

DETAILED BIO DATA

PROF (DR) C.P. REGHUNADHAN NAIR



Name: Prof (Dr) C.P. Reghunadhan Nair

Date of Birth/Age: 13-04-1956, 64 years 8 months and 2 days (wrt the last date for acceptance of nomination, it is **3 months and 28 days** short for attaining 65 years)

Present Position: Professor Emeritus

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Cochin University of Science and Technology,
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Previous positions held: (i) **Scientist/Engineer-H & Dy Director**
Propellant, Polymers Chemicals & Materials
Vikram Sarabhai Space Centre (VSSC), ISRO
Trivandrum - 695 022 (Retired, 30 April 2016)
(1980-2016)

(ii) **UGC visiting Professor**, Cochin University of Science & Technology (CUSAT) (July - November 2016)

(iii) **KSCSTE Emeritus Scientist**, CUSAT (NOV 2016 to OCT 2020)

1. Educational Qualification:

Degree	University	Year	Subject/Area	CLASS / RANK
PhD	University Louis Pasteur, France	1989	Macromolecular Materials (Physical Chemistry)	Grade :Distinctly outstanding (<i>Felicitacion de jury par ecrite</i>)
Masters (M.Sc.)	Cochin University of Science & Technology	1979	Applied Chemistry	Distinction & First Rank
Degree (B.Sc.)	Kerala University (the then)	1977	Chemistry	3 rd Rank at university level
Post-Doctoral Training	Visiting scientist at CNRS, France	1993 (Jan-Dec)	Free Radical Addition-Fragmentation	One Year Published 12 papers
Diploma	Kerala University	1982-84	GERMAN language	2 Years. Passed in First class and with First rank

1. **Publications, Patents, Books etc.** See separate list

2. Work Experience:@ ISRO, Scientist/Division Head/Group Director/Dy Project Director/Dy Director[1980 to 2016]

From 1980 till 2008, Dr Nair served as scientist at different levels in the field of material research for space application at ISRO. In 2008, he took up pro-managerial responsibilities in different capacities at ISRO, leading teams for major missions of launch vehicles and satellites, while keeping the tempo of research. He developed several specialty chemical/material systems for space missions. While working for mission-oriented program, he pursued academic research with vigour.

(A) RESEARCH ON SPACE MATERIALS- ACHIEVEMENTS

- 1** Introduced high temperature polymeric materials (i) imido-benzoxazole (ii) cyclomatrix polyphosphazines (iii) phosphazine-triazines (iv) polybenzoxazoles (v) Propargyl-phenolics (vi) Addition-cure phenolics, etc for space applications.
- 2** Introduced the concepts of Thermal *iniferters*& Free Radical Addition-Fragmentation in Free-radical Polymer chemistry, new chapters opened up
- 3** Speciality polymers as adhesives/ coatings (for extreme temperatures in space)
- 4** Development of light-weight thermal protection systems for earth atmospheric re-entry missions.
- 5** Research for quality improvement in solid /liquid propellants for space missions, evolved new theories and resolved decades-old issues in propellant ageing, burn rate variation etc.
- 6** Simulating experimental conditions on earth for the vapour phase reaction of propellants on board MANGALYAAN (Mars mission) near for orbit capture, to rule out possibility for mission failure consequent to propellant leak through failed valve and eventual propellant (fuel and oxidiser) mixing.Solved major issues related to:
Dissolution of propellant pressurant gas in liquid propellant in GSLV- mark IIIresolved through simulation studies days ahead of its scheduled flight.
- 7** Troubleshooting in all areas of chemicals/materials in ISRO for diverse space missions
- 8** Major responsibility in all programs of ISRO and overall responsibilities for chemicals and propellants.

- 9 Developed special thermal protection system based on syntactic foams for earth re-entry satellites. Used in projects SRE and HSP. This TPS is now earmarked for use in ambitious mission, i. e. Indian manned mission
- 10 Through techno-managerial approach, he worked toward achieving ISRO's set goals of self-reliance in materials and propellants in space navigation. He held overall responsibilities for chemicals and propellants in VSSC

(B). VISITING SCIENTIST @ CNRS-FRANCE (1993Jan-Dec 1993)

In this capacity, the work was focussed in the area of FREE RADICAL ADDITION-FRAGMENTATION reactions. This invoked synthesis of special molecules capable of undergoing free radical addition followed by fragmentation of the resulting intermediate free radical. This process generates useful organic groups in mid of the polymer chain conferring special properties to the polymer, like UV absorbability, hydrophilicity, bacterophilicity, crystallisability etc to the base polymer which is otherwise deprived of these properties. Published 12 papers within 12 months in high impact factor journals.

© RESEARCH ACTIVITIES AND ACHIEVEMENTS FROM THE SUPERANNUATION(FROM ISRO,2016) TILL DATE

After superannuation from ISRO, C P R Nair continued his research activities in different domains not necessarily relevant to space. He extended the topic of research also to the phytochemical-based raw materials from the exclusive petrochemical based ones. The idea behind this was to probe alternate means to petrochemicals as renewable source of chemicals and raw materials for serving as precursors for monomers and polymers. This would pave way for sourcing chemicals from nature, looked at from the renewable resource point of view. Thus, he directed his research activities towards cellulose, vegetable oil, natural rubber etc. The other areas included polyester, polyurethanes, toughened unsaturated resins, supramolecular structured material's, propellant binders etc. The work continued in Nano domain also. Here, the focus was on deriving carboxy functional Nano cellulose for scavenging the toxic ions from polluted water. He continued the activities on research and guidance for PhD in limited capacities as permitted by U G C, in areas of propellant chemistry, supra-molecular systems, Nano materials, high temperature materials, polymer toughening, deriving polymers from phytochemicals etc. Thus carboxyl functional nano cellulose was synthesised using different carboxylic anhydride and their metal scavenging capacities evaluated and correlated to the complex's stability and special configuration.. While he was at CUSAT,

he served also as ex-officio technical expert extending his services back to ISRO in different capacities. He, though, retired from active service, continued to enrich the Malayalam

literature with technical articles in the regional language and publishing books in the same.(see list below) During the four years at CUSAT, he authored 6 books. His science literature work has been recognised appropriately by awards and similar honours.. Recently he has been recognised as one of the top polymer scientists of the world by the U S A based international body. Of late, he proved that water cannot exist in liquid form on Mars. This was proven by using his deep footing in thermodynamics concepts and was published in an Americans chemical society journal. He also invented “the common man’s polyurethane” by converting rubber seed oil in to a polyol and then to polyurethane. During this period, he did pioneering work in extending CLICK CHEMISTRY to polymer systems, thus deigning molecular architectures, otherwise impossible to realise from polymer segments of dissimilarsolubilitycharacteristiques.

The new field of phytochemicals also yielded good results which led to more than a dozen of publications in high impact journals and a few patents. One technology was commercialised by himself by establishing a small-scale enterprise named **Formule Unique®**. Under this brand, he produced an excellent, phytochemical mix-based mosquito repellent which is an effective and non-allergy generating system. So by all these means, C P R Nair proved himself as a very active researcher *cum* entrepreneur *cum* a good teacher. This is also evident from list of reports in his credit during this period as given below:

List of publications for the post superannuated period (2016-2020)- 4 years

BOOKS (Aauthored): 6 Nos

1. C.P. Reghunadhan Nair, രസതന്ത്രം നമ്മുടെ കൈകുമ്പിളിൽ (Chemistry in our Palm holds), Popular chemistry book in Malayalam, Publisher :Notion Press, Chennai, ISBN 978-1-947027, December 2016.
2. C.P. Reghunadhan Nair, *Chemistry and You*, Publisher: Notion Press, Chennai, ISBN-9781946869388, March 2017
3. C.P. Reghunadhan Nair, അതിശയം ഈ രസതന്ത്രം (What an Amazing Chemistry, Malayalam), Publisher: Powran publishers, Aluva, DEC 2019,
4. Dhanya Augustin, Satheesh Chandran, Dona Mathew and C.P. Reghunadhan Nair*, *“HighPerformance Phthalonitrile Resins: Challenges and Engineering Applications”*, De Gruyter. ISBN: 978-3-11-064383-1, Publisher: DE Gruyter, ISBN978-3-11-0640854, Germany,May, 2019
5. C.P.Reghunadhan Nair, എത്ര രസകരം രസതന്ത്രം “What an Amusing Chemistry” Book in Malayalam, Sahithy Publications, Trivandrum, first edition December 2019. 2nd Edition August 2020, pages 130 .
6. C.P.Reghunadhan Nair,V.Unnikrishnan *Answered Questions in Advanced Chemistry and Chemical Engineerin*, Lambert Academic Publishers, Latina (July, 2020)

BOOK CHAPTERS:

1. S.Reshmi, E.Arunan and C.P.Reghunadhan Nair, *Telechilic Polybutadiene Solid PropellantBinders Based on ‘Click’ Chemistry Approach*, Chapter 12, Book: *Click*

Chemistry: Approaches, Applications and Challenges, Nova Science Publishers, ISBN: 978-1-53611-903-9 (2016) pp 347-366,

2. D. Augustine, M.Satheeshkumar, D Mathew, CPR Nair, chapter 18: ***Polyphthalonitrile resins and their high-end applications***, Thermosets, 2nd Edition, Elsevier, 2018, Thermosets, Structure, Properties, and Applications, 2nd Edition, Editors: Qipeng Guo, ISBN: 9780081010211

Bibin John, CPR Nair, CH 13 in Thermosetting polymer based syntactic foams, in Thermoset Plastics, 4th Edition, Editor: Hanna Dodiuk ISBN: 9780128216323 (2021)

INVITED REVIEWS3.

1. MR Ramdas, K. S. Santhosh Kumar*, **C. P. Reghunadhan Nair**, ***Click polymerizations: Encouraging route for shape memory polymers***, Materials Letters 172, 216-221(2016)
2. S. Reshmi and C.P. Reghunadhan Nair, ***Gas Phase Ignition Characteristics of Mono methylhydrazine (MMH) –Nitrogen tetroxide (NTO) Bi propellant System: A Review***, Progress in Aerospace Sciences (2017)

JOURNAL PUBLICATIONS:

1. S Reshmi, H Hemanth, S Gayathri, **C.P. Reghunadhan Nair**, ***Polyether triazoles: An effective binder for 'green' gas generator solid propellants***, Polymer 92, 201-209(2016)
2. S Reshmi, KP Vijayalakshmi, D Thomas, R Rajeev, **C.P. Reghunadhan Nair**, ***Polybutadiene crosslinked by 1, 3-dipolar cycloaddition: Pyrolysis mechanism, DFT studies and propellant burning rate characteristics***, Combustion and Flame 167, 380-391(2016)
3. R Konnola, **C.P. Reghunadhan Nair**, K.J. Joseph, ***Cross-linking of carboxyl-terminated nitrile rubber with polyhedral oligomeric silsesquioxane***, Journal of Thermal Analysis and Calorimetry 123 (2), 1479-1489 (2016)
4. Santhosh Kumar K.S, Ramakrishna S, Dona Mathew, **C.P. Reghunadhan Nair**, ***A one pot route for a melt processable, bulk superhydrophobic nano material with built-in self-cleaning ability***, Scientific Reports | 5:18510 | DOI: 10.1038/srep18510(2016)
5. M Satheesh Chandran, K Sunitha, D Mathew, **CP Reghunadhan Nair**, ***Alder-ene polymers derived from allyl aralkyl phenolic resin and bismaleimides: carbon fiber composites properties***, Polym Adv Tech, DOI: 10.1002/pat.3758 (2016)
6. Dhanya P, S. Ratheesh, Shashi Bhushan Singh, and **C P Reghunadhan Nair**, ***Bromo butyl rubber cross-linked by bismaleimide resins, curing kinetics and properties***, J Polym Mater, 33, 723-736 (Nov 2016)
7. Temina Mary Robert, Soorya Nair, Dona Mathew, **C.P. Reghunadhan Nair**, ***Room temperature processable heat-resistant epoxy-oxazolidone-based syntactic foams***, Polym Adv Tech, DOI: 10.1002/pat.4094 (2017)

8. S. Reshmi,* K. P. Vijayalakshmi, R. Sadhana, B. K. George, E. Arunanc and C. P. Reghunadhan Nair ***Inter molecular azide–diisocyanate coupling: new insights for energetic solid propellants***, RSC Adv.,5, 50478-50482 (2015)
9. S.Reshmi, K.P.Vijayalakshmi, C.Srinivas, DeepthiThomas, C.P.R. Nair ***Facile Crosslinking of Polybutadienes via Triazoline Heterocyclics: Deciphering Mechanism and Structural-Property Relations*** Polym AdvTech, 2020, DOI: 10.1002/pat.501
10. MR Ramdas, KSS Kumar, CPR Nair, ***Heat and solvent responsive polytriazole: shape recovery properties in different solvents***, RSC advances 6 (59), 53602-53613 (2016)
11. M.R.Ramdas, CPReghunadhan Nair, KSS Kumar, ***H-Bonded polytriazoles: Synthesis and thermoresponsive shape memory properties***, - European Polymer Journal, 91, 176-186,(2017)
12. TM Robert, S Nair, D Mathew, CP Reghunadhan Nair,***Room temperature processable heat-resistant epoxy-oxazolidone-based syntactic foams***, Polymers for Advanced Technologies, 29,121-129 (2018)
13. K. Sunitha, S Bhuvanewari, ***Dona Mathew, G Unnikrishnan, C.P.Reghunadhan Nair,Comb Polymer Network of Polydimethylsiloxane with a Novolac Stem; Synthesis via Click- Coupling and Surface Morphology Architecturing by Solvents***, Macromolecules. 50 (24), pp 9656–9665 (2017)
14. S. Reshmi, K. P. Vijayalakshmi, B. K. George and C. P. Reghunadhan Nair, ***"Facile Crosslinking of Polybutadienes via Triazoline Heterocyclics: Deciphering Mechanism and Structural-Property Relations"***, Polymers Adv Technologies ,31, 2842-2847(2020)
15. G. Santhosh, S. Reshmi, C. P. Reghunadhan Nair, ***Rheokinetic characterization of polyurethane formation in a highly filled composite solidpropellant***, Journal of Thermal Analysis and Calorimetry DOI - 10.1007/s10973-019-08793-6, vol\,140 (2019)
16. K. Sunitha, G Unnikrishnan, C.P.Reghunadhan Nair ***Azide telechelics chain extended by click reaction: Synthesis, characterization, and cross-linking***, Polymers for Advanced Technologies,30(2), 435-446 (2019)
17. Georgi J. V, Sabu Thomas, C.P.Reghunadhan. Nair, ***Maleic acid modified cellulose for scavenging lead from water.***,International Journal of Biological Macromolecules, (2019) ;**129**:pp293-304
18. Sona Stanly, J.Jelmya, C.P.Reghunadhan Nair, Honey John, ***Carbon dioxide adsorption studies on modified montmorillonite clay/reduced graphene oxide hybrids at low pressure***,Journal of Environmental Chemical Engineering, 7(5), 1033-44(2019)
19. CP Reghunadhan Nair, S Shukla, ***Hydroxylation of EPDM as a means for ambient temperature vulcanisation via urethane chemistry***, Journal of Polymer Research 26 (3), 84, (2019)

20. Georgi J. Vadakkekara, Sabu Thomas, **C.P.Reghunadhan. Nair," Sodium itaconate grafted nanocellulose for facile elimination of lead ion from water** Cellulose, 27, 3233–3248(2020)
21. **C.P.Reghunadhan Nair, P.K. Manshad, A.M. Ashir and S.Athul** *Synthesis of 3-Carbonoyl Acrylic Acid-functionalised Polystyrene and Some Aspects of its Mechanistic roll in Crosslinking of Natural Rubber*, European Polymer Journal, **131**, 15, 109688 (2020)
22. K.Sunitha P. B.Soumyamol D.Mathew. G.PanickerUnnikrishnan , **C.P.Reghunadhan Nair** *Novolac-Polydimethyl Siloxane networks through click chemistry: Thermal and Thermophysical characterization*, International Journal of Applied Ceramic Technology, <https://doi.org/10.1111/ijac.1347198>.(2020)
23. Savitha Nair, Suresh Mathew, **C.P.Reghunadhan Nair, High energy materials as thermal decomposition modifiers of Ammonium perchlorate**, Materials Today: Proceedings, **25**, Part 2, (2020), Pages 144-147
24. Savitha Nair, Suresh Mathew, **C.P.Reghunadhan Nair, Lattice Inclusion of Copper Ions in Ammonium Perchlorate through Co-crystallization: Impact on Lattice, Physical, and Thermal Characteristics**, ACS Omega, DOI-10.1021/acsomega.9b03893.
25. **C.P.Reghunadhan Nair, Vibhu Unnikrishnan, , Stability of the Liquid Water Phase on Mars: A Thermodynamic Analysis Considering Martian Atmospheric Conditions and Perchlorate Brine Solutions**, ACS Omega, 5, 16, 9391-9397 (2020)
26. George Justine, Athul S., **C.P. Reghunadhan nair, "one step hydroxylation of unsaturated oils an sythesisof crosslinked Polyurethanes thereof**, Journal of Polymer Research, Pub Date : 2020-07-02, DOI: 10.1007/s10965-020-02134-02033.
27. A. Jeemol, Suresh Mathew, **C.P. Reghunadhan Nair, - Maleimide end-capped polyether telechelics as novel toughening agents for unsaturated polyester resin**, Journal of Polymer Research, 27, 300 (2020);DO - 10.1007/s10965-020-02197-z
28. A. Jeemol, Suresh Mathew, **C.P. Reghunadhan Nair, Itaconimide telechelics of polyethers, synthesis and their impact on mechanical properties of Unsaturated Polyester Resins**, Polymers for Adv. Techol (in Press)
29. Savitha Nair, SK Nair, **C.P. Reghunadhan Nair, S Mathew Crystallization modelling for lattice modified ammonium perchlorate AIP Conference Proceedings** 2263 (1), 040005(2020)

30. Savitha Nair, Suresh Mathew, **C.P. Reghunadhan Nair**. Impact of inclusion of Cu and Fe ions in lattice on thermal decomposition characteristics of ammonium perchlorate. *PeerJ Inorganic Chemistry* 2:e1 [https://doi.org/10.7717/peerj-ichem.1\(2020\)](https://doi.org/10.7717/peerj-ichem.1(2020))
31. C. Srinivas, P. K. Solasa, S.K.ManU, R.Sadhana, V.Kumar, A.S. Alex,**C.P. Reghunadhan Nair**, Kinetics of alkali catalyzed monomethylol phenol formation for F/P<1 by ¹H NMR spectroscopy for ablative applications, Transactions of the Indian National Academy of Engineering (in press)
32. A. Jeemol, Suresh Mathew, **C.P. Reghunadhan Nair**, *copolymerisation of nadic anhydriwith styrene, reactivity ratios*,Polymers for Adv. Techol (in Press)
33. . A. Jeemol, Suresh Mathew, **C.P. Reghunadhan Nair**, **on the toughening of nadimide encapped** Polymers for Adv. Techol (in Press)

BOOK CHAPTER

3. Bibin John, CPR Nair, CH 13 in Thermosetting polymer xased syntactuc foams,in Thermoset Plastics,4th Edition, Editor: Hanna Dodiuk ISBN: 9780128216323 (2021)

POIPULAR SCIENCE ARTICLES:

- 1.C.P.Reghundhan Nair, കൊച്ചും വിറ്റാമിൻ സി -യും അപകടകരമായേക്കാം Konch and Vitamin-C can be dangerous to health,p.70, Kavimozhi magazine,, Kottayam, Kerala, Oct,2016
2. C.P.Reghundhan Nair, തീക്കളി (the science of flames) Malayala manorama,Padhippura,February, 2017.
- 3 C.P.Reghundhan Nairജലമെന്ന അത്യുത തന്മാത്ര (Jalamenna Atbhutha Thanmathra), Sasthrakeralam, March 2017
4. C.P.Reghundhan Nair “സ്വർണമുണ്ടാക്കാൻ സുത്രമുണ്ടോ?(can we synthesise gold?), Mathrubhumi Newspaper,Vidyapage, (Malayalam), 19, NOVEMBER, 2016

5. C.P.Reghundhan Nair “കൂട്ടുകൂടി!പണികിട്ടി (the theory of contradictory foods), Mathrubhumi Newspaper,Vidyapage, (Malayalam), 25, APRIL 2017
6. C.P.Reghundhan Nair “പച്ചയടുപ്പിട്ട കൊലയാളികൾ (the green camouflaged assassins)”, Mathrubhumi Newspaper,Vidyapage, (Malayalam), 20, JUNE 2017
7. C.P.Reghundhan Nair , പുളി(രസ)ശാസ്ത്രം (**The** story of acids)Malayala manorama,Padhippura 28-6-17
- 8.. C.P.Reghundhan Nair.“ഒട്ടും, അകൽച്ചയില്ലാതെ“(the story of adhesives), Malayala manorama,Padhippura July 14 (2017)
9. C.P.Reghundhan Nair “ജൈവ സാങ്കേതിക മഹാവിദ്യ (Biotechonogy)), Malayala manorama,Padhippura September 8 (2017) Malayala Manorma news paper [padippura]
10. C.P.Reghundhan Nair “കൊതുകിനെ തുരത്താൻ രസതന്ത്രം(chemistry of mosquito repellants), Malayala manorama,Padhippura September 18 (2017)
11. C.P.Reghundhan Nair, *The Story of Acids Retold*, Dream 2047, P.31, October 2017
12. C.P.Reghundhan Nair,കാൽസ്യം കാർബൈഡ് എങ്ങനെ വിഷമയമാകും? How Can Calcium Carbide be Poisonous, MathrubhumiNewspaper, 27-12-2017
13. C.P.Reghundhan Nair, പോളിമറുകൾ, അറിഞ്ഞിരിക്കേണ്ടവ(Facts About Polymers), Sasthrakeralam, November 2017
14. C.P.Reghundhan Nair,ഔഷധ വാഴ (Aloe Vera), Padippura, MI manorma newspaper8-01-2018
15. C.P.Reghundhan Nair,**Dietary Acids**, Health Scan, Jan 2018
16. C.P.Reghundhan Nair,**Aloe vera**, Health Scan, CHENNAI, Feb 2018
17. C.P.Reghundhan Nair **കറിവേപ്പില , ചുമ്മാ കളയാനുള്ളതല്ല (“curry leaf, not simply for throwing out)**, article in Kavimozhy magazine, June 2018
- 18.C.P.Reghundhan Nair പ്രണയത്തിന്റെ ഗൂഢ രസതന്ത്രം“**THE MIRACULOUS CHEMISTRY OF LOVE**”, article in Kavimozhy magazine, JULY 2018
19. C.P.Reghundhan Nair, **Aloe vera**, the sajeevani plant, Dream 2047 (MARCH, 2019)

PATENTS

1. A Process for Obtaining Polyols from Rubber Seed Oil by a one-step Hydroxylation, Crosslinkable Polymer Products Derived Thereof and Methods of Preparing Them, inv: Athul Sasidharan, George Justine, **Chethrappilly Padmanabhan Reghunadhan Nair**, Indian Patent Application No. 201841018530 (2018)
2. Vapour-Phase Active, Green Insect Repellent Composition Based on Mixtures of Natural Chemicals and A Method for Controlling Their Vaporization”, **C. P.**

Reghunadhan Nair, Indian patent application No.201741033330:AUGUST 21, (2017) India, (Granted)

Major processes developed (2016-2020)

1. A low-cost process for the quantitative hydroxylation of unsaturated systems and polymers (Patented)
2. A method for hydroxylation of unsaturated organic molecules, polymers and elastomers
3. A non-conventional route for vulcanisation of unsaturated rubbers typically ethylene-propylene- diene polymer, through hydroxylation followed by curing through isocyanate route
4. A process for high strength polyurethane from rubber seed oil.
5. A green and sustainable route for unsaturated polyester resin from rubber seed oil and similar compounds
6. Introduced a method for sulfur-free RT vulcanisation of natural rubber.
7. A process for value addition of waste polystyrene-for use as grafting agent for NR
8. Evolved a mechanism of polystyrene grafting on rubber, a method for strengthening natural rubber.
9. Investigated the mechanism of maleic anhydride grafting on to natural rubber
10. An eco- and human-friendly, green mosquito-repellent formulation based on phytochemicals mix for societal needs (**brand name: Formule Unique, patented, commercialised**)

Highlights of Activities and Achievements in post-super annuation period (July 2016 till date):

1. Plant extract/ plant seed oil seed-based monomers and polymers were derived. Rubber seed oil-based polyol and multifunctional monomers for cross-linkable derivative polymers were derived from it. Thus, polyurethanes and unsaturated polyesters were derived (patented)
2. Commercial polymer resin products were improved for quality in terms of strength and toughness. A company in Kerala (M/s Riotech Industries) was technically helped for resolving their long lasting problem of inherent brittleness of the resin they produced and was therefore stuck once and for ever. The problem was solved by CPR NAIR and the new resin based products are now well accepted throughout India, improving the financial prospects of the company which as a result is able to create

new jobs directly for 300 people and indirectly for an equal number of people. So, it is not an exaggeration if Dr Nair claims the intellectual rights/responsibility for causing economic changes in a small community of people in one part of Kerala(Pala, Kottayam). The authenticity of this claim can be verified with Mr Biju John (Proprietor, tel:9539069727) or with Mr AnishV(Technical Manager, tel:9895732292), Riotech Industries, Mini Industrial Estate, Valavoor, Pala (Kottayam),Kerala 686635, email:info@riotech.in.

3. Toughening studies on unsaturated polyester resins (UPR) using imide telechelic polyethers was investigated. The nature and concentration of the ether group and the Poly Ether end groups on the toughening effect was established. Results published.
4. Detailed crystallographic studies on ammonium perchlorate (AP) were carried out. AP was doped by co-crystallising with various inorganic ions in small but varying concentrations. The resulting doped crystals were investigated for their lattice features, thermo-chemical and thermo-dynamic properties. This study permitted to evolve a process for deriving AP with predestined decomposition temperature. The temperature dependency of the lattice parameters gave valid input about the interatomic interactions of different species present in AP lattice. The impact of doping AP with elements of the transition metal group like Fe cobalt copper Ni etc was investigated.
5. Development of lead ion scavengers based on nano cellulose. Toxic metal ions in potable water need be eliminated totally to guard our health. These can be done by nanotechnology invoking usage of nanocellulose. Thus, nanocellulose was modified by transforming the primary hydroxyl group of glucose molecules by reacting it with maleic, itaconic and nadic anhydrides to derive monocarboxylic acid. The effect of these three carboxylic acids located on the nanocellulose was examined for their relative efficiency for lead ion scavenging. This study led to the understanding of the metal ions in coordination with the metal ions to offer a proper shape of the complex for trapping the metal ion of concern.
6. Thermodynamic analyses of water under Mars atmospheric condition was done. It was proven that Water cannot exist in liquid form on Mars unless it is saturated with strong electrolytes like magnesium perchlorates.
7. Development and popularisation of Polyurethane (PU) technology through media. Rubber Seed Oil, plenty available in Kerala was value-added by hydroxylation to Polyol that served as the raw material for polyurethane coatings, foam etc. This was considered as the “poor man’s polymer”. The same polyol also served as precursor for unsaturated polyester resins

8. Recognition by Stanford university: Accounting for the technical contributions of Dr Nair in polymer area, the Stanford university rated him as one of the eminent polymer scientists among the top 2% of world's polymer scientists.
9. Conferring of the SAHITHY INTERNATIONAL PUBLISHERS AWARD for the best book on science literature in Malayalam language for the book "ETHRA RASAKARAM RASATHANTHRAM "(WHAT AN EXCITING CHEMISTRY)-nov 2020.

===== **work during super -nnuated period ends here**