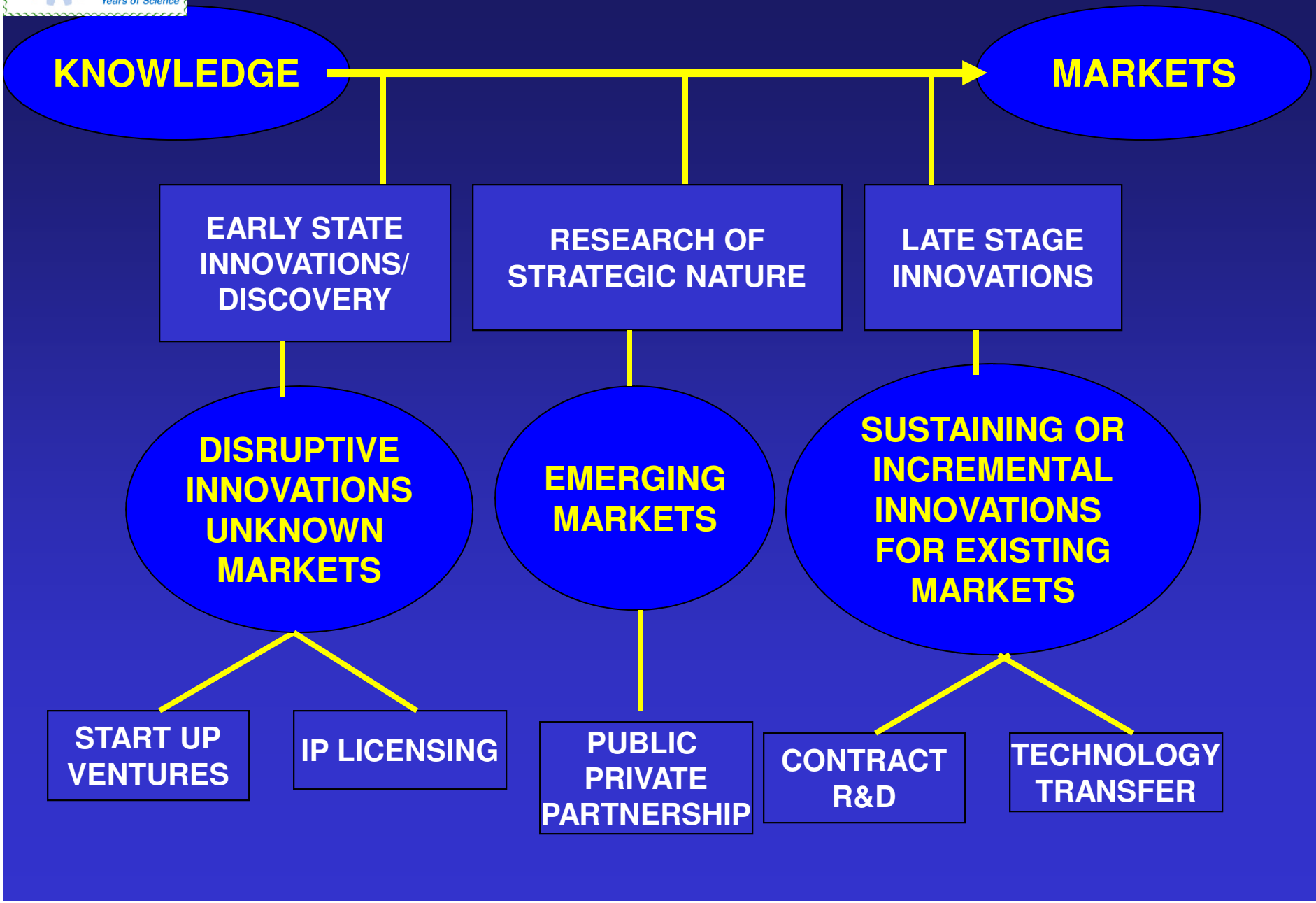

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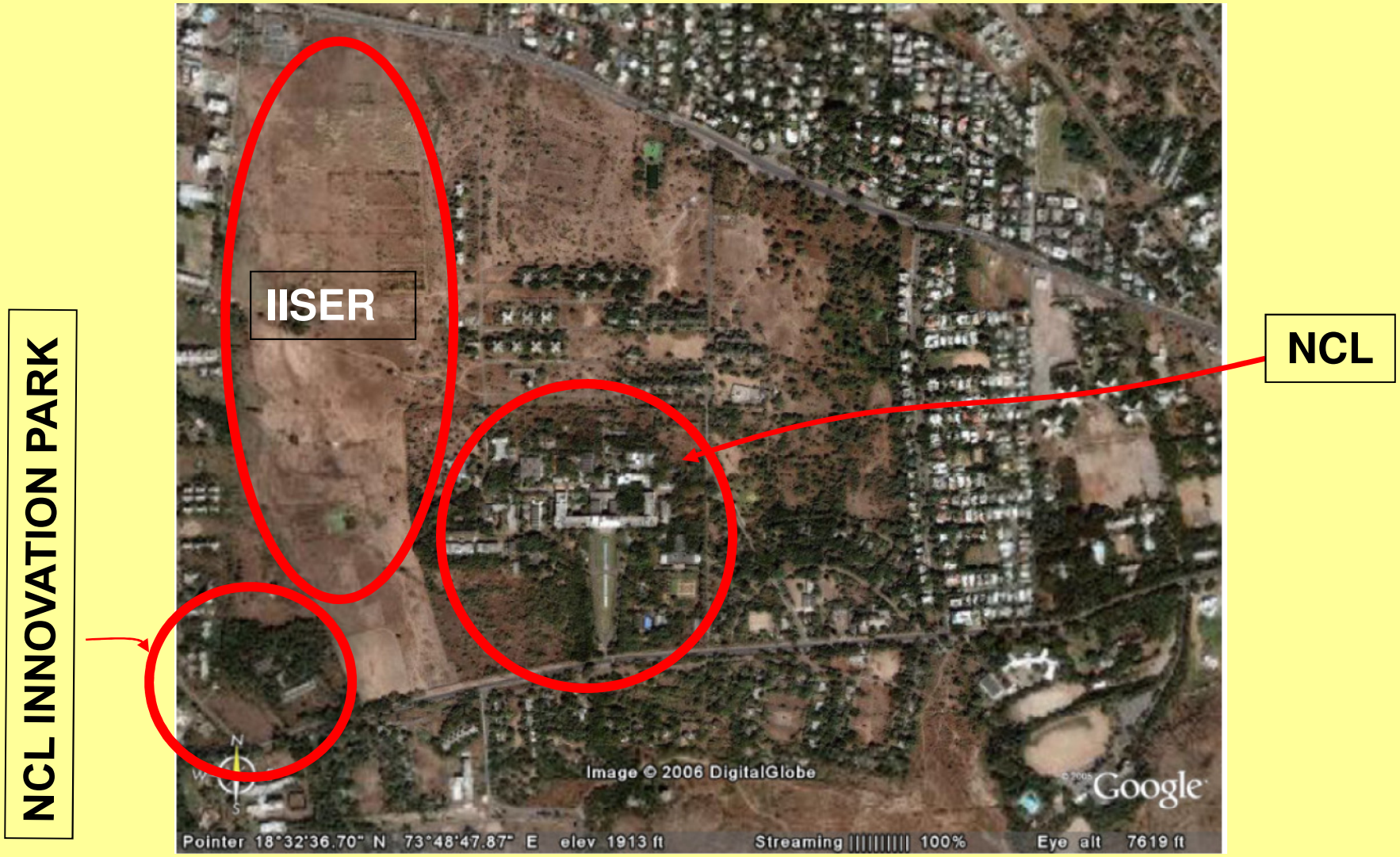


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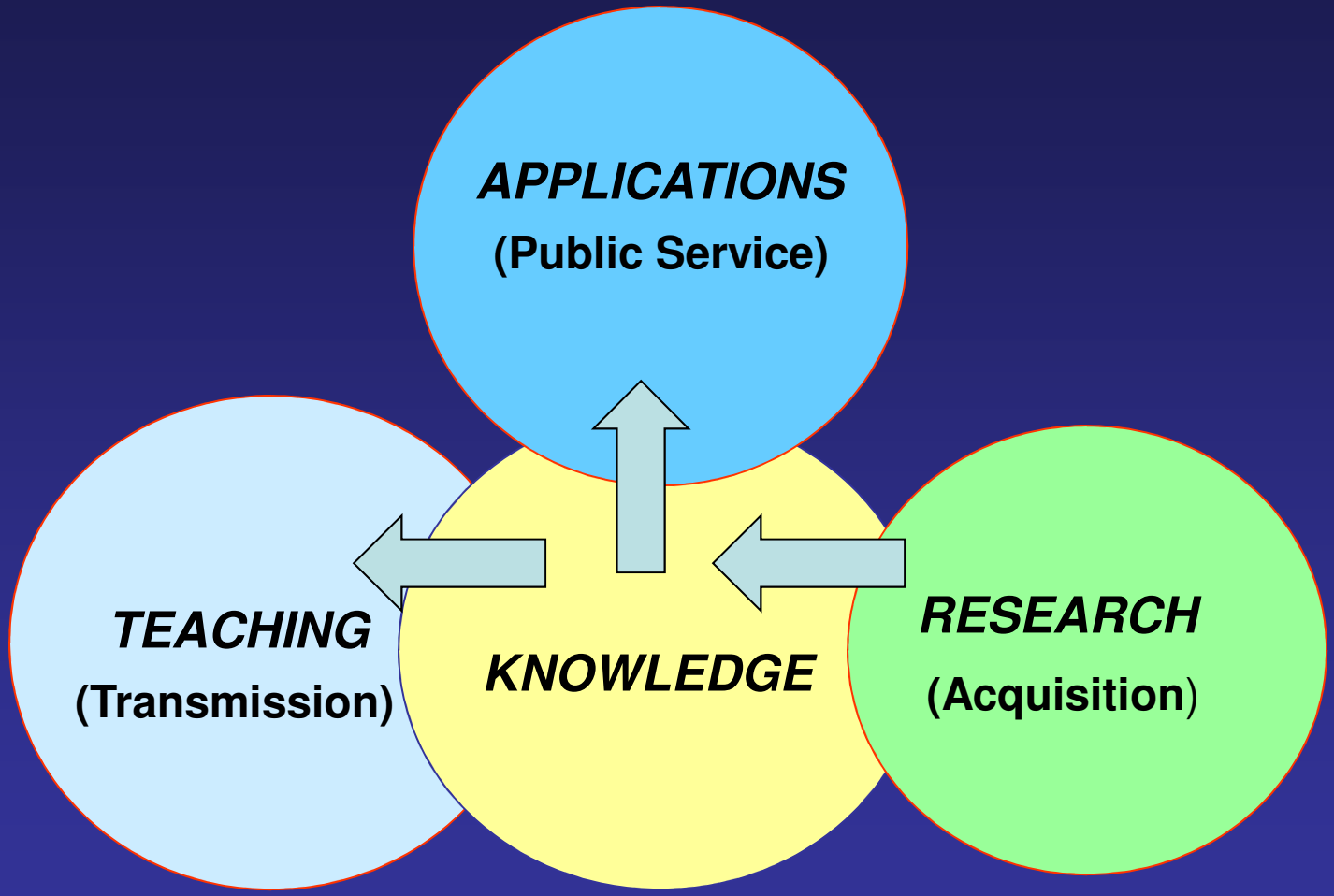

THANK YOU