T. MOHAN

Personal Details

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Vision

To enable India to become a clean, green destination using the state-of-the-art Li-ion battery technology.

About Myself

PhD in synthetic Main Group Chemistry from IIT Madras with more than 22 years of experience in the field of Li-ion batteries, starting from the development of novel electrode materials, design & process development for manufacturing of various sizes of Li-ion cells , developing procedures for testing and quality assurance according to international standards like IEC, and set up an industrial scale battery assembly unit.

Highlights of my professional achievements are

1. Developing the process indigenously, for manufacturing Lithium - ion cells of capacities ranging from **0.5 Ah** to **50 Ah** in both cylindrical and rectangular configuration - ***the first of its kind in India*****.**
2. Establishing the infrastructure for the production & quality assurance which include
    a) The establishment of Inward Material Inspection Lab, R&D and Battery Testing Labs at United Nanotech Product Limited, Kolkata
    b) Pilot Plant for Li-ion Cell fabrication at CAEM, ARCI, Chennai.
    c) The Battery Assembly at Exide Industries Ltd at IITM Research Park, Chennai.
    d) Have been actively involved with BIS to develop the test standards specific to Li-ion Cells/ batteries complying with the international standards like IEC 62133, UN 38.3, UL 1642 etc.

PROFESSIONAL EXPERIENCE

From 2020 Senior Scientist at International Advanced Research Centre for Powder Metallurgy & New Materials, ARCI, Chennai for the Development of Large Lithium- ion batteries for automotive and ESS application

2019-2020 General Manager at Exide Leclanche Energy private Ltd (JV with Exide Industries Ltd.) IITM, Research Park, Chennai.

2014-2019 General Manager at Exide Industries Limited.

2010–2014 Senior Scientist at International Advanced Research Centre for Powder Metallurgy & New Materials, ARCI, Chennai for the Development of Large Lithium- ion batteries for EV and HEV application.

2010 –2014 Senior Scientist at International Advanced Research Centre for Powder Metallurgy & New Materials, ARCI, Chennai for the Development of Large Lithium- ion batteries for EV and HEV application.

2009-2010 Senior Scientist at United Nanotech Products Ltd. Howrah as Head, Quality Assurance & control, and R & D.

1999 - 2008 Senior Manager- Technical, Lithium - ion Batteries at HBL Power Systems Ltd. Hyderabad, India.

Project Design and Development of High energy and High-Power Lithium -ion cells and batteries of different sizes.

1995 - 99 Scientist Fellow at Lithium Batteries Division, Central Electrochemical Research Institute, Karaikudi, Tamil Nadu, India

Project Synthesis of 4V - Positive Electrode Materials for Lithium - ion Batteries, and their Physico-Chemical Characterization. - sponsored by Indo- French Centre for the Promotion of Advanced Research (IFCPAR).

POSTDOCTORAL

1992-95 With Prof. John G. Verkade, Dept. of Chemistry, Iowa State University, Ames, Iowa - 50011, USA

Project Utility of organophosphorus compounds in the desulphurization of solid coal, and as NMR tagging reagents for the estimation of total phenolics in the coal liquefaction resids.

Studies on the reactions of a proazaphosphatrane which is a non - nucleophilic super base.

1991-92 With Prof. Robert R. Holmes in the Dept. of Chemistry, University of Massachusetts, Amherst, Massachusetts-01003,USA

Project Synthesis and structural studies on the hyper-valent phosphorus compounds which are useful models in the ester hydrolysis of c-AMP.

EDUCTAIONAL QUALIFICATION

Doctoral

1986-90 Dept of Chemistry, Indian Institute of Technology, Madras.

Project Studies on the reactions of cyclothiazenes with unsymmetrical phosphines and phosphinimines.

Thesis Advisors: Prof. G. Aravamudan & Dr. M.N. Sudheendra Rao

M.Sc

1983-85 Madura College (Autonomus), Madurai, Tamil Nadu, India.

Major General Chemistry

B.Sc

1980-83 Madura College (Autonomus), Madurai, Tamil Nadu, India

Majors Mathematics and Chemistry

Achievements at the

Exide Industries Limited

- Established the Li-ion battery Assembly & Testing Facility at IITMRP, Chennai for manufacturing batteries for 2W and 3W application.
- Involved in the development of test standards specific to Li-ion Cells/ batteries for BIS certification – held periodic discussions with scientists of ICAT (International Centre for Automobile Testing, Gurugram), BIS (Bureau of Indian Standards, New Delhi), ARAI (Automotive Research Association of India, Pune).
- Providing Techno-Marketing support for the Li-ion batteries for EV applications which helped in understanding the customer/market requirement in various automotive segments.
- Visited various Li-ion battery manufacturers in China & Fraunhofer Institute, Germany updating the latest advances in the world in Li-ion battery development technology.
- Provided technical support for the fabrication of the Li-ion batteries to Mahindra Reva for their electric cars e2o & e-varito.
- Involved in studies to improve Lead Acid Batteries for SLI application.

Centre for Automotive Energy Materials, ARCI, Chennai

- Techno-administrative support for establishing the infrastructure for the center.

- Set up the Pilot Scale Research Facility for the fabrication of large format Lithium-ion cells and batteries and testing. This includes
  a) Deriving the specification of the equipment for the fabrication line with a peak production capacity of 15 KW/ week; identifying suitable suppliers and procurement of the equipment after successful pre-dispatch inspection.
  b) Design, installation and commissioning of the dehumidified rooms for locating the equipment for the pilot scale research facility.
  c) Establishment of the processes for the fabrication of cells and batteries.
  d) Standardizing the procedures for testing the cells and batteries complying with the requirement of EV, HEV.

United Nanotech Products Ltd., Howrah.

- Set up the analytical laboratory and laid down the procedures for testing the Inward Chemicals & Raw Materials to produce Electrode Materials (large scale) for Li-ion cells. The materials include LFP, NCA and LTO
- Established the online QC of the final Products, both by chemical and electrochemical methods ensuring both QC and QA.
- Developed indigenous sources of raw materials and accordingly modified the process to manufacture the electrode materials at low cost. The $LiFePO_4$, thus manufactured, was provided to many Li-ion cell manufacturers at China. It was learnt that the charge/discharge characteristics of the indigenously manufactured $LiFePO_4$ was comparable to that of some high-end commercial product.
- Design of the electrode materials to the customer requirements.
- Worked closely with various foreign customers, visited their labs and provided solutions for processing the materials to produce the electrodes and hence the cells.
- A working model for the solar street lights was made with white LEDs', lead acid battery and commercial solar panels.

HBL Power Systems Ltd, Hyderabad

- Was twice presented the **Value-Added Employee Award** at HBL Power Systems.
- Developed the complete process for manufacturing Lithium - ion cells of capacities ranging from 0.5 Ah to 50 Ah in both cylindrical and rectangular configuration, the first of its kind in India. This comprises of
  I. Arriving at the composition of the active material, the binder and the conductive additive.
  II. Methods of mixing, coating and calendaring and hence the fabrication of the electrodes with both non-aqueous and aqueous binders.

III. Designing the electrolytes and cell Assembly.
IV. Cell Formation and Charge/discharge studies under various conditions.

- The cells provided cycle life more than 1000 times at "C" rate discharge and 90% DOD.
- The electrolyte was developed in-house that can perform at -30^{o} C.
- Developed a membrane for the gel type Lithium-ion polymer cell.
- Developed nine different types of Lithium-ion batteries under CODE program for NSTL, Visakhapatnam, ADE, and LRDE, Bangalore, complying with the stringent requirement of the Defense. Demonstrated the batteries to the scientist of LRDE Bangalore.
- Developed a simple procedure for the synthesis of a low cost, stable and safe electrolyte salt.
- Developed Lithium Iron Phosphate, a safer positive electrode material for the Lithium-ion battery by resorting to various processes on a lab scale
- Developed acceleration and spin activated (30V,50mA), and stab activated (3V, 50 mA) Li/$SOCl_2$ Reserve Battery and demonstrated to the scientist of ARDE, Pune.
- Developed and supplied 12V, 5 Ah Lithium-ion batteries (300 nos.) for the Hand-Held Thermal Imager (HHTI) to the Indian defense.

CENTRAL ELECTROCHEMICAL RESEARCH INSTITUTE, Karaikudi

- Developed six different types of the positive electrode materials for the Lithium-ion battery by resorting to the combustion Synthesis.
- Fabricated coin-cells and showed their utility as the promising cathode materials for Li-ion cells.
- The usefulness of Li_2MnO_3 as a possible candidate for the Lithium-ion battery was revealed for the first time.

INVITED TALKS

- *"***Nano Materials in Lithium Batteries***"* at *Ceramic Society of India, CGCRI, Kolkata, in April 2010.*
- *"***Recent Advances in Lithium-ion Battery Technology in India***"* at *Kongu Engineering College, Erode, in Dec.2012*.
- *"***Materials for Electrochemical Power Sources***"* at *Vel-Tech University, Avadi, Chennai, August 2013.*
- *"***Design and Development of Lithium-ion Batteries for EV application***"* at *ICAT, Gurgaon, May 2017.*

- *"Design & Development of Lithium-ion Batteries and Challenges",* AICTE QIP sponsored Workshop on **Frontiers in Materials Research for Energy Applications***"* Dec. 2017, *Thyagaraja College of Engineering, Madurai.*
- Opening Panel Member in the conference on **"Lithium-ion Battery Technology for EV's: Packs and cells"** organized by Niti Ayog, IIT Delhi , India.
- Panel Member in **"The Premier Lithium Ion and Electric Vehicle Testers *Meet* 2018"** *Nov 2018 at Ador- Digatron, Pune, India.*

MEETS AND SUMMIT

- **Workshop on Emerging Trends in Power Sources for Aerospace and Related Applications**, organized by RCI, Hyderabad, *2006***.**
- **"India Energy Storage Technology Summit",** organized by *Underwriters Laboratory***,** New Delhi, India *2016.*
- **"First TPEM Group 1 Battery Meeting"** Chennai 2016
- **"India E-Vehicle Show and BV Tech Expo",** New Delhi, India**,** *2017***.**
- **"Meet on e-Rickshaws, e-Autos and e-Vans",** organized by *Ministry of Power (MOP) and Ministry of New & renewable Energy (MNRE), Govt. of India*, ***2017***.
- "**2nd Industrial On-site Li-ion Cells Production Technology Seminar"** *held at Fraunhofer Institute/Custom Cells,* Itzehoe, Germany, *2017.*
- **"International Conference & Expo on Lithium Batteries, Used Battery & E-Waste Management (EWM India- 2018)"** Goa, India, *2018*.
- **"2nd IESA-ICAT EV"** Gurgaon, India, *2018*.
- **"Southern Regional Workshop of MOVE Summit"** organized by **Govt. of Karnataka, WEC India & Niti Ayog, held at Bengaluru, India, *2018*.**
- "**World Sustainable Development Summit**" New Delhi, India, *2019*

ANNEXURE

Achievements during

POSTDOCTORAL

- Organophosphines as catalysts for the removal of sulfur from of solid coal.
- Estimation of total phenolics in the coal liquefaction resids by ^{31}P-NMR spectroscopy.
- Proazaphosphatrane as catalyst for the conversion of alkyl isocyanates to isocyanurates.
- Solvent dependency in the enhanced utility of proazaphosphatrane and hence the stereo specific synthesis of certain bioactive molecules.
- Safety coordinator that conforms to the rules and regulations of OSHA and EPA of Ames Lab.

DOCTORAL

- The synthesis of stable, chiral but racemic phosphonus diamides.
- Synthesis of a Cyclophosphathiazene i.e Phosphorus, Sulphur and Nitrogen containing Inorganic Heterocycle wherein, phosphorus atom bears two different substituents, the first of its kind.
- A facile N - C bond cleavage at room temperature.

PATENTS

1. "Method for the Removal of Sulphur from coal and petroleum products", Verkade, J.G. **Mohan, T**.; Anjelici, R.J.; US Patent No : 5,437,696 / 95, **1995**

2. "Mild Desulphurization of Sulphur Bearing Materials", Verkade, J.G. **Mohan, T**. US Patent No : 5,509,945 / 96,**1996**

3. "Prophosphatrane Deprotonation of Solvents, Verkade, J.G. **Mohan, T**.; Wroblewski, AE. US Patent No : 5,698,737,**1997.**

4. “A Lithium-ion Cell with a Good Cycle Life”, Prasad, A. J; Mohan,T. **Indian Patent Application No. 1453/CHE/2004 A**, *filed on 30.12.2004*.

5. “Lithium-ion Polymer Cell” **,** Prasad, A. J ; Mohan,T. **Indian Patent Application No. 1452/CHE/2004 A**, *filed on 30.12.2004*.

JOURNALS

1. "Stable Chiral but Racemic Phosphines, Ph(R')(R")P Containing two Different (amino) Substituents : High Yield Synthesis and Conversion to the Respective Sulphides", **Mohan ,T**.; Sudheendra Rao, M.N.;Aravamudan, G. *Tetrahedron Lett*.**1989**,*30(36)*,4871.

2. "Preparation and structural characterization of 1- Phenyl 1-dicyclohexylamino-cyclo-1-phospha-3, 5-dithia-2,4,6-triazene", **Mohan, T**.; Thomas, C.J.; Sudheendra Rao,M.N..; Aravamudan, C.J.; Meetsma,A.; Vande Grampel, J.C. *Phosphorus Sulphur*,**1992**,*65,79.*

3. "A Reinvestigation of the reaction of Triphenylphosphine with Tetracyano-ethylene. Molecular Structure of N-(Heptacyanocyclopent- 1- enyl) triphenyl phosphoranimine", **Mohan, T**.; Day, R.O.; Holmes, R.R. *Inorg. Chem*.**1992,** *31,*2271.

4. "Determination of Total Phenol Concentration in Coal Liquefaction Resids by ^{31} P -NMR Spectroscopy", **Mohan, T.; Verkade**, J.G.*Energy Fuels*.**1993**,*7*,222.

5. "Cyclic S-N Compounds and Phosphorus Reagents: Part XII. Reactions of S_4N_4 with (2-Pyridylamino) phosphine", Mohan, T.; Thomas, C.J. Aravamudan,G.; Sudheendra Rao, M.N..; Meetsma,A.; Van de Grampel, J.C. *Heteroatom Chem*. **1994,** *5*,19.

6. "Selective and Efficient Synthesis of Perhydro- 1,3,5- triazene - 2,4,6- triones and Carbodiimide from Isocyanates Using $ZP(CH_3NCH_2CH_2)_3N$ as Catalyst", Tang. J. –S,; **Mohan, T**; Verkade,J. G. *J. Org. Chem*. **1994**, *59*,4931.

7. "Novel Halogen Chemistry of Atranes",Mohan,T.; Wan, Y.; Verkade,J.G. *J. Fluorine Chem*.**1995**,*71*(2),185.

8. "^{31}P Solid State NMR Study of Coals Derivatized with Phosphorus Reagents", Erdmann, K.; **Mohan, T**.; Verkade, J.*G.Energy Fuels*, **1995**,*9* (2),354.

9. "Reactions of Triphenylphosphine with cyclic S-N Chlorides:Influence of a tertiary Base, Et_3N and the Ring size of the Cyclothiazyl Chloride on the Product Selectivity",**Mohan,T**.; Senthivel,P.; Rao, M.N.S. *Indian J. Chem*. **1995**, *34A,* 961.

10. "HPLC and ^{31}P -NMR Analysis of Phenols in Coal Liquefaction Oils", Erdmann, K.; **Mohan,T**.; Verkade, J.*G. Energy Fuels*,**1996**,*10*,378.

11. Reactions of $P(CH_3NCH_2CH_2)_3N$ with primary, secondary and tertiary Hallides. Evidence for a Solvent-Enhanced Dehydrohalogenation",**Mohan, T**.; Arumugam, S.; Verkade,J.G.; Wang,T.;Jacobson, R.A. in *Heteroatom Chem.***1996,***7*,455.

12. "S-{(dicyclohexylamino)(Phenyl) (1-Pyrrolidinyl) phosphinimino-cyclo-trithiazene ," Janaswamy, S. ; Murthy G.S. ; **Mohan, T**. ; Rao, M.N.S. *Acta Crystallogr. C, Crystal Struct. Commun*., **1996**, *C52*, 1250.

13. "Reaction of S_4N_4 with Tertiary phosphines - Synthesis of Phosphinmino-cyclothiazenes and their Reactions", Mohan,T.;Sudheendra Rao, M.N. *Heteroatom Chem.***1997,***8(3)*,225.

14. "Crystal Structure of (phenyl)(pipperidino)(dicycolohexylamino) phosphinmino-cyclo-trithiazene.dichloromethane hemisolvate,"Srinivas, J . ; Murthy, G.S. ; **Mohan, T**. ; Rao, M.N.S*. Z.Krisatllogr- New Cryst. Struct*. **1997**, *212*, 323.

15. "Physical Properties of $LiMn_2O_4$ Spinel Prepared at Moderate Temperature", Chitra ,S. ; Kalyani,P. ; **Mohan,T**.; Gangadharan, R. ; Eddrief, M. ; Julien, C. *Ionics*, **1998**, *4*,8.

16. ^{31}P NMR Analysis of and Sulfur Removal from Coal Materials, Yu, Z.K. ; **Mohan, T**. ; K. Erdmann, K.; Verkade,J.G. *American Chemical Society, Division of Fuel Chemistry, Preprints*, **1998**, *43*, 905-908.

17. "Lithium Metal Rechargeable Cells using Li_2MnO_3 as the Positive Electrode , " Kalyani , P. ; Chitra, S. ; **Mohan, T**. ; Gopu kumar, S. *J. Power Sources*, **1999**, *80,* 103.

18. "Synthesis, Characterization and Electrochemical Studies of $LiNiVO_4$ Cathode Material in Rechargeable Lithium Batteries ", Chitra, S. ; Kalyani, P. ; Yebka , B. ; **Mohan, T**. ; Poniatowski, E.H .; Gangadharan , R . ; Julien,C. *Mater Chem.Phys*. **2000***,65*,32.

19. "Combustion Synthesis and Characterizations of Substituted Lithium Cobalt oxides in Lithium Batteries" ,Julien, C ; Camacho – Lopez, M.A. ; **Mohan, T**., Chitra.,S; Gopukumar, .S , *Solid State Ionics* **(2000),** *135,*241.

20. "Characterization and Electrochemical Studies of $LiMn_2O_4$ Cathode Materials Prepared by Combustion Method" Chitra ,S. ; Kalyani,P. ; **Mohan,T**.; Gangadharan, R. ; Yebka,B. ; Castro-Garcia,S. ; Massot, M.; Julien, C. ; Eddrief, M. *J.Electroceramaics,*, **1999**, 3(4), 433.

21. "Crystal Structure Analysis of (morpholoino)(phenyl)(dicycolohexylamino) phosphinmino-cyclo-trithiazene,"Janaswamy,S.; Murthy, G.S. ; **Mohan, T**. ; Rao, M.N.S*. Crystallogr.Reports*. **2003**,*48(1),* 68.

22. "Crystal Structure Analysis of (N.Methylpiperazino)(dicycolohexylamino) (phenyl)(phosphinmino-cyclo-trithiazene,"Janaswamy,S.; Murthy, G.S.; **Mohan, T**. ; Rao, M.N.S*. Crystallogr.Reports*. **2005**, *35,* 27.

23. "Microstructure and Mechanical Properties of Pulse Laser Welded Stainless Steel and Aluminium alloys for Lithium-ion Cell Casings" Vallabha Rao Rikka, Sumit Ranjan Sah[1], Rajappa Tadepalli, Ravi Bathe **T. Mohan**, R. Prakash, G. Padmanabham, and R. Gopalan, *Journal of Materials Science and Engineering B* **(2016)** , *6 (9-10),* 218-225

REPORT

"Coal Liquefaction Process Streams Characterization and evaluation: Estimation of Total Phenol Concentration in Coal Liquefaction Resids by ^{31}P - NMR Spectroscopy ", **Mohan, T**; Verkade, J.G. Report 1992, DOE/PC /89883 - 62 Order No. DE93007941 *Energy Res. Abst* **1993,** *18(1)*, no. 11672.

PRESENTATIONS AT CONFERENCES

1. " Reactions of Aminotriphenylphoniumchloride with 1,3,5,6- Tetrathia - 2,4,6,8-tetrazocine in presence of a base ", **Mohan, T.**; Aravamudan, G. ; Sudheendra Rao, M.N. *Symposium on Recent Trends in Heterocyclic chemistry,* **1986,** *BHU, Varanasi,* **India***.*

2. " A Compartive study of the Reactions of the phosphines $Ph_xP(NC_4H_8O)_{3-x}$ [x=0,1,2,3] with S_3N_2Cl AND S_4N_3Cl ",**Mohan, T**.; Thomas, C.J. Aravmudan, G. Sudheendra Rao, M.N. ; *First International Conference on Heteroatom Chemistry, **1987**, Kobe*, **Japan.**

3. " High Yield Syntheses of Triphenylphosphinimino- cyclo- trisulphurtrinitride and 1,5 - Bis (Thriphenylphosphinimino)- cyclo- trisulphurtrinitride from cyclic S-N Chlorides", **Mohan, T**.; Aravamudan, G.Sudheendra Rao, M.N.; *VII Annual Conference, Indian Council of chemists,* **1987***, Gwalior*, **India.**

4. "A Comparitive Study of The Reactions of Cyclic S-N Chlorides With Ph_3 P and Ph_3PR_2 (R= Morpholino- & Piperidino) ", **Mohan, T**,; Aravamudan, G. Sudheendra Rao, M.N. ;*Second Symposium on The Modem Trends in Inorganic Chemistry,* **1988**, *Madras,* **India.**

5. "Reaction of cyclic S-N Chlorides with Phosphines, Ph_3 PR_2 (R= Morpholino- & Piperidino-, pyrrolidino-, hexamethylenimino- and N-methylpiperazino-). Syntheses of R-S_3N_3 and their Norbornadiene Adducts", **Mohan, T**.; Aravmudan, G. Sudheendra Rao, M.N. *Third Group Monitoring workshop on the DST Funded Projects in Organic Chemistry, **1988**, Calcutta*, **India.**

6. "Syntheses And Mass Spectral Behaviour of Asymmetric Phosphines, Ph (DCA)PR [R=morpholino-, piperidino- pyrrolidino- hexamethylenimino- and N-methylpiperazino- DCA = Dicyclohexylamino-]", **Mohan, T**.; Aravamudan, G. Sudheendra Rao, M.N. *XIV Annual Symposium In Chemistry, **1989**, IIT, Madras*, **India.**

7. "Novel Halogen Chemistry of Atranes " **Mohan, T**. ; Wan, Y .; Verkade, J. G. *207th Conference , American Chemical Society, Division of Fluorine Chemistry*, **1994,** *San Diego,* **USA.**

8. "Unusual Reaction of a Super Base, proazaphosphatrane, with Water", **Mohan, T**. *Modern trends in Main Group Chemistry,* **1997**, *Indian Institute of Technology, New Delhi,* **India.**

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11. Structure electrochemcial property correlation of carbon free Mn doped $LiFePO_4$ prepared by hydrothermal method M. B. Sahana, R. Prakash, **Mohan, T**. Rajappa, R. Gopalan, and G. Sundararajan, 2nd International Conference on Materials for Energy, En Mat II, Karlsrue/Germany from May 12-17, **2013** .

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13. Development of large lithium-ion batteries for electrical vehicle applications. R. Prakash, **T. Mohan**, M. B. Sahana, R. Gopalan, Indo-UK joint seminar on functional energy materials, manufacturing and structures (FAEMMA-2013), University of Hyderabad, Hyderabad, March 25-26, **2013** .