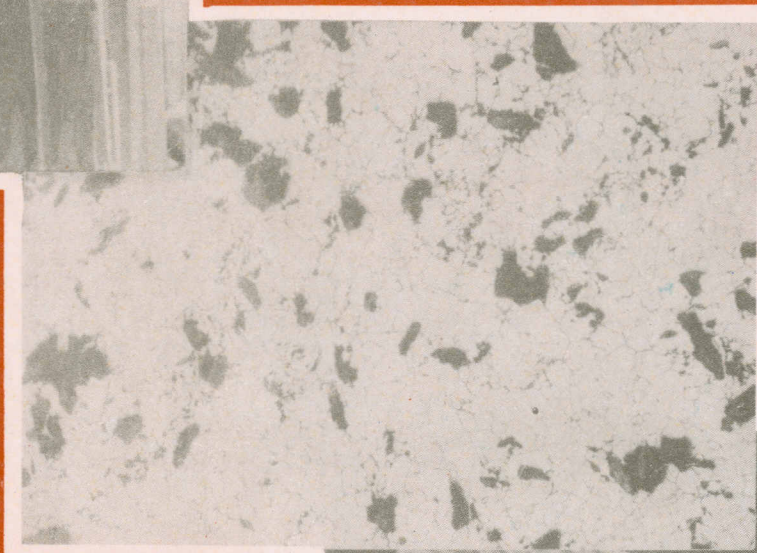
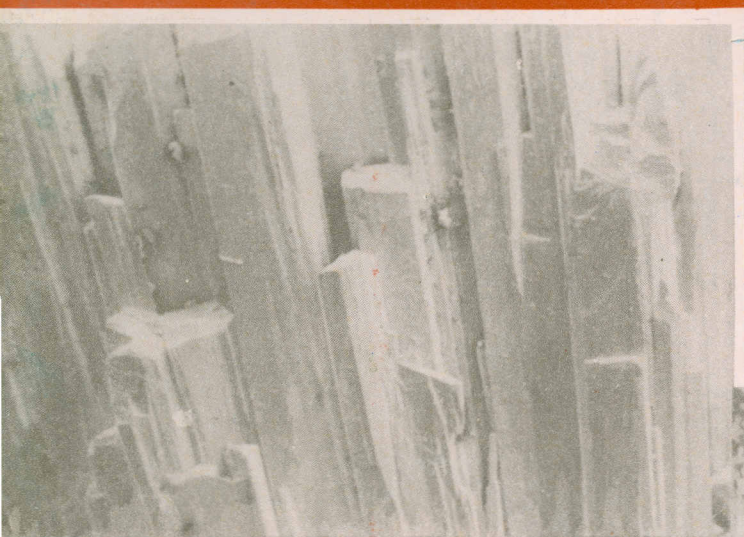


ANNUAL REPORT

1985-86



REGIONAL RESEARCH LABORATORY (BHOPAL)

ANNUAL REPORT

1985-86



REGIONAL RESEARCH LABORATORY (BHOPAL)

(COUNCIL OF SCIENTIFIC & INDUSTRIAL RESEARCH)

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क्षेत्रीय अनुसंधान प्रयोगशाला
(वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद)
REGIONAL RESEARCH LABORATORY
(Council of Scientific & Industrial Research)

होशंगाबाद रोड, हबीबगंज नाका, भोपाल - ४६२ ०२६ (म० प्र०) भारत
HOSHANGABAD ROAD, HABIBGANJ NAKA, BHOPAL-462 026 (M. P.) INDIA

प्रो. पी. के. रोहतगी

निर्देशक

Prof. P. K. Rohatgi
DIRECTOR

Ref. No. :

क्रमांक

दिनांक / Date.

August 19, 1986

I have great pleasure in enclosing a copy of the latest Annual Report, of RRL (Bhopal). Regional Research Laboratory, Bhopal, started with absolutely no infrastructure in 1981 and we are happy to report this progress. The staff has been provided with housing and transport. The laboratory now has a good nucleus of Scientists and buildings of its own which houses modern equipment like Scanning Electron Microscope, Optical Microscope, Image Analyser, X-ray Diffraction machine, Instron Testing machine and metal processing equipment. During this short 5 years existence the laboratory has published over 200 research papers in prestigious journals, executed sponsored and consultancy projects, and has provided help to local industries and Madhya Pradesh government.

This laboratory has established a lead in science and technology related to solidification processing of metal-matrix composites. This technology now represents one of the first technologies which is in demand in advanced countries like United States and Australia, in addition to Indian industries. The laboratory had passed on the know-how to NRDC through CSIR for transfer to industries within India and outside India.

The laboratory has done pioneering research in the Materials Science of plant based materials of Madhya Pradesh, specially of Ipomoea, sunhemp and sisal fibres, and the composites made using these fibres.

The laboratory also had the privilege of playing a major role in providing the base from which the scientific work was done after the gas leakage at Bhopal in 1984. During this period, even though the laboratory had to move through five locations, its staff have managed to create a name for the laboratory in national and international science and technology.

The laboratory shall greatly appreciate receiving your comments and advice on its further growth.

With kind regards,

Sincerely yours,

Pradeep Rohatgi

(P K ROHATGI)

FOREWORD

It is my privilege to present the Fourth Annual Report 1985-86 of the Regional Research Laboratory (CSIR), Bhopal.

Since 1st April 1985, four new projects approved by the Research Advisory Council have been started. More infrastructure in terms of facilities, equipment and sophisticated instrumentation has been added. Process know-how related to preparation of Al-graphite particle composites has been referred to NRDC for commercial exploitation. Specifications for fibre roofing sheets have been filed. Over fifty research papers have been published in reputed national and international journals. Two monographs entitled "Materials Science and Technology in the Future of Madhya Pradesh" and "Solidification Processing of Cast Metal Ceramic Composites" have been brought out. The laboratory was associated in the holding of a seminar on "Industrial applications of composites" and a Workshop on "CSIR in the service of Rural M.P.". A number of in house seminars were arranged in which eminent scientists and technologists from all over the country and abroad delivered lectures on recent scientific and technological advances in various fields.

The laboratory had its First Foundation Day celebrations between May 14th and 18th, 1985.

Lastly the help, support and guidance received from the CSIR headquarters is gratefully acknowledged. I am also grateful to the State Government of M.P. for their help and support. I also thank the staff of RRL, Bhopal for their hard work and co-operation.

March 31, 1986

A.C. KHAZANCHI
Scientist-in-Charge

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SCIENTIFIC ACTIVITIES

METAL MATRIX PARTICULATE COMPOSITE MATERIALS

Considerable progress has been made both in terms of product development as well as academic output. Documents on process know-how related to the transfer of technology to prepare Al-graphite particle composites have been prepared and submitted to NRDC for transfer to interested parties. Several industries from within the country and abroad (one from U.S.A. and one from Australia) have expressed their interest to purchase the technology developed at RRL, Bhopal. In addition, a number of studies have been completed to gain more complete understanding of the solidification behaviour of Al-alloys in presence of second-phase particles, thermomechanical processing of particle composites, tribological behaviour of Al-alloy particle composites and rapid solidification of composite materials. The progress made along these lines is briefly described below:

I. Work related to the development of pistons

It has been reported in the last year's annual report that RRL, Bhopal has entered into collaboration with M/s La Cast Metals and components (Pvt) Ltd., Bombay, to produce Al-graphite composite pistons for internal combustion engines, using the actual shop floor conditions. A team of scientists from RRL Bhopal and engineers from La Cast carried out the collaborative work at Bhopal and Bombay. Al-graphite composite material which was originally synthesized and produced at Bhopal was taken to Bombay for remelting and casting into pistons for various IC engines. Some of these pistons (Kirloskar AVI series-2 pistons) were sent to Automotive Research Association of India for evaluation. A photograph of the AVI series-2 piston made out of Al-graphite material is shown in Fig. 1.

Preliminary results on the evaluation of AVI series-2 pistons

Trial pistons of AVI series-2 have been made from LM 13+3 and 5% graphite composites. 500 hours test on 3% composite pistons at ARAI has been completed. Results indicate that specific fuel consumption (SFC) decreases as the test advances. Al-3 wt. % graphite piston has been found to be at par with cast iron pistons now used in Kirloskar Internal Combustion Engines. Similar tests on standard LM-13 piston are in progress at ARAI. Tests on 5% composite pistons will be taken up as soon as tests on standard piston are over.

II. Work related to development of cylinder blocks

Industrial contacts were established with leading automobile (two and three wheelers) manufacturers in India to develop cylinder blocks from Al-alloy-graphite composites for scooter engines. After a number of trials, it was decided to select a hypereutectic Al-Si alloy (LM-30) as the matrix. Accordingly composites containing 3 wt.% graphite in LM-30 alloy matrix were prepared

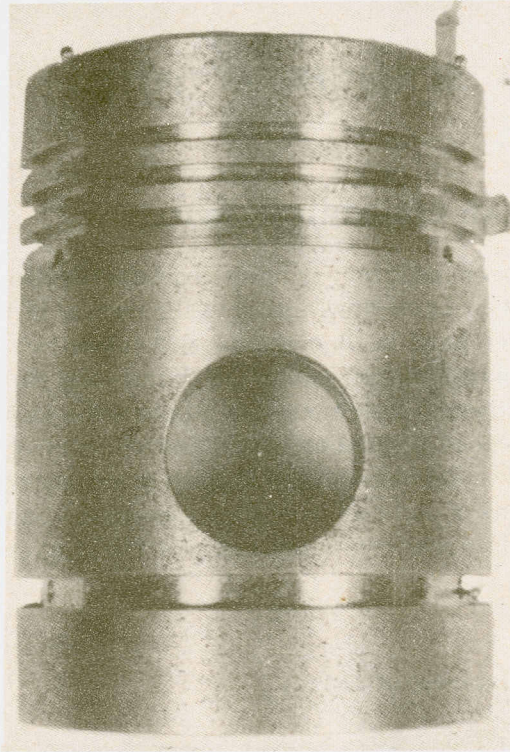


Fig. 1. A photograph of LM 13-3 wt. graphite composite piston for Kirloskar AVI Series-2 engine. Above piston was cast in collaboration with M/s. La Cast Metals Components Pvt. Ltd., Bombay. It is currently under evaluation at ARAI, Pune.

and taken to a few auto manufacturers. These were remelted and cast into cylinder blocks. In view of the need to change certain shop floor practices, it was felt that it would be much easier if the blocks were cast directly in our laboratory. These have now been cast using shell moulds borrowed from the manufacturers and are subjected to suitable heat treatment and are ready for evaluation. A photograph showing two typical cylinder blocks made out of LM-30-3 wt.% graphite composite is shown in Fig. 2(a) and microstructure in as cast condition in Fig. 2(b). It is hoped that the presence of primary silicon in the matrix will give enough hardness and the graphite particles in the composite will enhance the lubricating property and extend the life of the piston under boundary lubrication conditions. Secondly, if the field trials are successful, replacement of heavier cast iron cylinder blocks which are currently used in most of the Indian scooters will lead to significant weight savings and corresponding fuel savings. The presence of graphite particles could also eliminate the expensive chrome plating adopted by Japanese manufacturers while using light weight Al-alloy liner blocks.

III. Bush bearings from Al-graphite

Work related to the development of Al-graphite composite bushes for table fans has already been reported in the last year's annual report. After suitable heat treatment, preliminary evaluation conducted at RRL Bhopal as well as at Sah Industrial Research Institute, Varanasi has shown satisfactory performance as far as slow speed application is concerned. Trials towards developing 2.- suitable composites for high speed application are currently in progress. Photograph of worn out

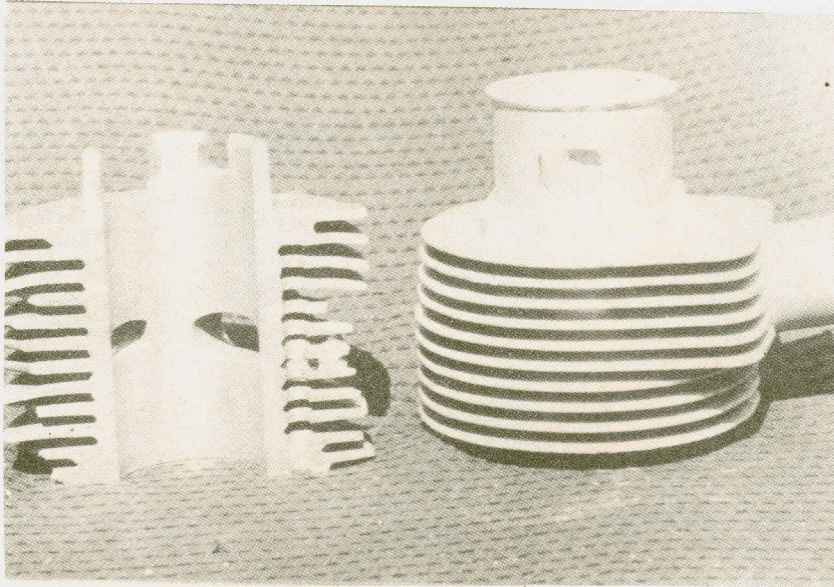


Fig. 2(a) Photograph showing light weight cylinder blocks weighing 1.7 kgs each made out of LM 30-3 wt.% graphite composite for scooter engines. Currently cast iron cylinder blocks weighing approximately 5.5 kgs are being used in these engines.

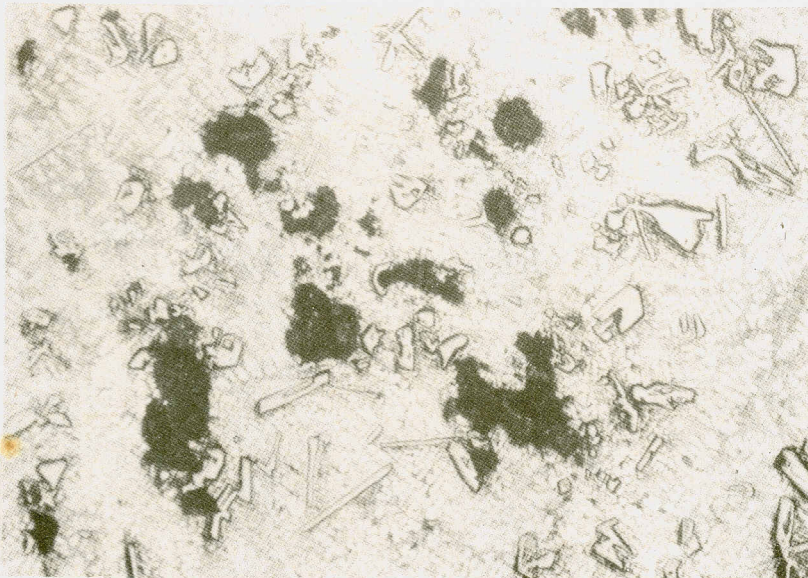


Fig. 2(b) Optical micrograph of the as cast composite showing graphite particle distribution, primary and eutectic silicon.

Al alloy-graphite fan bush is shown in Fig. 3(a) and an SEM micrograph of a magnified region of the inner side of the used bush after a 500 hour test is shown in Fig. 3(b). Spreading of graphite on the mating surface of the bush can be clearly seen.

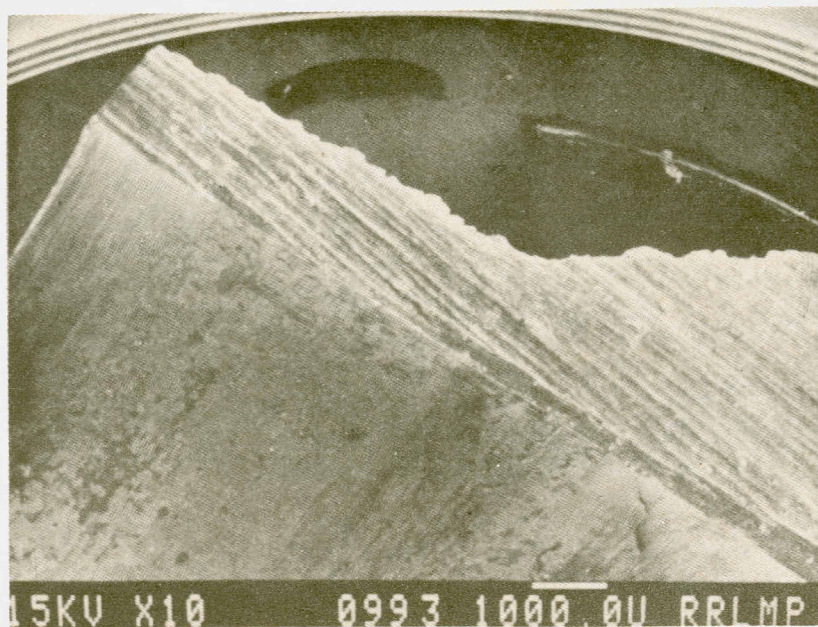


Fig. 3(a) Photograph of used bushes.

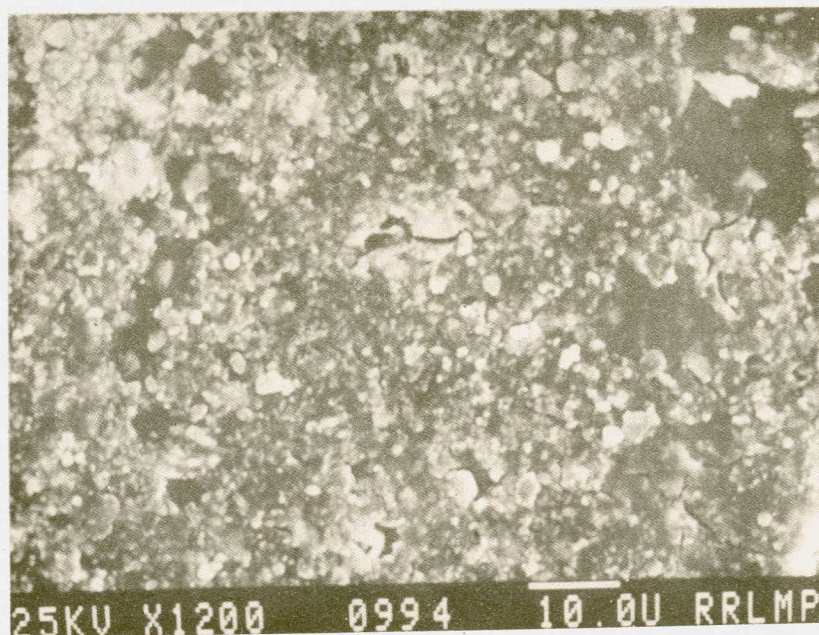


Fig. 3(b) SEM micrograph of mating surface of the Al alloy graphite fan bush after 500 hours test.

Collaboration with M/s TRW Group of Companies (USA)

The highlight of the project is the interest expressed by the TRW Group of Companies to try out Al-graphite bush bearings in their aircraft fuel pumps. If the trials which are shortly going to commence at TRW laboratories are successful, these bearings will be used in Boeing aircrafts. This represents a major milestone in India's R&D whereby the technology developed purely under Indian conditions will be transferred to a highly industrialised country like the United States. TRW have listed the mechanical properties of bronze which are currently in use in their aircraft fuel pumps. To meet the requirements as far as mechanical properties are concerned, we have chosen a 2014 (Al-Cu) alloy and composites containing 3 wt.% graphite and synthesised. Evaluation of the mechanical properties of heat treated 2014-3 wt.% graphite composites showed that the strength matches with that of bronze. Bearings as per TRW specifications will be rough machined and sent to USA for evaluation. It should be worth noting that replacement of bronze with Al-graphite will lead to significant weight saving, which is the primary objective in any material for aircraft applications. Typical microstructures of the composite are shown in Fig.4.

Applied Research and Engineering Pvt. Ltd., MIDC, Miraj have also expressed their interest to try Al-graphite bushes in their consolidating machine in place of bronze bushings. Work in this direction will be taken up soon.

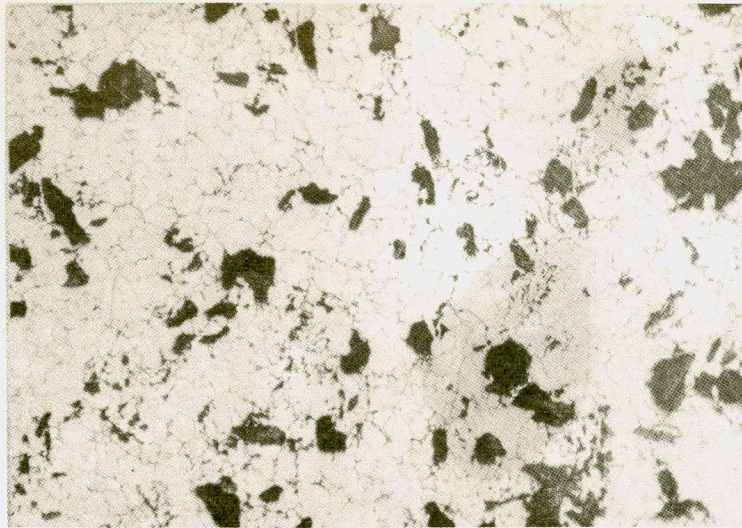


Fig. 4. Typical microstructure of 2014 Al alloy-graphite composite in the as cast condition. Bush bearings for aircraft fuel pumps are being made from this composite material after suitable heat treatment.

IV. Development of pump bodies from Al-sand composites

In addition to Al-graphite, attempts have been made to develop corrosion-erosion resistant materials from Al-sand composites for pump bodies. These composites prepared in our laboratory have been taken to Sah Industrial Research Institute, Varanasi, for making the pump bodies. Currently, these pump bodies made out of Al-sand and Al-zircon composites are being evaluated at Varanasi. Simultaneously, a programme is undertaken to systematically study the

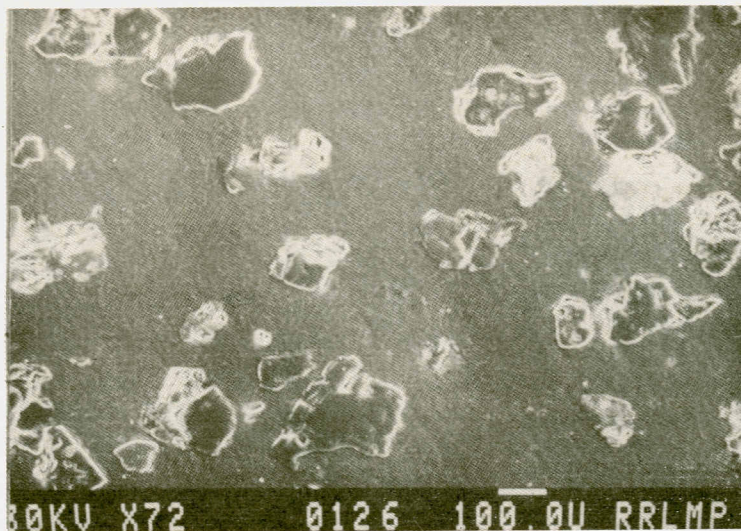


Fig. 5. Typical microstructure of Al alloy-silica sand composite. This composite is being used to make pump bodies.

behaviour of these dual-phase materials under the combined action of corrosion and erosion. A microstructure of Al alloy-sand composite used for making pump bodies is shown in Fig. 5.

Solidification studies

In order to eliminate problems encountered during the introduction of non-wettable particle like graphite talc etc. and also during casting in permanent moulds, fundamental research on solidification has been initiated.

The results of the thermodynamic analysis show that for this particle the change in the surface energy occurring during the process of particle immersion over ride the buoyance and potential energy changes. The analysis also predicts the magnitudes of energy input required for incorporation of non-wettable particles into molten alloys as functions of the shape, size, particle orientation and the path of immersion. Attempt has also been made to analyse the influence of suspended graphite particles on the solidification time of Al-graphite composite castings.

Quantitative metallographic techniques were used to characterise the distribution of inter particle spacing and particle size in die cast LM 13-3 wt.% graphite composite.

Rapid solidification of Al-Si alloy and Al-Si-graphite composites was carried out. Correlations between change in the morphology of eutectic silicon and cooling rate have been proposed. Rapidly solidified melt spun composite ribbon of Al-Si graphite exhibit uniformly embedded graphite particles (Fig. 6) and good interfacial bonding between the particle and the rapidly solidified alloy matrix.

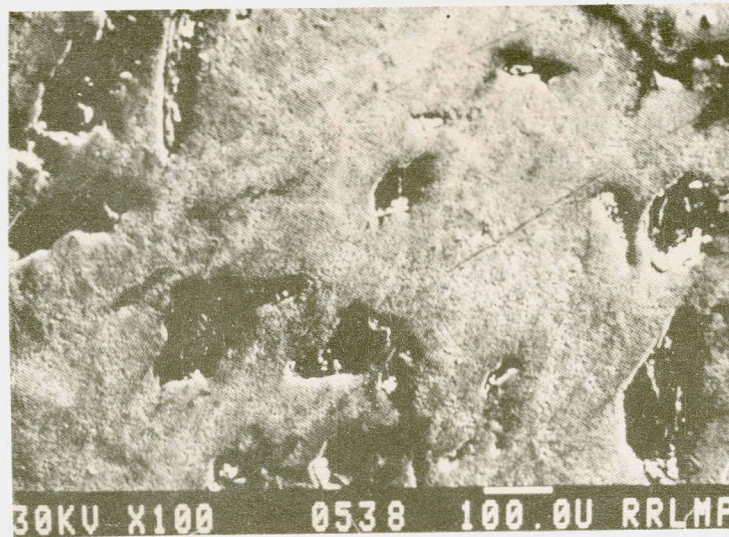


Fig. 6(a) Graphite particles, embedded in LM-13 rapidly solidified alloy ribbon.



Fig. 6(b) Magnified SEM picture showing good bonding between particle and matrix.

THERMOMECHANICAL PROCESSING

In order to increase the strength and ductility of the above mentioned metal matrix particulate composites both heat treatment and thermomechanical processing were carried out. Treatment procedures involved both solutionising and ageing treatments. Hardness tests showed that after suitable solutionising and ageing treatments, the hardness value increased by up to 40%. The microstructural analysis of heat treated samples is being carried out to optimise the heat treatment cycles for various composite materials.

TABLE 1 - MECHANICAL AND PHYSICAL PROPERTIES OF PARTICULATE COMPOSITES

Material	Processing conditions	Hardness	Tensile strength	Elongation	Density	
		HB	MPa	%	g/cc	
Al-1 Mg	As cast		84	10		
Al-1 Mg-2.5 Gr	As cast	30 ± 1.2	70	4	2.64	
	Cast and extruded					
	R 9.77	673 K	40 ± 1.5	130	20	-
		733 K	35 ± 1.8	124	22	2.66
	R 25	673 K	42.6 ± 0.55	149.82	14	2.68
		793 K	41 ± 0.54	134.45	18	-

Thermomechanical processing such as extrusion, rolling and forging have been carried out on Al-1 Mg-2.5 graphite particulate composite in order to explore the possibility of using these composite materials for structural applications. Table-1 shows the mechanical property measurements on these worked materials. It is seen that extruded sample exhibit higher strength and ductility than the rolled and forged samples. The strength increased with the increasing extrusion ratio and decreased with increase in extrusion temperature in the temperature range studied. The improvement in mechanical properties after working is attributed microstructural refinement, increase in graphite length along the direction of working and decrease in casting defects. Similar work has now been initiated on the 6061 and 2014 Al alloy based composites. Industries like Patel Extrusion Industries and other sister laboratories like SERC Roorkee have shown interest to use these materials provided they have attractive appearance. Hence anodising and dyeing of rolled, forged and extruded composites were carried out and a variety of colours were developed on the surface.

EVALUATION OF MINERALS OF M.P.

The year is marked by completion of statistical mineral resource survey, selection of sites for collection and procurement of minerals for R&D works.

Most of the minerals under study are from tribal area of M.P.

Comprehensive reports are being made for pyrophyllite, and other unexplored minerals. More than 30 local mineral industries have been helped through analysis and advice.

Mica and Talc from Jhabua district have been beneficiated successfully to be used as additive in Al-metal and polymer composites. Work has been initiated for producing insulating and cellular products from these minerals. Mica from mica schist is being studied with a view to produce flakes of higher aspect ratio. Pyrophyllite from Tikamgarh district has been collected and successful laboratory scale experiments have been made for production of various ceramicware with other mineral additives available locally. Industrial scale production of some ceramic items is decided to be made in 1986-87.

Lepidolite from Bastar district is being examined for production of Li_2CO_3 , used in Al-industry. Bauxite mineral from Bilaspur district has been collected and preliminary work has been initiated for production of ceramic materials. Zeolite minerals from Khargaon are being studied for developing inorganic membranes to remove bacteria from potable water (Figs 7 and 8). Bentonite samples from Sagar and Dhar districts are being studied for refining of crude soyabean oil.

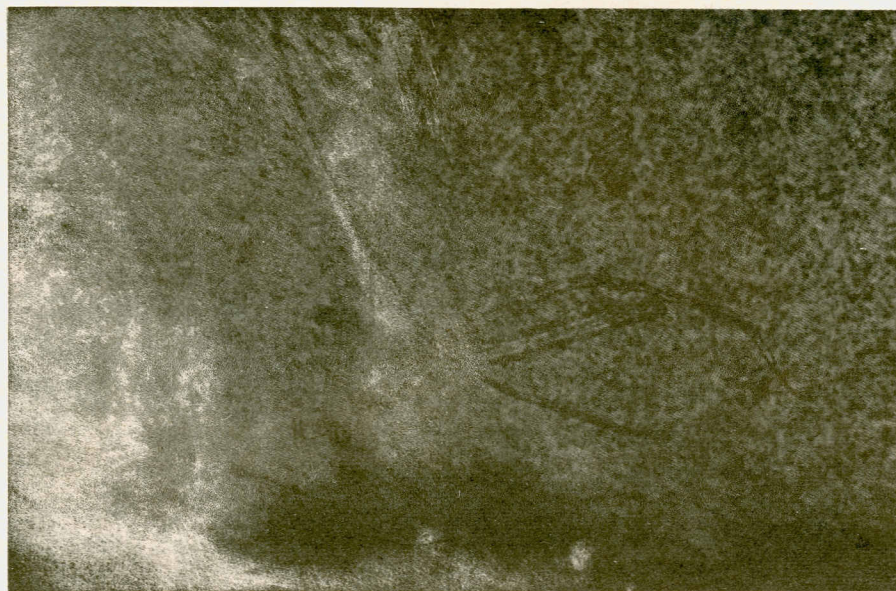


Fig. 7. Photomicrograph of bacteria in tap water (x 50).



Fig. 8. Photomicrograph of bacteria in tap water passed through commercial ceramic filter and then zeolite filter (x 50).

Extensive studies are being made for producing ultra pure silica from some of the agro wastes, useful for ceramic industries. process to produce silicon carbide whisker in gram scale from agro-waste has been accomplished. This project is visualized to be a mission oriented project and high temperature furnace facilities are being created (micrograph attached)

Considerable infrastructure in terms of equipment and sophisticated instruments has been developed in the mineral division during 1985-86.

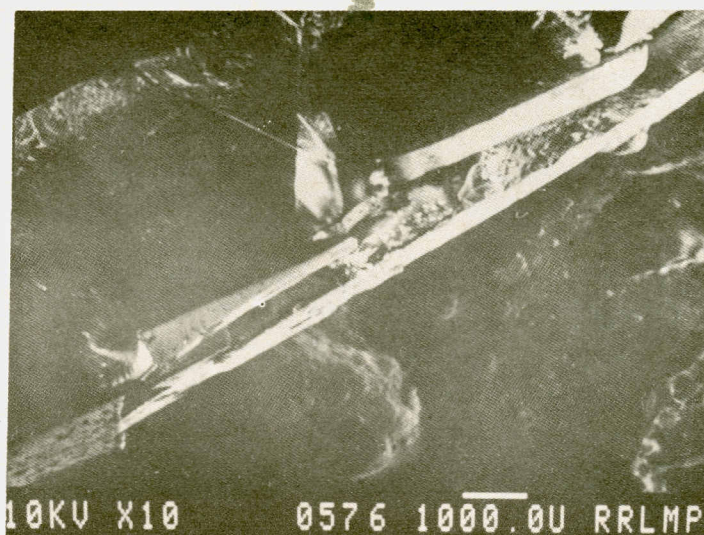
- Simultaneous thermal analyser of M/s Stranton Red Croft, U.K. was purchased and set.
- Infra red spectrophotometer of M/s Perkin Elmer was purchased and installed.

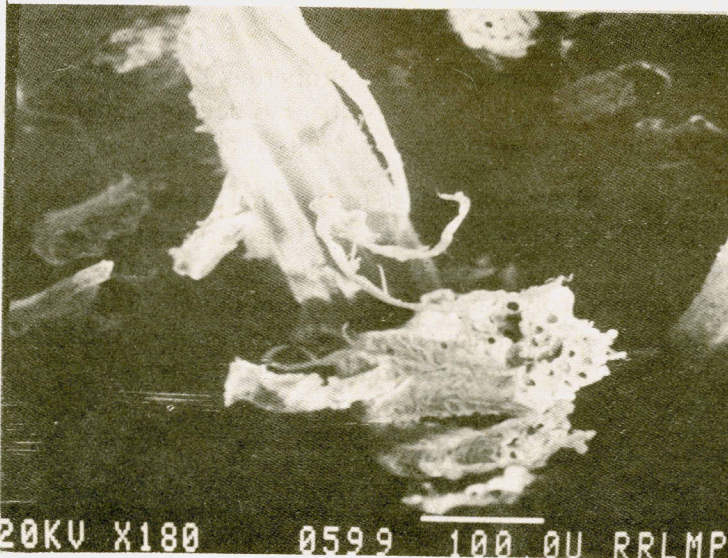
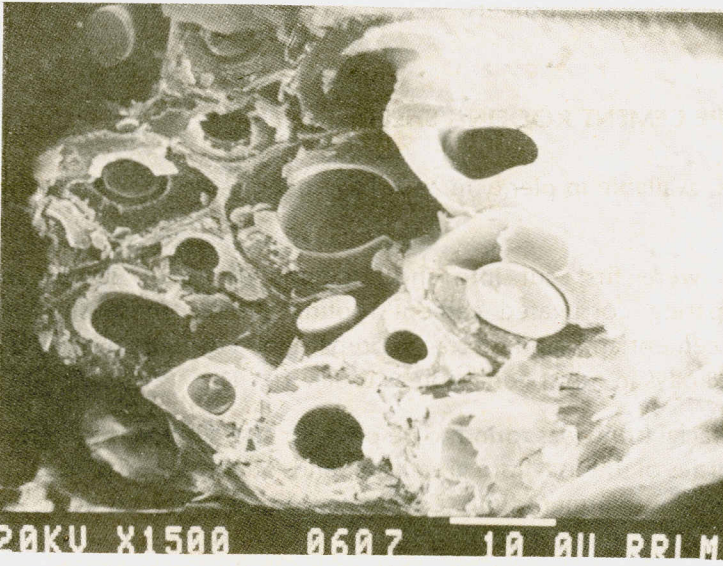
Formalities have been completed to purchase particle size analyser, surface area analyser (BET), plasma emission spectrospan for mineral characterisation and other related studies.

NATURAL FIBRES AGROWASTES AND POLYMER COMPOSITES

A number of studies have been undertaken to evaluate the properties of natural fibres available in the region of Madhya Pradesh and to study the potential of these fibres and other agrowaste materials as reinforcements and fillers in polymers. Work was also carried out to study the metal-polymer composites. Composites containing polyester as matrix material and rapidly solidified Al-Si alloy ribbons as reinforcements have been synthesised. A fractograph of polyester Al-Si ribbon composite is shown in (Fig. 9). Attempts have also been made to synthesise PVC-Red Mud particle composite and to make pipes for irrigation purposes and tiles using these composite materials.

An indepth study on the impact strength of these composite is being conducted. A very high work of fracture of about 22 KJm⁻² could be achieved with 0.24 V_r samples. Theoretical analysis of the work of fracture suggests that pull-out and interface debonding work are the major contributors to the high toughness of these composites (Fig. 10. shows a fractograph of sunhemp-





Fractographs of sunhemp-polyester composite:
(a) fibre pull-out; (b) Step fracture; and (c) fibre splitting.

Fig. 11.

polyester composite; various energy absorbing mechanisms such as fibre pull-out, step fracture of sunhemp fibre and fibre splitting can be noted from these micrographs. The high specific properties for both tensile and impact indicate that these composites have potential as reinforcing fillers in developing countries where the costs of resin and glass fibre are high.

Work is in progress to evaluate the long term properties of these composites. The effect of the high moisture absorption of sunhemp fibres on the toughness of these composites is also being studied. Techniques to decrease the high moisture regain of these fibres, while embedded in resin, are being looked into.

ACTIVITIES IN BUILDING MATERIALS RESEARCH

The project was formulated with a view to utilise local resources including plant material and aluminium industrial waste material and to improve the quality of construction material which are available for low cost housing in rural areas. The major thrust during this year has been development of fibre-cement roofing sheets.

DEVELOPMENT OF FIBRE CEMENT ROOFING SHEET

Sisal and sunhemp fibre, available in plenty in M.P. have been selected with a view to replace asbestos fibre.

Sunhemp/sisal fibres were first cut into short lengths of about 30mm and used as reinforcements in preparing corrugated cement roofing sheets. These short fibres were thoroughly mixed with cement and sand mortar to prepare the corrugated roofing sheets. The sheets were cured for 28 days in moist condition as usual. Fig. 11.

The fibre-matrix interfacial bond was found to be poor for sisal fibre and therefore the fibres were treated. The properties of the sisal fibre greatly depends on the period of treatment. Studies have been conducted on the treatment time. Corrugated sheets prepared using these treated fibres resulted in improved strength due to a significant improvement in the fibre-cement interfacial bond. Experimental techniques to precisely measure the interfacial shear strength are being designed.

The influence of the cement environment on the properties of natural fibres are being evaluated through a simulated alkali environment test that has been designed at RRL Bhopal. Experiments to study the long term wet strength of sisal fibre is also in progress.

The breaking load of corrugated sheets using alkali treated sisal fibres was 2.0 Kg/cm width as compared to the 5 Kg/cm width obtained with asbestos sheets. Experiments are being carried out by varying the fibre length, fibre content and other parameters to improve the strength and overall performance of sisal-cement corrugated sheets. A point to note, is that the sheets have been made manually cast, as compared to the automatic set up for the manufacture of asbestos sheet. The moisture absorption of the sheet was found to be 12% which is well within the maximum permissible limit of 20%.



Fig. 12. Fibre (Sisal) cement corrugated roofing sheets.

CEMENTITIOUS BINDER FROM RED MUD

Preliminary investigations were taken up to prepare cementitious binder using red mud, local clay and paddy husk as fuel. Balls were made out of red mud, clay and rice husk mixed with water in suitable proportion and left for air drying. The balls were then fired in an open kiln and the material thus obtained was mixed with lime and sand and briquettes were prepared to check the compressive strength. The test showed encouraging results and detailed investigations will be undertaken including testing of materials.

SYSTEMS PLANNING AND RESEARCH MANAGEMENT (SP & RM)

The SP&RM division continued its function in project planning, evaluation and monitoring activities. In addition, the division provided services in supplying information on research activities of the laboratory in terms of monthly reports, responses to queries from CSIR headquarters on important policy matters, etc.

The division has a small computational facility consisting of three microprocessors. Computer programme for the preparation of pay bills and pay slips as developed and computerisation of pay roll was done by the division for RRL Bhopal. In addition, computing facilities and software expertise were extended to other divisions of the laboratory in scientific activities. A course consisting of training on operating system; D base-II, Supercalc, wordstar text editor; and compilation and linking in FORTRAN, COBOL and BASIC was held between January 14 and 18

1986 under the auspices of SP & RM division. Similarly, a short term course on BASIC language was also held between February 11 and March 4, 1986, at the Laboratory.

ACTIVITIES IN BIOMATERIALS

Techniques for the extraction of collagens from heart, brain, gonads and various other tissues of turtles have been standardised and are being perfected. The relationship between collagen deposition and Basal Metabolic Rate has been studied, and it has been observed that higher the BMR the larger is the collagen deposition.

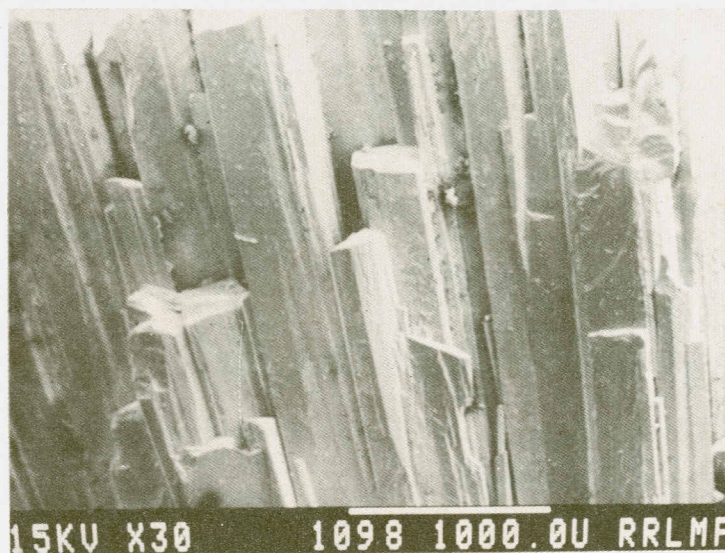


Fig. 13. Scanning Electron Micrograph of natural zeolite from M.P. showing crystal deposition during hydrothermal activity in secondary Igneous Basaltic rock.

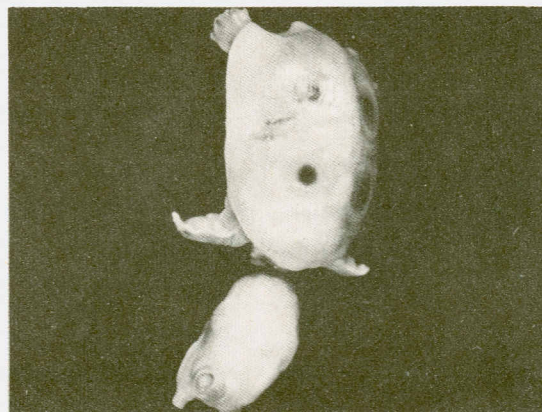


Fig. 14. Embryo of *Trionyx hurum* obtained by artificial incubation of eggs in laboratory. Reported for the first time from lakes of Bhopal (M.P.).

Solubility and insolubility ratio of collagen in turtle tissues has been investigated. Preliminary work has been done to evaluate collagen from heart and brain fibres.

Cholinesterase enzyme activity has been observed in the impulse conducting tissue in the turtle heart fibres. Qualitative and quantitative estimation of biogenic amines in the heart of rats and turtles has been done.

Natural zeolites from a few places in M.P. have been collected and those from the Khargoon district have been characterised and identified. The use of zeolites in aquaculture to increase Biomass production and as a dietary supplement to accelerate the growth of animals (turtles, fishes, mussels, prawns etc) and also its use as a biofertilizer is being investigated. Preliminary work shows positive results.

Histopathological and other follow up studies on the effects of MIC are underway on the Agro Ecosystem of Bhopal.

Trionyx hurum reported so far only from the upper Gangetic regions has also been found in the Bhopal Lakes. Eggs of these species were successfully incubated in the laboratory. Hatching and release programmes for turtles in these lakes are being undertaken to preserve ecosystem.

The role of hormones in the ageing and development of turtles in comparison to mammals is being investigated.

Work is also in progress on rehabilitation strategies, eutrophication control measures, risk analysis and risk management related to natural resources management of Bhopal Lakes. Extract of *Cyperus scarisus* (nagarmotha) a sedge grass, found in abundance in many tribal regions of M.P. is being evaluated for its therapeutic use in the treatment of dermatitis.

TABLE 1 DISTRIBUTION OF COLLAGEN IN TURTLE

In turtle about 18% of total protein is collagen of which the distribution is as follows :

Bone and carapace	10-20%
Skin	40%
Tendons	25%
Blood vessels	5-10%
Internal organs	2-8%
Muscle	2-3%

GENERAL INFORMATION

FOUNDATION DAY CELEBRATIONS AT RRL BHOPAL

On May 14, 1985, the laboratory completed four years of its existence. To mark this occasion, a week long foundation celebrations were held in the laboratory. These were inaugurated on May 14, 1985 by Dr S. Varadarajan, the then DGSIR. Dr Varadarajan and Prof K.L. Chopra of IIT Delhi delivered the foundation day orations of "Self Reliance in Chemicals" and "Science of Micromaterials" respectively. These lectures were largely attended by scientists, technologists and planners in the region. The laboratory conducted open-house during which various laboratories, equipment, instruments and activities were seen by a large number of visitors. The celebrations concluded on May 18, 1985 with addresses by Dr T.S. Murthy, Director, M.P. council of Science and Technology and Shri Sivaraman, Secretary, Finance Dept. Government of M.P. on "Science and Development". A monograph on "Material Science and Technology in the future of Madhya Pradesh" prepared by the laboratory was released on the occasion. Certificates of appreciation of services were distributed to the staff of the laboratory.

PUBLICATIONS AUTHORED BY STAFF OF RRL BHOPAL

1. U.T.S. Pillai, R.K. Pandey, K.D.P. Nigam, R.N. Yadav and P.K. Rohatgi, Modified relationships for computing the tensile properties of Aluminium alloy based particulate composites, *Trans IIM*, 38(2), 1985, 162-165.
2. C.B. Raju, M. Patel, and P.K. Rohatgi, Research and Development Imperatives in Bauxite Minerals, *J. Sci. ind. Res.*, 44, 6, 1985.
3. A.R. Sanadi, S.V. Prasad and P.K. Rohatgi, Natural fibres and agrowastes as fillers and reinforcement in polymer composites, *J. sci. ind. Res.*, 44, 1985, 437-442.
4. M. Patel, Identification of unconverted oxide phases in a synthetic clay mineral by scanning electron microscopy and the X-ray microprobe, *J. X-ray Spectrometry*, 14(1), 20, 1985.
5. M. Patel, Analysis of different phases in cement, *Indian Ceramics*, June, 1985.
6. M. Patel, Beneficiation of montmorillonite from bentonite, *Indian Ceramics*, August, 1985.
7. M. Patel, Structural analysis of some vermiculite minerals using X-ray diffraction method, *Indian Ceramics*, Sept., 1985.
8. M. Patel, Clinkerisation of cement from Industrial wastes with high chloride content (to appear in *Trans Indian Ceram. Soc.* (In press)
9. T.K. Dan and M.K. Chatterji, Activation of Indian blast furnace slag to lime and lime gypsum mixed activation in solution phase, *Indian Journal of Technology.*, 23(9) 337-344 (1985).
10. M. Maheshwari, S.S. Amritphale and M. Patel, Materials from pyrophyllite minerals-A review, *Proc. Clay-based materials for structural applications*, Trivandrum, 22nd Nov. 1985.
11. A.R. Sanadi and M.R. Piggott, Interfacial effects in carbon epoxies Part-I-Strength and modulus with short aligned fibres. *J. Mater. Sci.* (UK), 20, 1985, 421-430.

12. A.R. Sanadi and M.R. Piggott, Interfacial effects in carbon exopolymers Part-II, Strength and modulus with short random fibres. *Mater. Sci. (UK)*, 20, 1985, 431-437.
13. A.H. Yegneswaran, G.R. Char and P.K. Rohatgi, Production of secondary Aluminium-An overview. Proc. Seminar on conservation of non-ferrous metals and energy by recirculation, N. Delhi, Aug., 1985, 1-26.
14. Navin Chand and P.K. Rohatgi, Adhesion of sisal fibre in polyester, *Polymer*, 1986 (In press).
15. Navin Chand, A.C. Khazanchi and P.K. Rohatgi, Structure and properties of *Ipomoea carnea*: Its performance in polymer, clay and cement based composites, *International Journal of Cement Composite and Lightweight Concrete*, Vol. 8, No. 1, Feb., 1986.
16. A.C. Khazanchi, Navin Chand and P.K. Rohatgi, Use of sunhemp fibres in development of Non-carcinogenic cement composites. Proc. Third International Symposium on Development in Fibres Reinforcement and Concrete (Sheffield-accepted).
17. Navin Chand, S. Phakka, P. Agrawal, S.D.N Tiwari and P.K. Rohatgi, Structure and Properties of *Hibiscus panduraeformis*. A new type fibre. Proc. Third International Symposium on Development in Fibre Reinforced Cement and Concrete (Accepted 1986).
18. S. Das, A.H. Yegneswaran and P.K. Rohatgi, Microstructures of rapidly solidified Al-Si and Al-Si-graphite particle composites. Proc. Int. Conf. on Aluminium, INCAL-85, Oct. 30-Nov. 2, 1985, N. Delhi, 590-598.
19. O.P. Modi, A.H. Yegneswaran and P.K. Rohatgi, Thermomechanical processing of cast particulate composites. Proc. Int. Conf. on Aluminium, INCAL-85, Oct. 30-Nov. 2, 1985, N. Delhi, 545-552.
20. S.V. Prasad and P.K. Rohatgi, Wear of Aluminium alloy-ceramic particle composites. Proc. Int. Conf. on Aluminium, INCAL-85, Oct. 30-Nov. 2, 1985, N. Delhi, 561-567.
21. Navin Chand, S. Das and P.K. Rohatgi, Mechanical behaviour of Al RSP-polyester composite, *J. Materials Science*, Lett. accepted (1986).
22. Ravi Prakash, U. Banerji, M. Anwer Deshmukh and Sandhya Mathur, Histological observations in the human foetal kidney, Proc. XII International Anatomical Congress, Aug. 1985, A-567, London.
23. Ravi Prakash and U. Banerji, Study on the specialised conducting tissues of human foetal heart, A-563, Proc. XII International Anatomical Congress, Aug. 1985, London.
24. Ravi Prakash and Savita Gulati, Impulse conducting tissues in the heart of *Lissemus puncterceta*, A-569, Proc. XII International Anatomical Congress, Aug. 1985, London.
25. Ravi Prakash and S.M. Misra, Limnology of different aquatic impoundments in tropics of India with special reference to biological diversity, IV International Congress of Ecology, New York, USA, August, 1986, (Accepted).
26. A.K. Jha, T.K. Dan, S.V. Prasad and P.K. Rohatgi, Al alloy-solid lubricant talc particle composite. *J. Mater. Sci. (UK)* (In press).
27. A.K. Gupta, T.K. Dan and P.K. Rohatgi, Aluminium alloy-silica sand composite. Preparation and Properties. *J. Mater. Sci. (UK)*, (In press).

28. A.K. Jha, P.K. Rohatgi and G.S. Upadhyaya, Properties of composites of 2014 Al alloy with Ni-Mo based metallic glass particles, *J. Mater. Sci.* (UK), (In press).
29. C.S. Narendranath P.K. Rohatgi and A.H. Yegneswaran, Observation of graphite structure under optical and scanning electron microscopes, *J. Mater. Sci. Lett.* (UK), (In press).
30. C.S. Narendranath and A.R. Sanadi, Interfacial properties of metal wire, metal matrix composites produced by the liquid metallurgy technique, Proc. Int. Conf. on New Composites, Patras, Greece, Aug., 1986 (In press).
31. S. Das, R. Asthana and P.K. Rohatgi, Solidification of aluminium in presence of suspended graphite particles, Proc. Int. Conf. on Aluminium Alloys, Univ. of Virginia, Charlottesville, Virginia (USA). June 1986 (In press).
32. S.V. Prasad, C.S. Narendranath and P.K. Rohatgi, Tribological properties of Al alloy matrix particulate composites. Proc. Int. Conf. on Aluminium Alloys, Univ. of Virginia, Charlottesville, Virginia (USA), June, 1986 (In press).
33. P.K. Rohatgi, S. Das and R. Asthana, Synthesis, structure, properties and applications of cast Aluminium-ceramic particle composites. Proc. Int. Conf. on Aluminium Alloys, Univ. of Virginia, Charlottesville, Virginia (USA), June, 1986 (In press).
34. S.V. Prasad, T.H. Kosel and P.K. Rohatgi, Mechanism of material removal during high-stress and low-stress abrasion of Al alloy zircon particulate composites. *Mater. Sci. Engg* (USA), (In press).
35. S.V. Prasad, T.H. Kosel, Comparison of carbide fracture during fixed depth and fixed load scratch test conditions. Proc. Int. Conf. on wear of materials, Vancouver, B.C. 1985, Ed. by K.C. Ludema, ASME (In press).
36. S.V. Prasad, R. Asthana and P.K. Rohatgi, Recent advances in metal matrix composite materials, Proc. of the The First National Conv. of Met. and Science of Materials, The Institution of Engineers (India), Mar 7-8, 1986, Hyderabad, 14.1.
37. P.K. Rohatgi, S. Das and R. Asthana, Synthesis, structure and properties of cast metal-ceramic particle composites, ASM Metal Congress Detroit, Metals/Materials. Technology Series, 8408-032, *Amer. Soc. for Metals, Ohio* (USA).
38. P.K. Rohatgi, R. Asthana and S. Das, Solidification processing of cast metal-ceramic particle composite, *Int. Metals, Reviews* (UK), (In press).
39. A.R. Sanadi and M.R. Piggott, Interfacial effects in carbon epoxies Part-III-Toughness with short fibres. *J. Mater. Sci.* (UK), (In press).
40. A.R. Sanadi, S.V. Prasad and P.K. Rohatgi, SEM observation on the origins of toughness of natural fibre-polyester composites. *J. Mater. Sci. Lett.* (UK), (In press).
41. M. Saxena, A.H. Yegneswaran, Raj Kumar and P.K. Rohatgi, Surface finishing of Aluminium alloy particulate composites. Plating and surface finishing (UK), (In press).
42. S. Raman and T.K. Dan, Physico-chemical analysis of a raw brick clays of Bhopal, *Indian Ceramics* (In press).

43. T.K. Dan, Studies on the effect of MgO on hydraulic properties of slag, *Indian Ceramics* (In press).
44. T.K. Dan, Effect of salts on setting time of portland cement, *Indian Ceramics*, (In press).
45. K. Jayachandran and T.K. Dan, Development of Wollastonite based porcelains for low firing temperatures, *Research and Industry*, (In press).
46. R.P. Singh, O.P. Modi, M.N. Munagole and K.P. Singh, Corrosion of 2.25 Cr-1 Mo ferritic steel in sulphuric acid and sea water, *Br. Corros. J.* 1985, Vol. 20, No. 1, P. 28.
47. R.C. Srivastava, R.K. Sharma and S.B. Bhose, Liquid membrane phenomena in steroidal drugs, *Colloids and Surfaces* 14, 1 1985.
48. R.C. Srivastava, A.Tandon, S.Kurup, S.B.Bhose and R.K. Sharma, Photo-electric effect in liquid membrane Bilayers-studies on chloroplast extract, Halmoglobin, Protoposphyrin, *J. Electroanal Chem. & Interface Electroanal Chem.*, 187 325, 1985.
49. R.C. Srivastava, R.K. Sharma, A. Tandon and S.B. Bhose, Transport through liquid membrane bilayer generated from lieithin, cholestrol and leithin choslestrol mixtures-studies in presence of polyene antibiotics, *J. Colloid Interface Sci.* (In press).
50. J.B. Bhose, C.V.S Subrahmanyam, R.K. Sharma and R.C. Srivastava, Liquid Membrane phenomena in anti-arthythrice action *J. Pharm. Sci.* (Accepted).
51. R.C. Srivastava, A. Tandon, R.K.Sharma, S.B. Bhose and D.B. Madanwar, Photo-osmosis through liquid membrane bilayers generated from cytochrome, *J. Phys. Chem.* (communicated).
52. Navin Chand, K.G. Satyanarayana and P.K. Rohatgi, Mechanical behaviour of sunhemp fibre. *Ind. J. Text. Research*, 1986.
53. Navin Chand and A.C. Khazanchi, Some new type of cheaper building materials, Workshop on S&T for Rural M.P., 22-23 Feb., 1986.
54. Navin Chand and P.K.Rohatgi, Tensile and impact behaviour of chopped sunhemp-polyester composites, *Pol. J.* 1986 (accepted).
55. Ravi Prakash and Anwar Deshmukh, Bhopal Lakes: A study on bioproductivity, *Hydrobiological Journal*, John Wiley & Sons, New York (USA), (Accepted).
56. Vinita and Ravi Prakash, Preliminary observations on turtle carapace, *Science & Culture*, 1986 (Accepted).
57. Ravi Prakash and Anwar, Deshmukh, Solubility ratios of collagne in turllet Fissues, *JournalGerontologia*, US (communicated).
58. Ravi Prakash and U. Banerji, Therapeutic exploitation of *Cyperus scarisus* (Nagarmotha) from tribal areas of Madhya Pradesh, IV Session of M.P. Vigyan Academic, (Accepted).

PAPERS PRESENTED IN SEMINARS/CONFERENCES/SYMPOSIA

Seminar on conservation of non-ferrous metals and energy by recirculation, Aug 13-14, 1985, New Delhi.

1. Yegneswaran A.H., Char G.R., Rohatgi R.K., Production of secondary Aluminium-An overview.

Second National Symposium on Industrial Applications of Composites, Sept. 27-28, 1985, Bhopal.

2. Dan T.K., Navin Chand and Rohatgi P.K., Effect of Glass, Rice husk ash and Wollostonite on transverse strength of porcelain.
3. Navin Chand and Rohatgi P.K., Some Techno-economic consideration in the development of the natural fibre composite.
4. Navin Chand and Rohatgi P.K., Adhesion of sisal fibre polymer system.
5. Navin Chand, Raman S. and Rohatgi P.K., Acoustics Properties of sisal fibre filled polymer composites.
6. Navin Chand and Rohatgi P.K., Potential use, structural use, structural and Thermal studies of sabai grass fibre.
7. Navin Chand and Rohatgi P.K., Mechanical behaviour of sunhemp fibre.
8. Prasad S.V., Asthana P., Mohini Saxena, Yegneswaran A.H. and Rohatgi P.K., Potential uses of cast aluminium alloy-particulate composites.
9. Rohatgi P.K., Arya S.C., Dan T.K. and Prasad S.V., Studies on the large scale development of Al-alloy graphite pistons for IC Engines.
10. Prasad S.V., Particle reinforced polymer composite for dental filling application-biomedical materials.

International Conference on Aluminium INCAL-85, Oct 30-Nov. 2, 1985, Vigyan Bhavan, New Delhi.

11. Prasad S.V. and Rohatgi P.K., Wear of Aluminium alloy ceramic particle composites.
12. Das S., Yegneswaran A.H., Rohatgi P.K., Microstructure of rapidly solidified Al-Si, and Al-Si-graphite particle composite.
13. Modi O.P., Yegneswaran A.H. and Rohatgi P.K., Thermomechanical processing of cast particulate composites.
14. Char G.R., Yegneswaran A.H., Prasad B.K., Sarangi S, and Rohatgi P.K., Technology forecasting of Aluminium and its R&D in India.

22nd Annual Convention of Chemists, 4-8 Nov., 1985, Raipur.

15. Kujur B., Ray A.K., Raju C.B., Patel M., Problems in chemical analysis of Al-ceramic composites.

- Annual Session, National Academy of Sciences, India, Gwalior, Nov., 1985.
16. Prakash Ravi, Shrivastava P.K. and Deshmukh Anwar, Thermal treatment of turtle carpace. Indian Council of Chemists Annual Conference, Dec., 1985.
 17. Prakash Ravi, Shrivastava. P.K., Chromatographic separation of some food colouring dyes. Indian National Science Congress Association Annual Session, Jan., 1986, New Delhi.
 18. Prakash Ravi, Shrivastava P.K. and Deshmukh Anwar, TGA studies on M.P. region zeolites. All India Seminar on the Role of Zoology in the Development of Madhya Pradesh, March 17-18, 1986.
 19. Prakash Ravi, Misra S.M. and Banerji U., Mixed farming present status and future prospects. 50th Annual Session of Indian Ceramic Society, 7-9 February, 1986, Calcutta.
 20. Raju C.B., Patel M and Rohatgi P.K., R&D Imperatives on minerals of M.P.
 21. Patel M., Karera A, Ray A.K., Raju C.B. and Rohatgi P.K., Structural studies on some refractory fibres.
 22. Raju C.B., Gupta A, Ray A.K. and Patel M., Preparation of cellular insulating products from Mica schist and talc minerals of M.P.
 23. Amritphale S.S. and Patel M., Ceramic tiles from pyrophyllite and clay minerals of M.P.
 24. Maheshwari M. and Patel M., Developmmnt of bio-ceramic materials-A review.
 25. Ray A.K., Kujur B. and Patel M., Evaluation of lepidolite minerals from M.P.
 26. Swamy P., P. Kumari and Patel M., Recent development on products from clay-A review.
 27. Raju C.B., Development of antiwear and chemically durable tiles from thermal wastes. International Congress on Glass, New Delhi, 2-7 March, 1986.
 28. Raju C.B., and Yshkhishin I.N., Crystallisation of glasses in the systems CaO-MgO ($RO^2-R^1O^3-R^2O$) and CaO- $Al^2O^3-RO^2-Fe^2O^3-R^2O$).

The First National Convention of Met. and Science of Materials, Institution of Engineers (India) March 7-8, 1986, Hyderabad.
 29. Prasad S.V., Asthana R., Rohatgi P.K., Recent advances in metal matrix composite materials. 115th TMS Annual Meeting, New Orleans, LA, 3-5 March, 1986.
 30. Rohatgi P.K. "Interfacial Phenomenon in Cast Metal-Ceramic Composites" and "Properties and Solidification behaviour of mixtures of molten aluminum and Ceramic Particles".

Center for Surface Studies, University of Wisconsin, February, 1986.
 31. Rohatgi P.K. "Surface science considerations in cast metal ceramic composites".

PARTICIPATION IN CONFERENCES/SEMINARS/SYMPOSIA

1. Dr A.H. Yegneswaran attended the Round Table Conference on Non-ferrous metals, Ministry of Steel, Mines and Coal, May 8, 1985, New Delhi.
2. A.C. Khazanchi, Dr S.V. Prasad, Dr T.K. Dan, Dr A.H. Yegneswaran Dr Navin Chand, Mr P.D. Ekbote, Mr A.K. Jha, Mr S. Das, Mr A.R. Sanadi, Mr R. Asthana, Mr A.K. Gupta and Mr K.K.S. Gautam, attended Second National Symposium on Industrial Applications of Composites, Sept. 27-28, 1985, at Bhopal.
3. Mr A.K. Jha and Mr S.Das, attended symposium on EXAFS and Allied Phenomenon, July 19-21, 1985, Bhopal.
4. Dr S.V. Prasad, Dr T.K. Dan, Dr A.H. Yegneswaran, Dr C.S. Narendranath Mr P.D. Ekbote, Dr Navin Chand, Mr A.K. Jha, Mr S. Das, Mr R.Asthana, Mr O.P. Modi and Mr A.K. Gupta, attended the International Conference on Aluminium, INCAL-85, Oct. 30-Nov.2, 1985 at New Delhi.
5. Dr C.B. Raju and Mr B. Kujur attended Annual Convention of Chemists held at Raipur on 4-8 Nov., 1985.
6. Dr (Mrs) M. Maheshari attended Seminar on Clay based Materials for Structural Applications, Nov. 22, 1985, RRL, Trivandrum.
7. Dr R.N. Yadava and Shri A.C. Khazanchi attended a Workshop held at T.T.T.I., Bhopal on 3rd Nov., 1985 on Engineering Education in 2000's Curricula Change.
8. Dr R.N. Yadava attended the International Conference on Finite Elements in Computational Mechanics, held at IIT, Bombay, Dec. 2-6, 1985.
9. Dr Ray attended International Symposium on Recent Trends on Inorganic Chemistry held at Calcutta on Dec. 16-18, 1985.
10. Dr M. Patel, Dr C.B. Raju, Dr A.K. Ray, Dr Sharma, Mr A. Karera, Mr S.S.A. Phale attended the 50th Annual Session of Indian Ceramic Soc. at Calcutta on 7-9 Feb. 1986.
11. Mr A.C. Khazanchi and Dr. Navin Chand attended Workshop on Science and Technology for Rural Madhya Pradesh held at Bhopal on Feb. 22nd, 1986.
12. Dr M.Patel and Dr C.B. Raju attended International Seminar on Glass at New Delhi on 2-7 March, 1986.
13. Dr S.V. Prasad attended the First National Convention of Met. and Science of Materials, Institution of Engineers (India) March 7-8, 1986, Hyderabad.
14. Mr A.K. Jha attended the Annual Convention of Powder Metallurgy Association of India, March 15, 1986, Hyderabad.

TECHNICAL SERVICES/ADVICE GIVEN

S.No.	Party	Regarding
1.	M/s Shree Digvijaya Woollen Mills Limited Nagda (M.P.)	Analysis of coal samples
2.	M/s Madhya Pradesh United Polypropylene Ltd., Mandideep, Bhopal	Analysis of polypropylene samples
3.	M/s Punjab Engineers' Steel Works, Bhopal	Analysis of copper sample, silver and wool
4.	M/s. P.N.M. Products, Bhopal	Analysis of alum samples
5.	M/s. Super Cement Pvt. Ltd., Bhopal	Analysis of lime stone
6.	M/s. Saijadri Paper Mills, Limited, Budni (M.P.)	Analysis of alum samples
7.	M/s National Fertilizer Limited, New Delhi	Analysis of alum and sleaching
8.	M/s Sri Mill Enterprises Mandideep, Bhopal	Analysis of Clay for stoneware
9.	M/s. Bharat Aluminium Company Balco, Korba (M.P.)	Analysis of low grade bauxite
10.	M/s Ratlam Thermit Pvt. Ltd., Ratlam (M.P.)	Analysis of chrome ore
11.	M/s Laxmi Metal Powder Co. Pvt. Ltd., Ratlam	Analysis of chrome ore
12.	Commissioner of Industries, Govt. of M.P., Bhopal	Analysis of gum samples
13.	M/s Lime Industries, C/o Shri A. Singh Yadava	Analysis of Lime stone
14.	M/s M.P. Stone & Marble Industries, Gwalior	Analysis of ceramic of ceramic wares

15. M/s Soyabean Refining Plant, C/o My. Yusuf Khan, Bhopal	Analysis of bentonite samples
16. M/s Bharat Heavy Electricals Bhopal	Fibre shear load test
17. M/s Associated Engineers, Bhopal	FRP sheets tensile and compression testing
18. M/s Punjab Engineers Steel Works, Bhopal	Copper section, hardness conductivity
19. M/s Aliasons Industries, Bhoapl	Hardness testing
20. M/s J.S. Engg Works., Mandideep, Bhopal	Tensile test
21. CIAE, Bhopal	Sugar cane extraction and testing
22. HEG, Mandideep, M.P.	Testing of concrete cubes
23. Dept. of Mechanical Engg, MACT, Bhopal	Sample test on INSTRON, hardness testing, metallographic tests
24. IIT Kanpur	SEM studies on tensile fractured surfaces of dual phase materials

TRAINING PROGRAMES ORGANISED AT RRL BHOPAL

1. A course consisting of training programme on operating system D base-II, Supercalc, Wordstar test editor, Compilation and linking in FORTRAN, COBAL and BASIC, was arranged at RRL, Bhopal from 14th to 18th January, 1986 under the auspices of the SP & RM division.
2. A short term course on BASIC language programming was conducted by Dr R.N. Yadava, Head, SP & RM division, between Feb. 11 and March 4, 1986.

DEPUTATION ABROAD

Shri K.K.S. Gautam received training on Scanning Electron Microscope at JEOL, Japan, between Sept. 2nd and 20th, 1985.

PATENTS FILED

Specification for the improve ment in or relating to the manufacture of roof coverings, by K.K. Verma, Navin Chand, A.C. Khazanchi and P.K. Rohatgi, has been filed.

BUDGET AND EXPENDITURE

(Rs. in lakhs)

Year	Total expenditure
1981-82	9.860
1982-83	110.000
1983-84	94.242
1984-85	172.000
1985-86	81.900

LIBRARY STOCK

Total number of books	2343
Number of periodicals subscribed	85
Number of reprints	1644

LECTURES DELIVERED BY OUTSIDE SPEAKERS AT RRL, BHOPAL

Lecture delivered by	Subject
1. Dr. Amitava Rai, TCRDC, Patiala, on April 2nd, 1985	Structure of grain boundaries
2. Dr Amol Gokhale, Univ. of Pittsburgh, USA, on 10th April, 1985	Strength and ductility of partially solidified alloys in relation to hot tearing
3. Dr J.A. Sekhar, Scientist DMRL, Hyderabad, on 10th April, 1985	(a) 3-D Heat flow during solidification (b) Eutectic solidification (c) Rapid pressure application
4. Dr (Sister) Marie T. Dimond, on 25th April, 1985	Resources and Environment
5. Mr B.N. Keshava Ram, Bangalore, on 29th April, 1985	Preparation and properties of Aluminium-glass and Aluminium-fly ash particulate composite
6. Dr S. Varadarajan, Director General, CSIR, New Delhi, on 14th May 1985.	Self reliance in chemicals
7. Dr K.L. Chopra, Professor, IIT, Delhi, on 14th and 15th May, 1985	(a) Science and Technology on Micro Materials (b) Optically active surfaces
8. Dr V.B. Gupta, Professor IIT, Delhi, on 13th June, 1985	(a) Principles of fibre reinforced polymer composites (b) Short fibre reinforced polypropylene

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| 9. Miss P. Bajaj, Chairman,
Textile Technology Dept.,
IIT, Delhi, on 26th July, 1986 | Flame retardant polypropylene
and P.V.C. |
| 10. Dr S. Mirza, Chairman, Dept.
of Mechanical Engineering,
Univ. of Ottawa, Canada,
on 1st Aug., 1985 | Dynamics of composite materials |
| 11. Dr Kris Tangri, Professor
of Metallurgy and Research
Director, Metals Science
Laboratory, Univ. of Manitoba
Canada, on 19th Nov., 1985 | Non-equilibrium dislocation effects
at grain boundaries and their
influence on the properties of
polycrystals |
| 12. Prof. Robert Maddin,
Harward University, USA,
on 6th Dec., 1985 | Change of bronze to iron
technology |
| 13. Prof. N.K. Sarkar, Professor
and Chairman, Dept. of
Biomaterials, Louisiana
State Univ. on Jan. 30, 31 1986 | (a) Dental Metallurgy
(b) Dental Ceramics
(c) Restorative Polymers and
Composites. |

INTERNAL SEMINARS DELIVERED BY RRL STAFF

1. Dr R.N. Yadava on 9th July, 1985-Methodology of Project Costing
2. Dr C.S. Narendranath on 17th July 1985-Metal Processing
3. Dr A.H. Yegneswaran on 14th October 1985-Technology Forecasting of Aluminium and its R&D in India
4. Mr O.P. Modi on 14th October 1985-Thermomechanical processing of particulate composites
5. Dr S.V. Prasad on 15th October 1985-Friction and wear behaviour of cast Aluminium particulate composites
6. Dr S.V. Prasad on 14th March 1986-Wear of Dual-phase Materials
7. Mr. S.Das on 13th October 1985-Microstructure of Al-Si and Al-Si-graphite composite

LECTURES DELIVERED BY RRL STAFF AT OTHER ORGANISATIONS

Dr S.V. Prasad

1. Wear of Hard Materials by relatively softer abrasive particles, DMRL, Hyderabad, March 5, 1986.
2. Tough composites, DMRL, Hyderabad, March 6, 1986.
26. 3. Abrasive Wear of Materials ISTE, Summer School, MACT, Bhopal, June 19, 1985.

Prof P.K. Rohatgi

1. Solidification of cast metal-discontinuous ceramic particle composites, Massachusetts Institute of Technology, USA, Oct. 18, 1985.

Dr R.N. Yadava

1. Microprocessor based Data Analysis. Summer Institute of Green House and Environmental Control. Central Institute of Agricultural Engineering, Bhopal.
2. Word Processing on microcomputers, at Bhopal University, Bhopal on February 7, 1986.

Dr M. Patel

1. Rasayan Vidya mein Naye Anusandhan (Hindi), All India Radio Bhopal, on 23rd July, 1985.
2. Technology Forecasting and new developments in paper, chloro-caustic industries and Membrane Technology, at Ballarpur Industries Ltd., on 23rd August, 1985.
3. Technology Forecasting on paper, Chloro-caustic Industries and Membrane Technology, at Thapar Industries Ltd., Yamunanagar, Haryana on 1st Oct., 1985.

SEMINARS/WORKSHOPS

1. RRL Bhopal was associated in the 2nd Second National Symposium on "Industrial Applications of Composites", held under the auspices of Indian Society for Composite Materials, ISCM at Bhopal on September, 27-28, 1985. Shri A.C. Khazanchi, Scientist-in-Charge delivered a special talk on Plant Materials of M.P. for low cost housing and Dr S.V. Prasad, Head, Materials Division, and Dr Navin Chand, chaired technical sessions during the deliberations.
2. RRL Bhopal participated in the Workshop-cum-Exhibition on Science and Technology for rural Madhya Pradesh, held at Bhopal, on February 22nd, 1986.

A special **pavilion** was put up to depict various research activities of RRL Bhopal. Prominent amongst a large number of visitors to the pavilion were Shri Motilal Vora, Hon'ble Chief Minister of M.P. and Prof. P.K. Jena.

HONOURS AND AWARDS

1. Prof P.K. Rohatgi was elected the Fellow of Institute of Metals, London, U.K.
2. Prof P.K. Rohatgi was a member of the team of scientists which received the NRDC award for the work on coconut thatch roof on August 15, 1985.
3. Prof Ravi Prakash, Consultant, RRL, Bhopal was nominated as Chairman, Section of Splanchnology, for the XII International Anatomical Congress, held at London from 11 to 17th August 1985.
4. U. Banerjee and M.A. Deshmukh, Research Fellows, were awarded Young Anatomist Bursaries by the XII International Anatomical Congress, London, August 1985.
5. Prof Ravi Prakash has been nominated by M.P.C.S.T, as a Member, Advisory Committee to set up Centre for Advanced Studies and Technology in Madhya Pradesh.
6. M.P.C.S.T. has assigned the work of coordinating research pertaining to the effect of MIC on plants, animals and environment to Prof Ravi Prakash.

RESEARCH ADVISORY COUNCIL, RRL, BHOPAL

1. Dr R.V. Tamhankar, *Chairman*
362/2A, Vishrambag,
Sangli - 416 415
Maharashtra
2. Dr T.P. Ojha, *Member*
Director,
Central Institute of Agricultural
Engineering,
Nabi Bagh Berasia Road,
Bhopal - 462 010
3. Dr G.P. Dodeja, *Member*
Group General Manager,
Bharat Heavy Electricals Ltd.,
Bhopal - 462 022
4. Dr T.S. Murthy, *Member*
Director,
M.P. Council of Science & Technology,
E3/3, Arera Colony,
Bhopal - 462 016
5. Prof K.L. Chopra, *Member*
Professor of Physics,
Indian Institute of Technology,
Hauz Khas,
New Delhi - 110 016
6. Prof K.L. Gupta, *Member*
Head, Advanced Centre for Materials
Sciences,
Indian Institute of Technology,
Kanpur - 208 016
7. Dr Anil Sadgopal, *Member*
C/o Kishore Bharati,
P.O. Bankheri,
Dist. Hoshangabad-461 990
8. Mr Vinay Shanker, *Member*
Secretary to Govt. of M.P.
Department of Science & Technology,
Vallabh Bhawan,
Bhopal

- | | |
|---|---------------|
| 9. Dr D .Chakravorty,
Advanced Centre for Materials Sciences
Indian Institute of Technology,
Kanpur - 208 016 | <i>Member</i> |
| 10. Dr P. Ramachandra Rao,
Department of Metallurgy,
Banaras Hindu University,
Varanasi - 221 005 (U.P.) | <i>Member</i> |
| 11. Prof (Miss) P. Bajaj,
Department of Textile Engineering,
Indian Institute of Technology,
Hauz Khas,
New Delhi - 110 016 | <i>Member</i> |
| 12. Shri P.K. Pal,
Technical Manager,
MECON,
Hinoo, Doranda,
Ranchi - 834 002 | <i>Member</i> |
| 13. Director General,
CSIR
or
His nominee | <i>Member</i> |
| 14. Director,
RRL, Bhopal | <i>Member</i> |
| 15. Chairman,
Coordination Council for Engineering Sciences | <i>Member</i> |

EXECUTIVE COMMITTEE RRL BHOPAL

- | | |
|---|--------------------------------|
| 1. Director | <i>Chairman</i> |
| 2. Dr G.P. Dodeja,
Group General Manager,
Bharat Heavy Electricals Ltd.,
Bhopal | <i>Member</i> |
| 3. Dr K.L. Chopra
Professor of Physics,
Indian Institute of Technology
Hauz Khas,
New Delhi - 110 016 | <i>Member</i> |
| 4. Dr Anil Sadgopal
C/o Kishore Bharati,
P.O. Bankheri,
Hoshangabad - 461 990 (M.P.) | <i>Member</i> |
| 5. Dr C.B. Raju
Scientist,
RRL, Bhopal | <i>Member</i> |
| 6. Shri P.D. Ekbote
Scientist,
RRL, Bhopal | <i>Member</i> |
| 7. Dr A.H. Yegneswaran
Scientists,
RRL, Bhopal | <i>Member</i> |
| 8. Administrative Officer
RRL, Bhopal | <i>Member
(ex-officio)</i> |
| 9. Finance & Accounts Officer,
RRL, Bhopal | <i>Member
(ex-officio)</i> |

MEMBERSHIP OF COMMITTEES OR SCIENTIFIC SOCIETIES IN INDIA OR ABROAD**Dr P.K. Rohatgi**

- Fellow, American Society for Metals
- Director, M.P. Urja Vikas Nigam Ltd., Bhopal
- Fellow, The Institution of Engineers (India)
- Fellow, Institute of Ceramics (India)
- Life Member, Indian Institute of Metals
- Member, Board of International Editors, Technological Forecasting and Social Change International Journal, USA
- Member, ASM Historical land mark Selection Committee, USA
- Member, Editorial Board, ASIA 2000
- Member, Editorial Advisory Board, Current Literature Science of Science, CSIR
- Member, Solidification Committee, American Institute of Mining and Metallurgical Engineer, USA
- Member, Editorial Board of "Composite Materials Science", U.K.
- Member, Editorial Board, Journal of Scientific Research, Bhopal
- Member, National Steering Committee on Composite Materials
- Member, Academic Council of the Roorkee University
- Co-opted member of the Academic Council of the Bhopal University
- Member, Technical Committee, "International Conference on Aluminium" 1985
- Member of the Metals and Materials Committee of CSIR
- Member, Institute of Indian Foundrymen
- Fellow, Institution of Metallurgist, London
- Member, ASM Committee on Composite Materials (USA)
- Member, Editorial Boards of J. Materials for Energy (USA)
- Member, High Temperature Materials (UK)
- Member, Metallurgical Transactions (USA)

Dr Ravi Prakash

- Life Member, Zoological Society of India
- Life Member, Zoological Society of London
- Life Member, Indian National Science Congress Association
- Fellow of the Association of Zoologists (India)
- Fellow of the Zoological Society of London

Dr S.V. Prasad

- Member, Alpha Sigma Mu
- Member, Sigma Xi
- Member, Metallurgical Society of AIME
- Member, Indian Institute of Metals

Dr M. Patel

- Member, American Clay Minerals Society
- Member, Electron Microscopic Society of India
- Member, Indian Ceramic Society
- Member, Editorial Boards, International Journal of X-ray Spectrometry

Dr Ram Narayan

- Member, Computer Society of India
- Member, Institute of Indian Foundrymen

Dr T.K. Dan

- Member, Indian Ceramic Society
- Member, Institute of Indian Foundrymen

Dr A.H. Yegneswaran

- Member, Aluminium Association of India
- Associate Member, Institute of Indian Foundrymen
- Life Member, Metallurgical Society, Indian Institute of Science, Bangalore
- Member, Indian Society for Composite Materials.

Dr C.B. Raju

- Member, Indian Ceramic Society

Mr A.K. Jha

- Member, Powder Metallurgy Association of India

Mr K.K.S. Gautam

- Member, Institute of Electronics and Telecommunication Engineers (IETE)
- Member, Indian Physics Association, Bombay Chapter
- Member, Electron Microscopic Society of India

Mr R. Asthana

- Member, Aluminium Association of India
- Associate Member, The Indian Institute of Metals

Mr O.P. Modi

- Member, Society for Advancement of Electrochemical Sci. & Tech, Karaikudi

Mr S. Das

- Member, Institute of Indian Foundrymen

Mrs Savita Gulati

- Member of the Indian National Science Congress Association

Mr Udayan Banerji

- Member of Zoological Society of India
- Member of International Anatomical Congress Association

Mr Anwar Deshmukh

- Member, International Anatomical Congress Association
- Member, Zoological Society of India

STAFF AT RRL, BHOPAL

S.No.	Name/Designation	Area of interest
<i>Director</i>		
1.	Prof. P.K. Rohatgi B.Sc. (Met), BHU D.Sc. (MIT, USA)	Materials Science, Metallurgy Technology Forecasting, Solar Energy
<i>Scientist-in-Charge</i>		
2.	Shri A.C. Khazanchi M.Sc., B.Sc. (Engg) London A.C.G.I. (London)	Civil Engg, Building Materials, Foundation, Cement Concrete
<i>Scientist-E-I</i>		
3.	Dr S.V. Prasad M.E. (IISc., Bangalore) D. Phil (Sussex)	Composite Materials, Interfaces, Friction and Wear of Materials
4.	Dr M. Patel Ph.D (IIT, Delhi) D. Sc. (Univ. of Paris, France)	Ceramics, Surface Science Industrial and Mineral Chemistry
<i>Scientist-C</i>		
5.	Dr. RamNarayan Yadava Ph.D (IIT, Bombay)	Maths, Fracture Mechanics, System Analysis and Computational Mechanics
6.	Dr T.K. Dan Ph.D(Calcutta Univ.)	Ceramics, Composite materials

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|---|---|
| 7. Dr A.H. Yegneswaran,
Ph.D (IISc., Bangalore) | Metal Processing Deformation and
Texture |
| 8. Dr C.B. Raju
Ph. D (LPI, USSR) | Ceramic materials |
| 9. Dr. C.S. Narendranath
M.E. (IISc., Bangalore)
Ph. D (IISc., Bangalore) | Solidification of S.G. Iron Sand
Systems and Die Casting |
| 10. Dr. Navin Chand
Ph.D (IIT, Delhi) | Polymer, Composite and Natural
Fibres |
| <i>Scientist-B</i> | |
| 11. Shri K.K.S. Gautam
B.E. (Raipur) M. Tech (Bhopal) | Electronics, Instrumentation |
| 12. Shri P.D. Ekbote
M.E. (Nagpur Univ.) | Chem. Engg. Metallurgy, Management |
| 13. Shri A.K. Jha
M. Tech. (IIT Kanpur) | Powder Metallurgy |
| 14. Shri S. Das
M. Tech. (IIT Kanpur) | Rapid solidification |
| 15. Shri K.K. Verma
B.E. (Durgapur)
(Upto 15.7.1985) | Civil Engineering |
| 16. Shri Rajiv Asthana
M. Tech. (IIT Kharagpur) | Metallurgy, Process Modelling |
| 17. Shri O.P. Modi
M. Tech. (IIT Kanpur) | Corrosion and Deformation |
| 18. Shri A. Sanadi
M.Sc. (Univ. of Toronto) | Reinforced plastics |
| 19. Dr (Ms) Mohini Saxena
Ph.D (Bhopal Univ.) | Electro analytical chemistry |
| 20. Dr. A.K. Ray
Ph. D (Calcutta Univ.) | Inorganic chemistry |
| 21. Shri B.K. Prasad
M. Tech. (IIT Kanpur) | Metallurgy |
| 22. Shri A.K. Gupta
M. Tech. (BHU) | Metallurgy |
| <i>Scientific Assistants</i> | |
| 23. Shri A. Banerjee
B. Tech. (BHU) | Materials Science, Composites |
| 34. (On leave) | |

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|--|--|
| 24. Shri S.S. Amritphale
M.Sc. (Vikram Univ.) | Chemistry |
| 25. Shri B. Kujur
B.Sc. (Ravishankar Univ.) | Chemistry |
| <i>Technical Assistants</i> | |
| 26. Shri Venkateswarlu Karodi
L. Met. E | Metallurgy |
| 27. Shri Prakash K. Khade
Dip. Elect. Engg.
(Upto 4.4.1985) | Electrical Engineering |
| <i>Consultants</i> | |
| 28. Dr Ravi Prakash
M.Sc., Ph.D, D.Sc. | Life Sciences, Biological
Materials |
| 29. Shri S.C. Arya,
B.Sc.(Engg) (BHU) | Metallurgy |
| 30. Shri U. Mohan Rao
B.Sc. (Engg) (BHU) | Metallurgy |
| 31. Dr S.D.N. Tiwari
Ph.D | Forestry and Systematic
Botany |
| <i>Research Officers (on DST sponsored project)</i> | |
| 32. Shri G. Char
B. Tech. (Raipur Univ.)
(Upto 28.2.1986) | Metallurgy |
| <i>Pool Officers</i> | |
| 33. Dr (Mrs) M. Maheshwari
Ph.D (Roorkee Univ.)
(Upto Jan. 1986) | Organic Chemistry |
| 34. Dr (Ms) Pushpa Agrawal
Ph.D (Ravishankar Univ.) | Microbiology, Industrial Pollution |
| 35. Dr R.N. Sharma
Ph.D (BIT, Pilani) | Physical chemistry |
| <i>Research Associates</i> | |
| 36. Dr S.M. Misra
Ph.D | Limnology |
| <i>Sr. Research Fellows</i> | |
| 37. Mrs Savita Gulati
M.Sc. (Meerut Univ.) | Zoology |
| <i>Jr. Research Fellows</i> | |
| 38. Shri Udayan Banerji
M.Sc. (Bhopal Univ.) | Life Sciences, Endocrinology |

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|--|-------------------------------------|
| 39. Shir Anwar Desmukh
MSc. (Bhopal Univ.) | Life Sciences, Collagens |
| 40. Shri Avinash C. Karera
M.Sc. (Bhopal Univ.) | Chemistry |
| 41. Ms. Anju Gupta
M.Sc. (Bhopal Univ.) | Chemistry |
| 42. Shir Ajay Gawhad
B.E. (Raipur) | Metallurgy |
| 43. Shri B.R. Pati
B.E. (Kharagpur)
(Upto 20.4.1985) | Civil Engineering |
| 44. Shri Rajesh Gupta
B.E. (Bhopal Univ.) | Mechanical Engg. |
| 45. Ms. Sudha Verma
M.Sc. | Inorganic Chemistry |
| 46. Ms. Prasanna Kumari
M.Sc. | Physical Chemistry |
| 47. Shir R.K. Morchale
B.E. (Bhopal Univ.) | Civil Engineering |
| 48. Shir V.K. Jain | Civil Engineering |
| 49. Shri Navindra Pal Singh
M.Sc., M. Phil | Solid State Physics |
| 50. Mrs. Gita Choudhary
B.E. (Upto 12.8.1985) | Electrical Engineering |
| <i>Graduate Trainees</i> | |
| 51. Shri J.K. Jain
M.Sc. (Bhopal Univ.)
(Upto 14.6:1985) | Geology |
| 52. Shri A. Khare
M.Sc. (Bhopal Univ.) | Geology |
| 53. Ms J. Sreenivasan
B.Sc. (Left) | Computer Programming |
| 54. Ms. Padma Swamy
M.Sc. | Inorganic Chemistry |
| 55. Shri P.K. Shrivastava
M.Sc., M. Phil. | Chromotography, Inorganic Chemistry |
| 56. Ms. S. Jain,
36. M.Sc., (Upto 12.8.1985). | Geology |

Technical staff

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|--|---------------------------|
| 57. Shri S.K. Tiwari
B.Sc. (Library Science) | Jr. Librarian |
| 58. Shri N. Saha, B.Sc.
Diploma in Draughtsman (Mech.) | Draughtsman |
| 59. Shri R.K. Gurjar | Laboratory Assistant |
| 60. Shri Abhay Kumar | Roneo Operator |
| 61. Shri Prem Nath Patil | Laboratory Assistant |
| 62. Shri Akhtar Ullah | Jr. Electrician |
| 63. Shri Mani Ram Sharma | Helper |
| 64. Shri Bhaiyalal Pradhan | Helper |
| 65. Shri Madanlal Gujar | Plumber |
| <i>Administrative staff</i> | |
| 66. Shri K.L. Jain
B.A. | Administrative Officer |
| 67. Shri M.A. Baig
Dip. Com (Govt) | Fin. & Accounts Officer |
| 68. Shri N.C. Chakravarty
B.A. (Upto 15.1.1986) | Section Officer |
| 69. Shri Anil Kumar, B. Sc. | Section Officer |
| 70. Shri R.K. Bajaj
B.A. | Stores & Purchase Officer |
| 71. Shri Omman Panicker
B.A. Adm. Management | SPA to Director |
| 72. Shri T.P. Prasannan
B.A. | Sr. Stenographer |
| 73. Shri A. Kulshreshth
B.Sc. LLB., Diploma in
Hotel Reception and
Book Keeping | Receptionist |
| 74. Shri M.L. Sharma
B.P. Ed. (transferred) | Security Assistant |
| 75. Shri R.N. Ram | Assistant (Admn) |
| 76. Shri Dharendra Kumar
(Upto 5.7.1985) | Assistant (F&A) |

77. Ms. Shyamala K.	Jr. Stenographer
78. Shri R.P. Kapoor	U.D.C.
79. Shri A.N. Malla (Upto 30.4.1985)	U.D.C.
80. Shri P.K. Sathyanesan	L.D.C.
81. Shri Grish Chand	Telex Operator-cum-LDC
82. Shri Arun Saxena	Guest House Keeper
83. Shri D.M. Chilbule	Purchase Assistant
84. Shri Ashok Tayade (Upto Feb. 1985)	Store Assistant
85. Shri Mohd. Rafiq	Staff Car Driver
86. Ms. Asha Trivedi	LDC (Hindi)
87. Shri Jaipal Kujur	LDC
88. Shri R.N. Sharma	Store Attendant
89. Shri N.S. Jadav	Messenger
90. Shri Vijay Kumar	Messenger
91. Shri Harihar Singh	Watchman
92. Shri Anil Kumar	Messenger
93. Shri Sunil Kumar	Safai Karamchari
94. Shri Ramdayal Suryawanchi	Driver-cum-Cleaner